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Methodology and tools for improving competence of a chemical plant characterized by a complex Supply Chain network

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Dissertation for the degree of Doctor of Science in Engineering of Industrial Production to be presented with due permission of the Department of Mechanical and Aerospace Engineering, First University of Rome "La Sapienza", for public examination and debate at Faculty of Engineering of "La Sapienza" University, (Rome, Italy), on the December 17th, 2012.

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Acknowledgements

I specially wish to thank Professor Massimo Tronci, leader of the Industrial Plants Scientific Area under Department of Mechanical and Aerospace Engineering, for giving me the opportunity to work with his team at University of Rome “La Sapienza”. Professor Tronci was kind enough to trust me again when I had personal reasons to stop my studies at the end of the first year of research.

After a clarifying meeting renewed his vows and made it clear the responsibilities expected for the next future on me.

Along with this new scheme of research was assigned to me as my thesis advisor Professor Giulio di Gravio.

Giulio has the capability to analyses and discuss different supply chain study cases in a skilled and constructive manner. His professional skill really became evident when I had to associate all my field research within a theoretical framework. Then focus on that aspect of the research should deepen and propose an improved integrated model for the study of the industrial plant that was under this doctoral program.

He offered his expertise in scientific work and how to publish the research results. He has the capability to identify interesting and innovative ideas and to push them forward. The advice he gave me during the writing of this thesis was valuable. Without his support this thesis would have taken a quite different form.

I am grateful to both them, Professors Tronci and Di Gravio, who have helped me in many ways during these almost four years.

I also wish to give my thanks to the Supply Chain experts in the company that I proudly work every day. Of them I am especially grateful to Gaston Perez, Fernando Santos, Andres de Maria and Diego Lamas who have all contributed to my research development.

I thank them for the time and effort they have given to the research projects. In all these persons I admire the passion and enthusiasm with which they are pushing supply chain management forward in the company that we represent.

Particularly I want to thank the staff of Colorin general management and Materis Paints corporate Supply Chain top management to which it belongs for giving me the opportunity to travel and expand my technical knowledge to visit other industrial plants and had the opportunity to interview and share experiences with those who work daily in these sites. To Bernard Chapuis, Gilbert Perrin, Christian Gaussen, Aline D'harcourt, Olivier Caminade and once again Diego Lamas, to all of them I express my sincere gratitude.

The most special thanks go to my patient and sweet lady, my proudly brothers and loyal friends. They know who and how I am and I know well who they are. I have them always present at all times. Anywhere.

Mainly I would also like to address my thankfulness to my parents Luis and Teresa.

San Luis, Argentina. November 2012.

Guido

For Bruno,

Cuando el mundo pierda toda magia,
Cuando mi enemigo sea yo,
Cuando me apuñale la nostalgia,
Y no reconozca ni mi voz.
Cuando me amenace la locura,
Cuando en mi moneda salga cruz,
Cuando el diablo pase la factura,
O si alguna vez me faltas tú…

"Resistiré", Spanish Popular Song

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INTRODUCTION

1.1 Background

For over fifteen years, there has been an increasing interest in the use of supply chain methods to improve performance across the entire business enterprise. Supply chain management has become a standard part of the business language, and many firms now have a functional supply chain group. In addition to individual companies, numerous industries and their partners have recognized the importance of supply chain integration, coordination y collaborative plans. Initiatives that aim at getting multiple these companies to work together toward a more streamlined and efficient supply chain have been developed.

Coordinated upstream and downstream integration in the supply chain can improve and differentiate supply chain performance. Successful Supply Chain is increasingly recognizing the need to eliminate supply chain inefficiencies, and align the decisions and their execution more closely between the trading partners in order to achieve balance between supply and demand.

