THE IMPACT OF PACKAGING INNOVATIONS ON THE SUPPLY CHAIN

THESIS

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By

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DEDICATION

To my family, who taught me the right values to succeed in life.

AKNOWLEDGEMENTS

I would like to thank Dr. Cecilia Temponi, my chair and editor; without her none of this would have been possible. I thank her also for her understanding when it was not understandable. Thank you to Dr. Zank and Dr. Trinidad for their support. Last but not least, I would like to thank God, for giving me my wonderful parents and siblings.

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ABSTRACT

THE IMPACT OF PACKAGING INNOVATIONS ON THE SUPPLY CHAIN

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Continuous packaging innovation within companies leads to many activities related to the supply chain that should be optimized. These changes and innovations are the result of strategies and objectives that companies must focus on to remain competitive. Strong competition is the result of today's global market economy. In addition, customers' expectations have increased. Therefore, the product's life cycle has been decreasing, leading to changes in product presentation and/or formula because companies have found that packaging plays an important role in a variety of issues, such as the consumer selection process, cost reduction, and research and development applications. Consequently, the traditional manufacturing model of mass production and long production runs is being re-engineered and re-structured to improve each firm's competitiveness in this new environment.

A hypothetical scenario of a company facing the different challenges such as SKU proliferation and higher storage area needs is presented. A feasible solution is provided to overcome some of these challenges. Recommendations are given to improve the supply chain flow of materials and information within and outside the company. By improving

the different interactions among the different components of the supply chain, and by reducing the problems that arise when the packaging innovations and changes are implemented in an organization, companies improve their customer service, reduce the related cost of inventory management, and avoid unwanted write-offs of old materials. Future success and longevity of the company will be based in its ability to handle and foresee the different issues faced in an environment where customers' expectations regarding product quality and services continually increase.

CHAPTER I

INTRODUCTION TO THE STUDY

Description of the Problem

Today's global market economy has resulted in increased levels of competition in an environment where customers' expectations regarding product quality and services continually increase. At the same time, the product's life cycle has been shrinking, leading to more frequent changes in product presentation and/or formula because companies have found that packaging plays an important role in a variety of issues, such as the consumer selection process, cost reduction, and research and development applications. Consequently, the traditional manufacturing model of mass production and long production runs is being re-engineered and re-structured to improve each firm's competitiveness in this new environment.

The pressure from this continuous packaging innovation opens up opportunities within companies to optimize processes related to their supply chain. This thesis studies and presets a case solution of the impact of continuous packaging innovation on strategies and objectives that companies must address in order to remain competitive in this new environment.

At this point in time, the marketplace is full of new packaging innovations, such as color, shapes, materials, labels, corrugates, and displays. Just as a manufacturing organization must have the capability to respond to changes within the production system, the supply chain participants must be able respond to changes resulting because of package changes. For instance, a change in product formula often results in a redesign of the packaging in order to inform the consumer of the change in formula. Changes are also necessary when a new regulation either requires a new kind of packaging or description label. Many participants in the supply chain may be affected by this package change.

The ensuing product proliferation is one of the main issues facing every buyer and planner in any company. Buyers and planners are squeezed between proliferating SKUs *(stock-keeping unit)* and demands by retailers and every other point in the supply chain. To move to just-in-time deliveries and minimize inventory, manufacturers are pressured to schedule more frequent, shorter production runs (Forcinio 2001).

In addition, product proliferation creates problems and challenges through the supply chain and distribution channels. These complications can be divided into internal problems and external problems. The internal problems consist of mainly the delays, re-processing, and misunderstandings that can occur while both the old and new product specifications are being processed, stored, and delivered; but one problem that usually is forgotten is the destruction and write off of the old presentation inventories, decreasing the operation profit of the company.

External problems result from internal mistakes that could lead to trademark confusion such as the consumer finding the same product in two different packages. An additional external problem is the detriment in the customer satisfaction (retailer). Therefore, integrating the purchasing and logistics process with other key corporate processes creates a closely linked set of manufacturing and distribution processes. It allows firms to deliver products and services to both internal and external customers in a more timely and effective manner (Choon Tan 2002). This could help to prevent the problems mentioned above.

Objectives

The main objectives of this paper are:

- To study the supply chain process as it relates to packaging innovations.
- To recommend a process that can improve the performance of inventories, production runs, and purchasing policies through the supply chain when a product undergoes specification changes.
- To provide recommendations that can be used for any company facing problems caused by product innovations or changes, and the resulting improvement throughout the supply chain components.
- To suggest ways to reduce the amount of financial loss companies assume when there are inventory leftovers that cannot be used in any other product, and are therefore destroyed.

- To illustrate the impact of packaging innovation in the supply chain with an example of a hypothetical situation and feasible solution for it.

Definitions of the Terms

The following terms are defined for clarification purposes. Understanding these terms will assist in the appropriate interpretation of forthcoming theories and models. These terms will be presented in alphabetical order.

- Lead Time: The time that elapses between materials are ordered and when they arrive to the plant and are available for use.
- Kanban: A Japanese word meaning "visual record." Typically attached to a container, kanbans are used as a control tool to trigger replenishment. Kanban is therefore a technique to manage the flow of parts according to the rules of Just-in-Time production. These rules basically emphasize the use of a pull replenishment logic system for the production of the right items in the right quantity at the right time. Furthermore, by reducing the number of cards in the system, kanban can facilitate problem identification and thus be an important tool in a continuous improvement process. (Chausse et al. 2000).
- MRPII: a term developed in the 1970s from MRP (materials requirements planning), meaning "a computerized information system for integrating all business functions and for planning and controlling all company resources" (Brown 1994).
- Packaging: The degree of protection needed to protect the product from damage and climatic conditions, dimensional considerations to fit unitized loads such as

warehouse pallets, and labeling identification for automated barcode scanning (Handfield et al. 2002).

- Physical Density: This is the ratio of cubic volume to weight. The ratio determines the cost of transportation and storage. Products with high volume-to-weight ratios are costly both to transport and store. Such products are best produced closer to the user locations in order to reduce transportation and storage cost (Handfield et al. 2002).
- Picking area layout: A rack area where every SKU (see below) has a designated position. At this position the picking process is done by operators when the order requested by a client is lower that the number of cases in an entire pallet.
- Pull System: A system that works on the basis of constraints management and kanban-type work request signals. Once an operation is found to be a line constraint, work begins to improve its throughput and cycle time. Work that may be offloaded to other operations is taken away from the constraint, and the production effort at the constraint operation becomes highly focused. Parts and other inputs to the process are made readily available so that the constraint is able to work in its most efficient manner (Herbert 1996).
- SKU: stock-keeping unit
- Transportation and Handling: The characteristics of the product that make it transportable with ease of handling and stowability (Handfield et al. 2002).