"Manufacturers now compete less on product and quality — which are often comparable – and more on inventory turns and speed to market"

John Kasarda, 1999

In chemical manufacturing companies, managing capabilities and resources across companies boundaries' becomes increasingly important and, therefore, should be an important element in manufacturing strategy. This, however, presumes that firms integrate their production and distribution networks, instead of merely the resources of an individual company.

However, an integrated supply chain system is not always the main interest of individual members of the system. Consequently, supply chain coordination mechanisms are needed to change the behavior of individual partners in the supply chain to improve supply chain performance.

For efficient design and operation techniques of chemical manufacturing sub process and systems, it is well known that methods and tools are needed to improve complex material and control flows, to analyze behavior and interactions of manufacturing resources and to increase the performance measures such as productivity, cycle times and work-in-process.

This prevalent interest in operations management has led to innovative ways to re-engineer the supply chain, new technologies and field operations solutions to help companies plan and operate their supply chain, and new business models and services for existing and new players in the supply chain.

Reasonably, research interest in supply chain management has also been increasing. Practice in the field has sparked the interest of the research community and we have witnessed an explosive growth of research output on the theories and methods of supply chain management. Some of these new research developments have found their way into practice as companies have begun experiments using the developments.
Implementation and experimentation naturally lead to new ideas, and the practice research- practice-research cycle continues.

1.2 The state of art of SC and its chemical Manufacturing Plant (2009)

Analyzing in particular where we will make our research case study, we are faced with a chemicals manufacturing factory. Belonging to a company, Colorin IMSSA, this produces, sell and delivery home decorative and industrial paints, varnishes, enamels, lacquers and cleaning products for automotive care.

Colorin IMSSA is part of the multinational European group Materis, which acquired the firm in 2006. This group is the No. 2 in the European Paints market, Materis Paints offers its trade and Do It Yourself customers a variety of brands specifically dedicated to their needs: Tollens, Zolpan and Pladox, in France, Viero, Cepro, Settef, Max Meyer, Duco, Baldini and Mistercolor in Italy, Revetón, Alp and Duraval in Spain, Robbialac and VIP in Portugal, Claessens in France and Switzerland. In addition to manufacturing its paints, Materis Paints relies on networks of independent distributors as well as integrated distribution networks: Couleurs de Tollens and Zolpan in France (both with more than 250 points of sale in total make Materis Paints the first distributor of paints and decorative products in France), Colori di Tollens in Italy, Colores de Alp in Spain and 60 Robbialac points of sale in Portugal.

Global figures of the Materis Paints group:

- 2.23 billion Euros sales in 2011
- 9,300 people
- 90 industrial sites throughout the world

Colorin's chemical plant is placed in San Luis province, 780 Km from Buenos Aires. It has a unique logistic distribution center in Buenos Aires, as well as its R&D technical offices and finance general quarters.

As well, in Buenos Aires is located the only international trading port for foreigner raw materials. Also the 86% of the domestic raw material suppliers and 100% of the plastic and metallic packaging suppliers are placed in Buenos Aires surrounding areas.

There is only one reason why the manufacturing plant is 780 Km away from the firm's unique logistic distribution center, local suppliers, imported raw materials and its R&D center. The plant is located in a province, San Luis, which one gives tax benefits and exemptions to all business that go to San Luis and employ local labor. These benefits (in U$D) justify all the additional costs that are generated in the logistic department inside supply chain network.

Key Values of Supply Chain in 2009

- ✓ 27 million euro sales in 2009
- ✓ 235 employees
- ✓ 18.633.835 kilograms of paints manufactured (annual average 2009- 2011)

Higher costs related to logistic for raw materials and packaging as well as for shipment the finished products to the distribution centre.

The transportation of the entire production is done by trucks as the province does not have an interconnected railway system. This obligates to use trucks on entire logistic system. But, only 27% of the route is done in a highway, the rest of it is just a simple one-handed road with all the inconvenience it implies.

These logistic problems have make almost impossible to work with a coordinated replenish system, and though all the warehouses need to be over dimensioned and there is no chance to work with close manufacturing plans, overstocking goods and capitals higher than a month in terms of equivalent of production.