Methodology

This theoretical exploratory study will review the latest files of literature on supply chain management, logistics, distribution channels, and marketing information as they speak about packaging innovation and supply chain. In addition, it will contain observations from five years of work experience gained by the author during his career in manufacturing, marketing, and logistics.

This study will rely primarily on secondary data.

Significance of the Product

By addressing the different problems and challenges that arise when the packaging innovations and changes are implemented in an organization, companies improve their customer service, reduce the related cost of inventory management, and avoid unwanted write-offs of old materials. This is presented with the following examples.

- Transaction cost may be reduced when the supply chain process flows without delay and additional process are eliminated using simple models.
- Designing an effective warehouse flow process provides a competitive advantage and satisfies growing customer demands. Regardless of the design, certain principles remain important.
- Using this information to redesign the warehouse layout based on the pattern of inventory activity and movement creates new insights and a multitude of solutions.

- Inventory cost may be reduced using the pull system because kanban systems attempt to increase the number of shipments and, therefore, decrease the batch sizes. Thus the preference rate of this methodology can vary in different environments, for instance, when the cost of stock is very high and there is an insufficient space in a warehouse (Razmi et al. 1998).
- Compared with traditional processes, pull systems demonstrate a minimum of a 15% reduction in material costs alone. Efficiency at all levels increases, thereby facilitating a 30% to 40% increase in manufacturing (McHugh 1996).
- Of all these factors, the increased customer satisfaction holds the greatest long-term benefit. When customers are assured of receiving the correct configuration, in the correct quantity, and with reduced delivery times, they become tremendously loyal customers (McHugh 1996).

Expected Results

This research work will provide a better understanding of the issues related to supply chain management, distribution channels, and packaging innovation. Furthermore, it will discuss how to handle all the variables related to these important subjects within an organization, its partners, and final clients.

Also, a set of useful recommendations will be provided that will help companies facing issues related to supply chain management. In addition, these recommendations will prevent the occurrence of problems.

CHAPTER II

SUPPLY CHAIN

Supply Chain Management

Supply chain management is a set of approaches utilized to efficiently integrate suppliers, manufacturers, warehouses, distribution centers, and stores so that merchandise is produced and distributed at the right quantities, to the right locations, and at the right time in order to minimize system wide cost while satisfying service level requirements (Simchi-Levi et al. 2000).

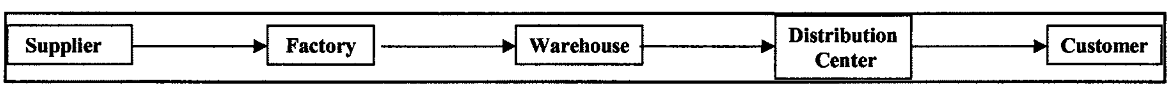

Figure 1. Supply Chain Model

As shown in Figure 1, the supply chain is directly related to every facility within the company that has an impact on cost. Also, the supply chain is a vital instrument to maintain quality in the customers' product and service from the suppliers to the manufacturing facility, from the manufacturing facility to the warehouse, from the warehouse to the distribution center and finally, from the distribution center to the retailers.

Accordingly, the supply chain has an added objective: to provide an efficient and cost-effective structure to support the whole system, being the whole system every stage in the supply chain. Reducing the cost of transportation and distribution of raw and packaging materials, and work-in-process inventories decreases the inherent cost of the finished goods. Hence, the goal is not to purely reduce cost through inventory reductions and in transportation fees, but to integrate a system approach to supply chain management.

Finally, the supply chain efficiently combines suppliers, manufactures, warehouses and distribution centers, and retailers and customers. Improvement in a company's activities is necessary in both strategic and operational stages in order to create supply chain efficiency. This is a process of planning, implementing, and controlling an efficient and cost effective flow and storage of raw materials, in process inventory, and finished goods. Therefore, related information is needed from point-of-origin to point-of-consumption for the purpose of conforming to customer requirements (Simchi-Levi et al. 2000).

Types of Distribution Channels

Distribution channels can be defined simply as the external contractual organization in which firms work to accomplish their distribution goals. All convey the notion of the route, path, or medium through which products flow from the manufacturer to the final consumer. (See Figure 2). As products become less differentiated and more commodity-like, the contest among firms rapidly moves away from products toward accomplishing efficiencies in distribution.

For the majority of service, consumer, and industrial companies, the distribution channel, or outsourcing of agents, wholesalers, distributors, and retailers, plays an important role in the flow of goods from producers to consumers. Because they depend on channel members to resell their products and perform diverse distribution responsibilities, manufacturers are increasingly concerned about the level of performance of these institutions.

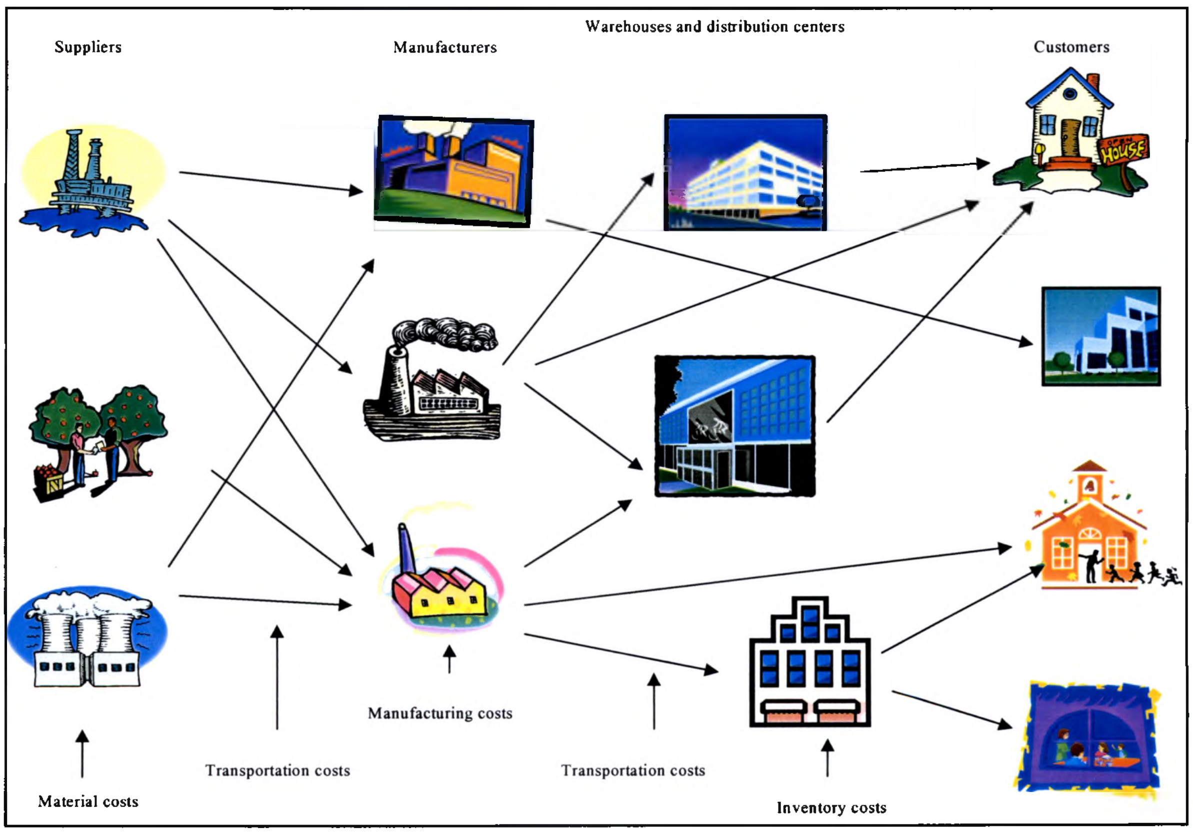

Figure 2. Different Distributions Channels. Source: (Simchi-Levi et al. 2000)

Channel management is the process of analyzing, planning, organizing, and controlling a firm's marketing channels. As is mentioned by Mehta et al. (2000), it includes some key decision areas: preparing channel strategy, designing market channels, selecting channel members, coordinating channel strategy, and evaluating channel member performance. Below is a brief discussion of each one.

Preparing Channel Strategy. Channel strategy encompasses the broad set of principles by which a firm seeks to achieve its distribution objectives. It focuses on the "big picture," such as the role distribution should play in the company's overall corporate objectives and strategies, and the overall congruency between channel strategy and marketing.

Designing Marketing Channels. Channel design includes the development of new channels or the modification of existing channel structures. Distribution channels should be aligned with the firm's overall objectives and competitive strategy. In developing the structure of the distribution channel system, the following areas should be considered: the number of levels in the channel, the amount of intermediaries used, and the types of intermediaries used.

Selecting Channel Members. Once the distribution channel has been designed, channel members must be selected to represent the firm and to resell its products to final customers.

Coordinating Channel Strategy. Distribution channels have conventionally been viewed as a network of dissimilar but interdependent institutions that have banded together for purposes of trade. Scholars have long theorized on the need for coordinating and integrating channel activities with other functional units of an organization.

Evaluating Channel Member Performance. Channel member performance represents the degree to which the channel member engages in behavior that contributes to the fulfillment of the channel leader's objectives (Gaski et al. 1985). Throughout the evaluation of the performance of channel members, companies can evaluate the success of channel implementation strategies, as well see the achievement of their distribution objectives (Mehta et al. 2000). One important way to assess a distribution channel's performance is when companies face too many changes in packaging at the same time, and the supply channel must respond with efficiency and timeliness in order to maintain excellent customer service with the same tools.

Packaging Changes and Innovations

As mentioned previously, the packaging of a product plays one of the most important roles during the consumer selection process. As stated by Young (2002), more than two-thirds of all purchase decisions are made at the shelf. In many categories, far more than 60 percent of shoppers decide which brand to buy when in the store. These realities add up to one indisputable conclusion: the package is the brands' primary selling tool. "An example of the need for a highly flexible supply chain due to continuous change in packaging can be given through the need of a chain to be able to deliver finished goods to the ultimate end-user" (Vokurka et al. 2002).

Packaging, designed initially for protection purposes, now plays a major role in product promotion, because it identifies brands, provides ingredients and directions, and conveys information regarding price, quality and quantity (Gupta et al. 1996) (Aduran, 1995); This is reflected in consumer companies' packaging expenditure from food to drink, which increased 23.3% between 1993 and 1997 in the United Kingdom. The increase can be attributed, at least in part, as a marketing response to the growing number of consumer decisions made in store and packaging changing role from "protector" to "information provider" and "persuader" (Hine, 1995).

Consequently, the packaging of a product is more than the cover or the container. It must grab the consumer's attention by using effective packaging that stimulates the purchase, differentiates between its family of products, is aesthetically pleasing, and is correctly positioned to communicate desired images, appetite appeal, and personality. Moreover, changes in marketing strategy involve modifications in packaging and brand positioning given that the target consumer profile continually changes. As a result, retailer shelf space is more difficult to gain (Young 2002). For these reasons, the supply chain must support all these changes and be as effective as possible to avoid any problem that could hold back any change and/or innovation in packaging.

CHAPTER III

PACKAGING INNOVATIONS

Packaging and Supply Chain Relationship

Increasingly selective customers and an overall decrease in sales are forcing the proliferation of product types and increasing service demands through more channels than ever. For suppliers, managing SKU abundance means more than just eliminating some SKUs. In production, SKU proliferation leads to frequent setups and short production runs, driving up manufacturing costs. But there are more subtle impacts on supply chains. Proliferation of SKUs can cause difficulties in forecasting sales volumes and increase transportation costs (Cook 2001).

As mentioned in Chapter I, there are many business reasons related for packaging innovation and changes, but marketing is one of the most important in countries like Latin America, where the economical situation has driven many companies to expand their portfolios with more and more promotional packs and offers (on-packs, pre-packs, multi packs). Some examples of these kinds of promotions are: “Buy a shampoo and get the conditioner free”, “buy 3 toothbrushes and get 2 free”, “Detergent plus bleach special price 25 off”, etc. The marketing departments of many Latin American companies and foreign companies with operations in these territories have found that promotions are an important way to guarantee the expected sales and to achieve shelf exposure among the major distributors. As a result many companies are implementing a greater number of these special products as regular products.