On Stock manufacturing system is used in which the plan fulfils the only customer represented by the Supply Chain distribution centre. This centre manages a specific amount of finished products equivalent to two entire months of production. This represents almost 1,5M litres in 535 SKU’s which could be 450.000 units of final product.

In 2009, the former production plan schedule did not issues PO (production orders) if all the manufacturing process inputs, raw materials and packaging, were not available in the respective plant warehouses. Even for those inputs that are in transit or for those that are under quality control testing. Bulk tank employment indicator, which measures the total installed capacity of the plant, was working with a utilization rate below 50% of its capacity.

There are no valid records to measure the operation and efficiency of mechanical equipment: dispersers, mixers and mills. It was performing using estimates from the experience of plant workers. Those values were not approved and homologated by industrial processes. Plant doesn’t have an Industrial Processing Department. These values taken directly from the plant floor are not part of an integrated program that allows weekly, biweekly operational sequences of different batches.

Suppliers agree the time and date supplies delivery but Supply Chain did not working with fixed shift schedules greater than ten days. Logically, poor logistic plan scheduling has generated poor operating performance.

Summarizing, besides the mainly root problem of the plant location and its associated longer distances to suppliers and distribution center, these are the focal points of the situation at the start of 2010:

- There is no coordinated and integrated information and communication system for Supply Chain Management, each area has its own internal system. Each of these with different platforms, minimizing any desired standardization process.

- Strong reliance on management of supplies due to higher delivery times and suppliers lead times. Oversized warehouses.
- High levels of complexity in manufacturing processes. Batches of intermediate and semi-finished products which are manufactured inside the plant. Low level of outsourcing.
- Sales forecast accuracy in less than 50%.
- Sales Forecast, Planning and Plant Production Schedule working on setback and unknown what is the actual efficiency of his MRP system.
- Operations development is not in compliance with the more demanding and rigorous quality standards.
- High levels of waste and industrial craps (Muda). Dropping resources in packaging scrap and poor quality efficiency in the formulation of manufacturing recipes increase operating costs and those ones directly impact on the profitability of finished products.

Identify, evaluate, select how and when to face each of these problems in the supply chain will be the main reason for this research study over three years of work.

1.3 The focus and the scope of the Thesis

This research is based inside chemical industry, specifically for paint and protective coatings manufacturing. It focuses on the factory plant operations for the Supply Chain management network and its strategic subsystems that support it for the increase of competitiveness.

The main aim is to achieve a competitive improvement of the plant, from the study, survey, analysis and implementation of the suggested plans about operative and logistic improvement. Starting with the assignment of going over the Supply Chain as in integrated and sustainable system that foregoes the purchase – supply – plant relationship and that involves other areas that add value to the final product.

In order to reach this goal, we need to decide what type of Supply Chain architecture is most appropriate for the case study to investigate. Separately and individually face problems not guarantee desired success. Thus, it is necessary to address each of the actions and improvements proposed included in a collaborative and interconnected work program. in this manner, the proposed developments and optimizations not only cause a positive effect on the performance of that single sub process , but will expand this benefit to other process connected within the supply chain network.

Based on these ideas and its arguments it is underlying the collaborative coordinated model for optimization of complex supply chain network like the methodology proposed to research and practitioner field implementation for the doctorate program.

Believing in this chosen improvement processes are the adequate tool to face and solve problems relating to the complex Supply Chain inside the Chemical Plant.

That is, the form and methodology for improved complex supply chain network have as a platform the choice of those processes most significant of all work identified in the first stage of the research. Followed by, the analysis of each of these processes chosen and their interconnections within the supply chain adopted architecture model. Starting with a programmed and overall approach, knowing the different architectures and possible strategies inside a supply chain. By the study of theoretical approaches of most recognized authors. Benchmark additional case studies of other manufacturing industries and service companies.