As a consequence of this event, the number of products (SKUs) has grown faster than ever; hence, the number of packaging materials such as corrugated boxes, individual cases, bags, stickers, and labels have grown as well. The outcome of this growth is an increase in necessary warehouse space for packaging material; work in process (bulk products), and finished goods. The finished goods boxes are even more impacted by these changes, because many of the different products are asymmetrical and when these products are packed into a corrugated box the volume optimization is lower than the space needed by symmetric products. As a result, the product density is higher, demanding more space per corrugated box.

These problems represent a challenge for every step in the supply chain, where the different inventories of packaging and raw material, work in process, and finished goods should be optimized in order to reduce the operation cost and offer the best customer service internally and externally. One of the available tools to undertake these problems is the pull system, in which the product history is analyzed to design its different suggested kanbans for packaging and raw materials, work in process, and finished goods. Thus, the production plant, materials warehouse, and finished goods are balanced. A more thorough explanation about the fundamentals, variables, and expectations of the pull system is explained next.

Pull System

Pull systems work on the basis of constraints management and kanban-type work request signals. Once an operation is found to be a line constraint, work begins to improve its throughput and cycle time. Work that may be offloaded to other operations is taken away from the constraint, and the production effort at the constraint operation becomes highly focused. Parts and other inputs to the process are made readily available so that the constraint is able to work in its most efficient manner. (Herbert 1996)

Pull system works through the supply chain from the suppliers, the production plant, the warehouse, and the distribution center (national sales and inter-company sales) using Kanban control systems. As shown in Figure 3 below, the pull system develops a set of kanban levels for every step in the supply chain.

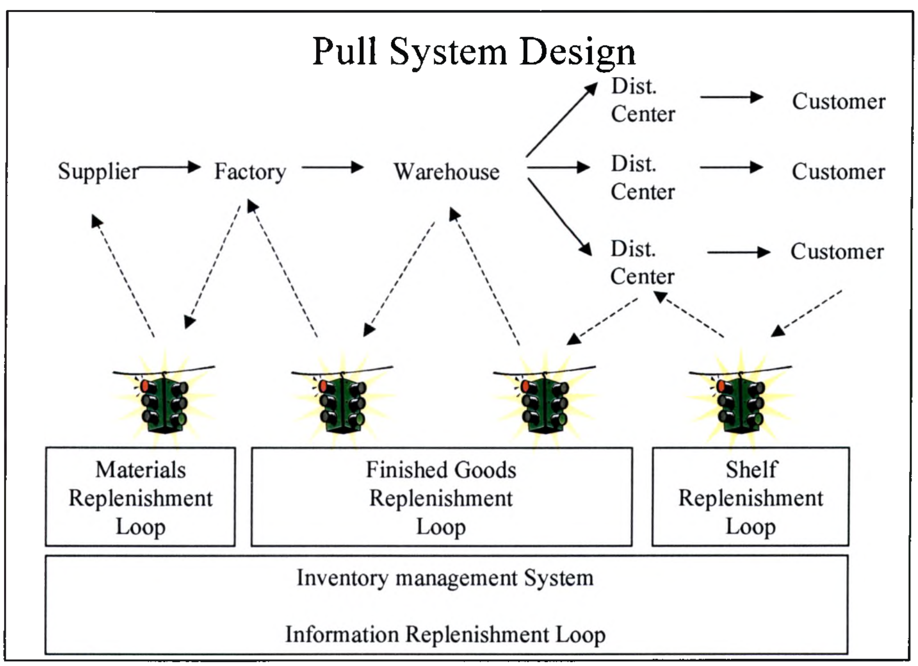

Figure 3. Pull System design through the Supply Chain Model

The kanban is based on the replacement philosophy; the key source of information used to manage the flow of materials is the actual use of completed blocks (purchase order quantity, production runs, and replenishment order) in the supply chain.

Raw and packaging materials: As soon as a block is pulled out of the inventory of raw and packaging materials, a replacement kanban is released to station for a replacement quantity. For example, when a quantity of a packaging material (labels) is taken out of inventory for use on the production line, a replacement kanban is given to the planner-buyer informing him to buy another labels quantity.

Production plant: the same activity is performed if there is no inventory or not enough inventory of a finished good to support a order placed by the warehouse, then the production supervisor must program the production lines with a production run. Therefore, a production can be programmed in function of production runs, and then the supervisor and planner-buyer should agree which is the best decision after analyzing the future forecast of the product and the different SKUs produced in the same production line.

Warehouse-Distribution Center: the distribution center kanbans are designed based on historical sales data, the lead time from the warehouse to the distribution center, the area used, and how the inventory is shipped to the customers. Thus, when the inventory reaches the kanban minimum value, the distribution center informs the warehouse to supply the amount needed in the next delivery.

Once these operations are found to be a line constraint, work is begun to improve its throughput and cycle time. Work that may be off loaded to other operations is taken away from the constraint, and the production effort at the constraint operation becomes highly focused. Parts and other inputs to the process are made readily available so that the constraint is able to work in its most efficient manner.

Project Evaluation

In this paper research an illustrative example is presented explaining the results of packaging changes in the supply chain, a feasible solution is described, this feasible solution exhibits theoretical values of investments and savings, therefore a financial analysis is done in order to show that the solution is no only feasible but also it will bring financial benefits to the company. One of the known project evaluation methods is the Net Present Value (NPV), and was selected because it shows the initial investment and future saving in the future that helps to understand the project benefits. This method will be used to assess the feasible investments and projected savings that will come out as a result of suggested action in the following case. A brief explanation of Net Present Value follows

Net Present Value

The Net Present Value (NPV) equals the sum of the present value of the expected future cash flows of the target company completely independent of any acquisition. The Net Present Value is the preferred method to analyze the potential return for different business opportunities. The NPV is used because it provides a consistent calculation for comparing different choices by converting money amounts from future years into current dollars. The present value is the amount of cash today that is equivalent in value to an amount of cash to be received or spent in the future. To calculate the present value, each future net cash flow is multiplied by a discount factor that is based upon the number of future years and a discount rate (Brigham et al. 2002). The NPV formula follows.

$$\mathbf{NPV = CF_0 + \frac{CF_1}{(1+k)^1} + \frac{CF_2}{(1+k)^2} + \ldots + \frac{CF_n}{(1+k)^n}}$$

CHAPTER IV

MODEL DESCRIPTION

Supply chain activity is the behavior of a very complex system involving many parties, whose decision-making procedures may be ill chosen or who may act on misinterpretation of true market demand. It is also well known that, as complexity increases, so does the chance occurrence of counter-intuitive behavior. Hence, wherever possible, the supply chain operation should be simplified, rather than complicate it. (Towill et al. 1992)

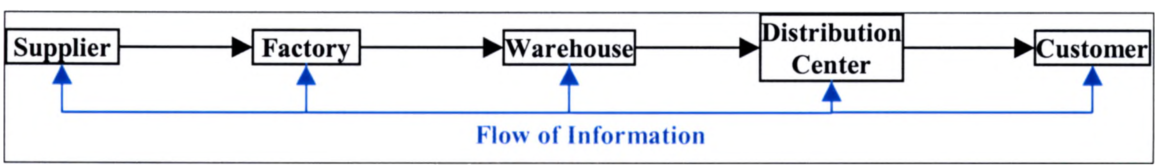

Figure 4: Supply Chain Model (materials and information flows)

This system includes material suppliers, production facilities, distribution services and customers linked together via the feed forward flow of materials, this is the flow of raw and packaging materials from suppliers to the factory, as well as the flow of work in process inventories within the factory, and the flow of finished goods from the factory to the warehouse, distribution center and the final customer. The feedback and feed forward flows of information are an essential element in the quest of improving the supply chain, thus the principal trends in the market can be communicated to every step in the supply chain in order to improve the customer service and reduce the handling inventory costs (See Figure 4). This model was selected because as it is mention by Towil et all (1992) wherever possible, we need to simplify supply chain operation, rather than complicate it that is the situation needed by the company in order to improve the customer service, reduce the handling inventory cost, and improve the flow of information among the different participants of the company's supply chain.

Illustrative Example

The selected company for this example is a consumer products firm located in Cali, Colombia (Southwest). The principal trade areas of this company are: Central Area (Bogotá), Antioquia, North Coast, and Southwest. In addition the company exports and imports products from different subsidiaries around the world, such as China, Mexico, Venezuela, Brazil, and Switzerland. The principal products traded in this country are oral care products (toothbrushes, toothpaste, and dental floss), detergents (powder and liquid), toilet soaps, surface cleaners, shampoo, and dishwashing cream. The illustrative example was selected because the firm has experienced the different challenges that may arise when a SKU proliferation situation occurs. The example also illustrates how to handle a difficult business situation.

Main Problem

The Colombian economical crisis has forced many consumers to buy low price products, creating a tough environment for every company without exception; this is the main reason why many consumer companies have launched new products and promotions. These kinds of products are described in Chapter 2.

As a result of these new products, the company experienced a SKU proliferation; the number of SKUs grew from a hypothetical number of 350 to an estimated number of 600 in two years. This situation created an increase in packaging materials such as: labels, cases, corrugated boxes, etc. These kinds of conditions create challenges and problems in every step of the supply chain, including suppliers, factories, and warehouse and distribution centers.

Suppliers: The number of items to be purchased will increase, creating a more complicated situation with suppliers. The needs in storage will increase, in addition to the handling costs.

Factories: When the number of SKUs increases, the factory faces shorter production runs. Shorter production runs will lead to more changes over production that will result in lower plant efficiency

Warehouses and Distribution Centers: These two stages in the supply chain will have to contend with the most urgent problems that need to be addressed. The problems are related to the higher storage space needed by the new SKUs, internal delay and extra costs when the available facilities are not prepared for these changes. In addition, the warehouse and distribution center have to deal with another result of this SKU proliferation: the increase in product density where two different products are packed in the same case or corrugate creating more warehouse space requirements. As illustrated in Figure 6, the empty space among the products with same shape packaged together (Surface Cleaner) is lower than the space among promotional products (Surface Cleaner + Soap).

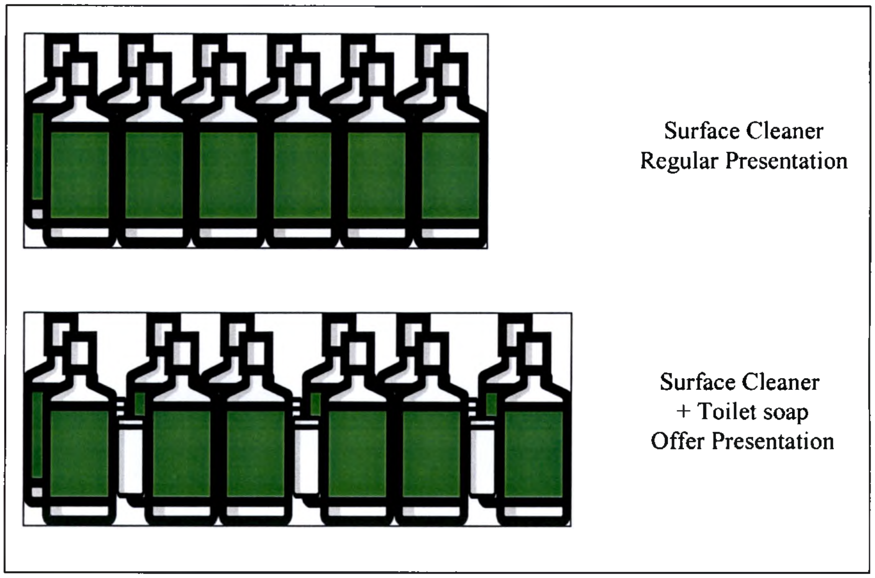

Figure 5: Product Density increase due to promotions products.

This situation also creates an additional executive decision to be addressed. When there is more space inside the corrugated boxes, the corrugated caliber should be higher or the number of lays in a pallet must be reduced. This decision should be analyzed by weighing the corrugated increase cost against additional area needs cost and the additional logistics activities' costs.

Supply Chain's Company Data

The situation described in the previous section created the need for a warehouse storage area bigger than the company had. Therefore, the company had to rent space outside its facilities. The company ended up with the distribution area for the warehousing of finished goods and raw and packaging materials shown in Table 1. Table 1 and Figure 7 illustrate a hypothetical company situation concerning storage area needs and warehouses distribution. The red arrows show the flow of raw and packaging materials while the blue arrows show the flow of finished goods.

Material Type	Total Area*	Company Area*	Rented Area*	% Rented	# Of External W.H.
Finish Goods	33,000	12,000	21,000	64%	5
Raw & Pack. Material	22,000	12,000	10,000	46%	3

*Area in Square Meters

Table 1: Warehouse distribution area

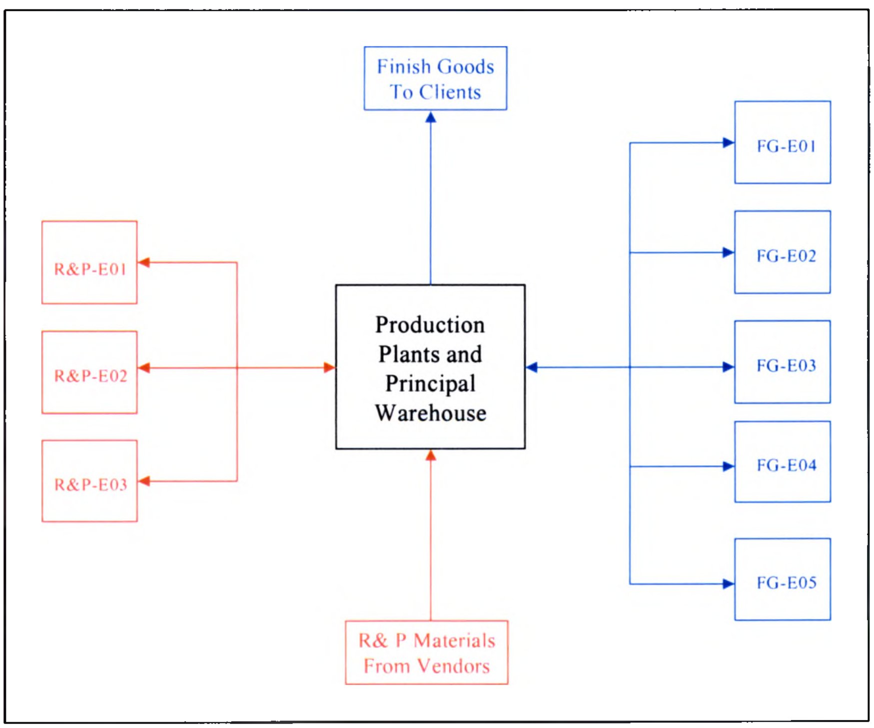

Figure 6: Warehouse Configuration

For safety reasons, the company received and shipped all its raw and packaging materials in the principal warehouse. This regulation created an additional shipping cost, because 64% of the finished goods were located in external warehouses and had to be transported from the principal warehouse to the external warehouses and moved back to the principal when the products were requested by a purchase order from the clients. This was a 128% round trip for finished goods and 92% for raw and packaging materials.

The operation described above created continuous delays in the loading operations, due to the fact that there were only 18 docks and 15 of them were used for loading while the other three were used for loading and unloading of products to and from external warehouses. Additional data concerning the company's supply chain is shown in Table 2.

Variable	Value	Notes
Number of SKU:	600	Including regular products and promotions
Maximum loading capacity:	700 tons per day	
Average Sales:	550 tons per day	
Average Sales during the last week of a month:	1.000 tons per day.	This 90% of increment in sales during the last week of the month is due to the increase in orders submitted by the sales force in order to achieve its goals.
Production rate	1 pallet per minute	
The average cases per pallet	80 (cases/pallet)	
Number of pallets per single position without racks	2.3 (pallets/position)	
Inventory average in pallets:	55,000 pallets	
Positions needed with this inventory:	29,913 single positions	
Relation single	1.45 (include	Based on the pallet and forklifts

position to square meter:	hallways and docks area)	used by the company

Table 2: Company's Data

Feasible Solution

A solution for this situation would be the construction of a separate warehouse where the whole finished goods inventories would be located, and from this facility the client orders would be loaded and shipped. The raw and packaging materials would be located in the actual principal warehouse; therefore external warehouses for this kind of inventory would not be needed and the raw and packaging material will be located in the closest place to the production facility. See Table 3 and Figure 8 for the proposed changes.

Material Type	Total Area*	Company Area*	Rented Area*	% Rented	# Of External W.H.
Finish Goods	33,000	**33,000****	0	0%	0
Raw & Pack. Material	22,000	22,000	0	0%	0

*Area in Square Meters

** Required Investment

Table 3: Warehouse Distribution Area (feasible solution)

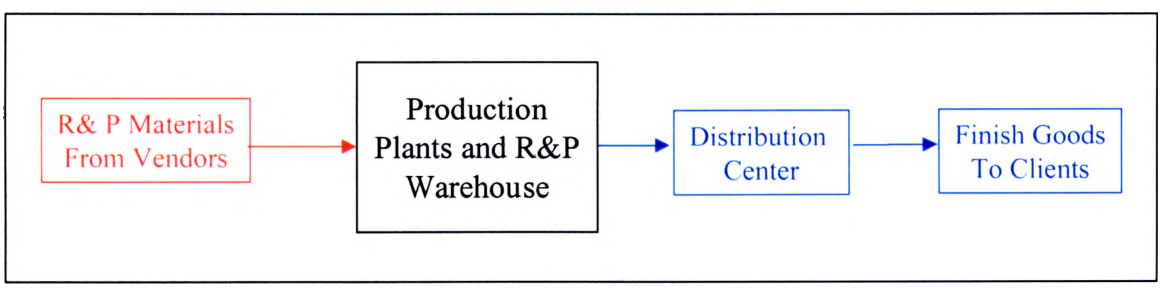

Figure 7: Proposed Supply chain model

Using the information above a feasible solution for this particular case is provided. First the finished goods area needed in square meters should be calculated. (29,913 single positions * 1.45 sqm/single position = 34,674 sqm) Then the internal warehouse flow should be decided; in this case an unloading area is suggested at the backside of the warehouse while the loading operation is performed at another side. Therefore, there is no interaction between intracompany transactions (internal) and customer related transactions. In relation to the internal distribution, the best storage philosophy would be the fixed location. This philosophy states the every SKU should have a designated location either in the storage area or in the picking area (McKnight 1999).

The picking area layout is a rack area where every SKU has a designated position. At this position the picking process is done by operators when the order requested by a client is lower than the number of cases in an entire pallet. The picking area layout should be integrated with the inbound and outbound flow. An efficient layout minimizes handling, maximizes space utilization, and reduces backtracking. The distance to other areas in the warehouse, such as reserve storage, must be considered in the layout design. Two layout alternatives include unshaped and straight-through flow (Saenz 200).

In addition, groups and categories should separate the products. For instance, the oral care products should be grouped in the same area. Likewise, products of high rotation should be organized closer to the docks than products with low rotation rates. Figure 8 shows how the products were ranked with the letters A, B, and C, with A being the products with highest rotation and C the lowest rotation. These items rank equally in terms of pick frequency and the associated travel time to pick. In relation to pick-to-order potential, there is no end in sight to the pick to-order trends and growth in SKUs impacting consumer products warehouses. The key to adapting to these changes is having the data available to analyze the details of side-bay load history and pick-to-order customer invoice detail. Using this information to rethink the warehouse layout based on the pattern of inventory activity and movement will create new insights and a multitude of solutions (Kibort 1999). The suggested layout for the new distribution center shown in Figure 8 would increase the loading capacity and reduce the current loading time. Consequently, the new operation capacity would be higher using the current number of operators.

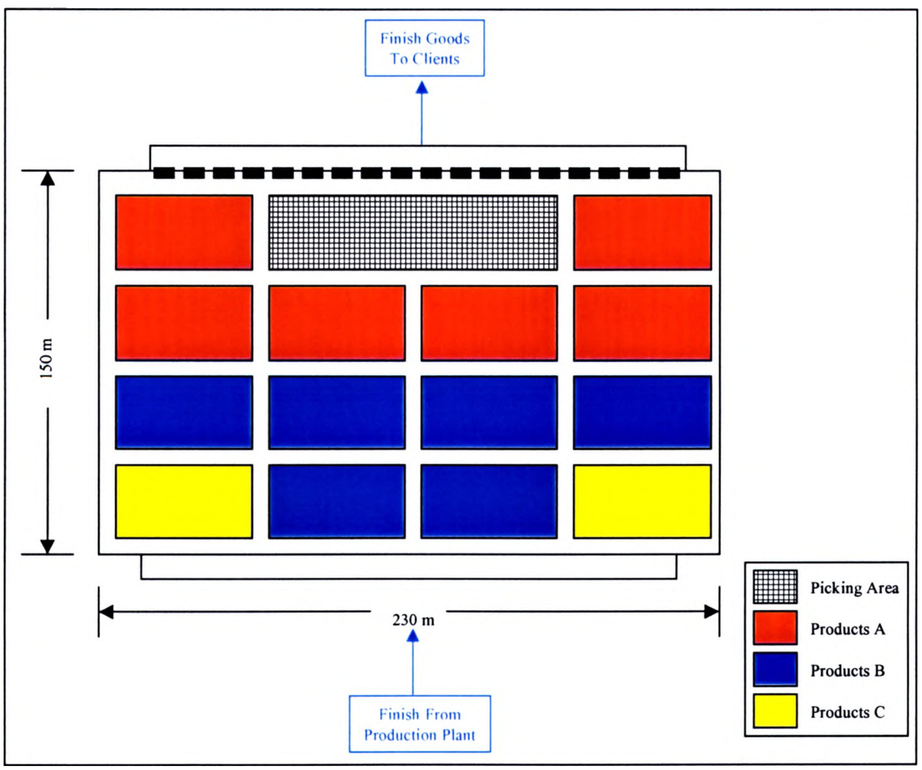

Figure 8: Distribution Center layout suggested.

Results Analysis

Required Investment: The required investment in this alternative consists of the construction of a new distribution center, and the supposed average cost per square meter of warehouse in Colombia including racks, offices, sprinklers, dock levers, and other devices is $130 dollars per square meters. The total cost for this investment would be $4,485,000 dollars.

Savings:

Rented Space: The company would not have to rent space after the construction of the new warehouse, for neither finished goods nor raw and packaging materials. With the actual distribution the company pays a supposed value of $3.7 dollars per square meter monthly. If the company rents an average of 31,000 monthly, the saving value would be $114,814.81, and $1,377,777.78 annually. See Table 4 below.

Current Situation	Proposed Solution	Notes
Rented area: 31,000 Cost per SQM: $4.44 Monthly Cost: $114,814.81 Annual Cost: $1,377,777.78	Rented area: 0 Cost: 0	The company will save this amount of money because they will not use external warehousing with the proposed situation

Table 4: Rented space savings

Finished Goods Intracompany Freights: Given the current situation, 127% of finished goods are transported (round trip) using external warehouses. The number of pallets transported during a year is approximately 523,037. With this proposal, 100% of the finished goods would be transported, and 27% of the finished goods represent

111,197 pallets less to be transported. The supposed average cost of freight between the warehouses is $66.67 per freight. Each freight can carry 32 pallets so 111,197 pallets represent 3,475 freights and savings of $231,660 per year. See Table 5 below.

Current Situation	Proposed Solution	Notes
% Pallets transported: 127%	% Pallets transported: 100% 27% pallets: 111,197 pallets 32 pallets per truck 3,475 freights Cost $66.67 per freight $231,660 savings annually	100% of Finished goods will be transported to the new distribution center

Table 5: Finished goods intracompany savings

Raw and Packaging Materials Freights: With the proposed distribution the whole raw and packaging material inventory would be stored in the principal warehouse, therefore, the cost of freights would be totally reduced. With the current situation, 92% of the raw and packaging material is transported between the principal warehouse and the different external warehouses. This represents a movement of 21,402 pallets per month and 256,839 pallets annually; the cost of moving this inventory is $535,080 per year. See Table 6 below.

Current Situation	Proposed Solution	Notes
% Material transported: 92%	0% Pallets transported 21,402 pallets per month 256,839 pallets annually 32 pallets per truck 8,026 Freights Cost $66.67 per freight $535,080 per year	100% of Raw and Packaging Materials will be located in the production plant

Table 6: Raw and Packaging Materials Freights savings

Additional Benefits: During the last week of the month the increase in orders shown in Table 2 can be supported and customer satisfaction would not be affected. In the current situation, low capacity and delays have led to a lower level of customer service.

Financial Analysis

The required investment is $4,485,000.00 and the projected annual savings for the company is $2,144,518.24. If we analyze this project from a 5-year standpoint, the result will be a Net Present Value of $2,877,304.74 dollars, using a 14% interest rate.

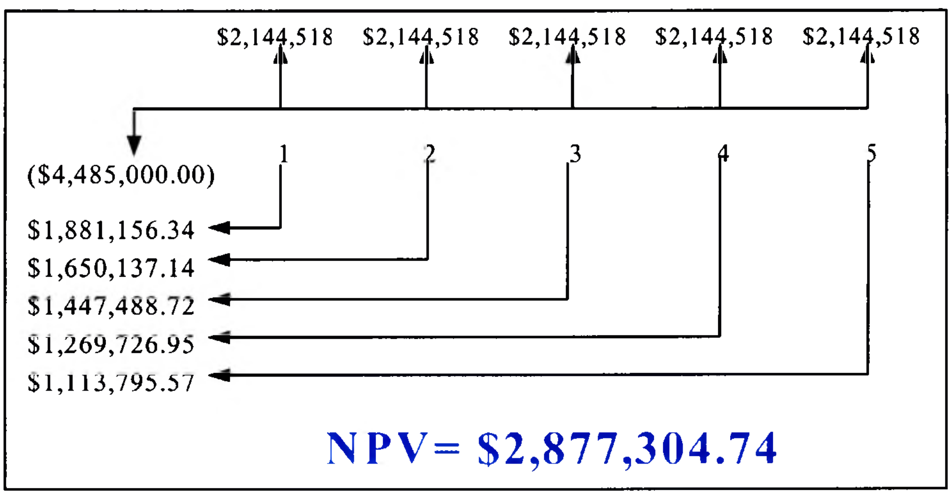

Figure 9: Net Present Value Values and Calculation

CHAPTER V

RECOMMENDATIONS

Pull system implementation using kanbans analysis for each SKU and its components must be calculated in order to improve customer service to suppliers and retailers and find possible savings issues in storage area and inventory expenses. This analysis is recommended in the distribution-production loop, as well as the raw and packaging materials. The staff in charge of the decisions related to buying, producing and distributing should pay attention to the sales trends and maintain constant communication with the sales and marketing departments. Sales and marketing departments must inform supply chain staff of the strategies and decisions that could influence the demand and update future forecasts of new discounts (offers) or special events. This information is significant in order to update pull system variables (kanbans). The interaction and constant tracking of the sales behavior may prevent future problems related to the lack of inventory or the overstock of finished goods and raw and packaging materials. These two issues affect the company's performance and are clarified next.

The primary issue refers to the lack of inventory that can damage customer relations if the actual shelf space taken by the firm is lost to a competitor's products. When the opposite situation takes place, the firm will incur additional costs. First, the company will have to use more warehousing space, and in some cases, when the company's warehouse is already full, an external warehouse spending would be necessary. Second, when the inventory is not sold the company has to make the decision to either dispose of the inventory or donate it. The cost of unsold inventory is known as a write-off, and this activity will reduce the net profit margin for the brand as well as the company.

These two situations can be remedied using analysis is recommended in this thesis for raw and packaging materials as well as the distribution-production loop.

Raw and packaging materials loop

The buyer planner and the production supervisors together should analyze the raw and packaging materials loop. The buyer-planner should analyze and strengthen the relation with the suppliers giving them information about the forecast and coming special events. The goal is the transformation of linear, serial supply chains into parallel, collaborative communities, dramatically reducing cycle times, improving customer relationships, and increasing productivity. In a supply chain, information is provided about inventory levels: how much inventory is available, when it's available, and so on. Benefits are obtained when companies are able to easily share forecast data, so that different companies at different points in the supply chain know how much to make, how much to ship, and when to do so.

If there is any one key success factor for the implementation of supply chain technologies, it's the ability to overcome the fears that suppliers traditionally have about sharing forecasts and other proprietary information. Collaboration is, at heart, an extended process of developing trust (Ince 2001).

To improve the raw and packaging materials loop, every week the planner-buyer and production supervisor should check the Supply Chain Inventory = On-hand + Pending Purchase Order to Supplier.

- If the supply chain inventory is close to, at, or below kanban minimum, the planner place a new purchase order, the purchase order should be related with the production run (production quantity to be produce)
- The role of the planner is to manage this kanban loop, monitor and understand the composition of the Lead Time, and work with the supplier to reduce the variability of the lead.

Production-Warehouse loop

In the Production-Warehouse loop the system the production supervisor should keep track of the inventory levels every day. The factory lead-time is the potential to respond to a kanban-triggering event. If the kanban levels are checked every day, the Lead Time will be the actual factory response time plus transportation Lead Time. This action will lead to a faster response if the product has reached the kmin.

Production supervisors should level the production lines and establish a hierarchy of SKU priorities per line, in order to:

- Balance lines and factory
- Reduce or eliminate weekly line planning and balancing
- Make the system simple enough as to be operated by Line Supervisor /Operators

Frequency for information updates

The following variables should be monitored in order to update the different kanban levels. The frequency for information calculation and reviews will be:

- Demand - generated monthly.
- Standard deviation of the demand - calculated monthly.
- Lead time - reviewed quarterly.
- Kanban maximum, kanban minimum, and safety stock - calculated monthly.

Future Research

The amount of competitiveness, from the supply channel operation point of view, that countries like Colombia lose when external investors evaluate the number of difficulties and constraints a company would face when they evaluate starting business in the country.

Colombia's social and political problems create a more complicated supply chain for any organization. For instance, safety issues, poor country infrastructure (ports, highways, railroads, etc), and bureaucracy in the state agencies related to export and import of goods. All these problems offset all the country's advantages and strength to be considered a feasible place for external investor.

CHAPTER VI

SUMMARY AND CONCLUSIONS

The supply chain and its components within a company are adversely affected by internal factors and external factors.

The internal factors that are inherent to the company are the people driving the company and their ideas and strategies, the kind of products the firm produces, the facilities available for the company, the equipment used by the company, and the technology and communication tools the company uses to analyze the different variables related to the supply chain. These internal factors affect the way the company responds to the market trends and competitors. The strategies implemented by the management directly affect the company's supply chain; management decisions such as SKU proliferation and packaging innovation can create a more complicated situation for the supply chain. The company's infrastructure and the equipment used by the firm are fundamental variables when the supply chain needs to be improved. The accuracy and type of data used by the company, influences the supply chain performance. Consequently, the flow of information within the company is one of the key elements in the supply chain development.

The external factors that affect a company's operations are its principal competitors strategies, the current market, and all the relevant social variables, such as political and economic situations. These factors force the company to implement some guidelines that either create a simpler supply chain model or a more complicated one. A more complicated model should be used when the company chooses a customer-driven strategy, despite an increase in overall costs. External factors such as economic situations may lead the company to produce more SKUs, creating a more complicated situation a long the supply chain.

Finally, communication and teamwork among the company's departments related to the supply chain is one of the most important tools for facing the difficult challenges that packaging innovations introduce into the model. Communication is also vital in anticipating and solving problems within the supply chain model. These problems may directly or indirectly affect the company's goals and financial expectations.

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VITA

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