Finally, by the implementation of an operational Supply Chain collaborative improvement program and the subsequent measurement and optimization validated by proper choice of key performance indicators (KPI).

1.4 Theory applied

Due to the characteristic of this study work with a high degree of practical implementation in the field there was no single model of thought or dominant theory that marked a line of research.

Logically, introspective research of theoretical foundation in reading, analysis and interpretation of the various and different approaches to managing a supply chain network.

Taking or attempting to take and use the concepts and methodologies appropriate for each of the different problems faced.

In order to appoint one of the most relevant, in the choice of architecture scheme that prioritized and determines our supply chain architecture it was using *Christopher* research study of hybrids Lean - Agile Supply Chain models systems. The same line research guide was used for the foundation in the study of manufacturing complexity and complexity theory expounded by *Christopher (1998)* also.

Towill and Christopher puts emphasis about the importance of time as a competitive weapon has been recognized for some time. The ability to be able to meet the demands of customers for ever-shorter delivery times and to ensure that supply can be synchronized to meet the peaks and troughs of demand is clearly of critical importance in this era of time-based competition. To become more responsive to the needs of the market requires more than speed, it also requires a high level of maneuverability that today has come to be termed agility.

Other authors with a strong impact for the research study, modeling and choice of processes that were part of coordinated collaborative improving model were *Malone and Crowston* and *Simatupang* with his SC coordination theory. *Malone and Crowston* coordination theory affirms and sustains that coordination is more problematical in supply networks where business limitations and supply chain phases cross. In such networks, focal companies may act as coordinators and link downstream and upstream operations and subsequently interact with them. Coordination mechanisms offer a system for supply chain members to collectively create value and achieve improved supply chain performance. Exist three ways to reach that: sharing decision responsibility, sharing information, and logistics synchronization. Sharing decision responsibility refers to redeployment of decision rights, work, and resources to the best-positioned supply chain member. Logistics synchronization refers to organizing the supply chain according to the market: to mediate customer demand and to adjust stock inventory management, manufacturing, and delivery to meet up the sales demand.

Simatupang, complete and extends the concept of coordination including the sharing responsibility. The focus of coordination may be on operational or organizational supply chain linkages. Mutuality of coordination requires sharing responsibility in achieving better performance. This can be achieved in two manners: by adding complementarily (how chain members collectively increase value) or coherency (creating common understanding). Coordination may focus on organizational linkages, and sharing benefits and risks. This coordination way is needed to penalize or reward decision makers according to how their proceedings support reaching common goals. Coordinating collective learning means dispersion knowledge and capabilities across managerial borders, reaching those capabilities that implement logistics improvement initiatives.

1.5 Thesis structure

This research study is organized in five chapters. At Chapter Two are presented the theoretical backgrounds of the thesis: general Supply Chain management System, Lean and Agility Architectures, Coordination Theory, Supply Chain mechanism applied in coordination, Supply Chain collaboration and partnership schemes and advantages. The last section of this chapter summarizes into a schematic chart the findings from the collaborative coordination model and its interconnections.

In the Chapter Three are included a field practice qualification of the plant as part of a modern Supply Chain, research questions that aims to discover the ending purpose of the coordinated collaborative system, the methodology, short descriptions of each of five process chosen and selected to implement innovative changes and the weight of any process inside the interconnected model. These ones focused and addressed to answering the research questions. In Chapter Four are shown results from these five processes for plant improvement.

Chapter Five presents concluding remarks, discusses the results in the light of previous literature, perform a comparison between expected results and suggests further research.

Discussion on the limitations of the thesis also is included in Chapter Five.

2. THEORITICAL FOUNDATIONS

The theoretical background of this thesis contains the following topics: supply chain principles, SC architecture design, agile and lean strategies, added value in sales and planning operations, complexity and flexibility approaches, supply chain coordination, information sharing for collaborative and partnership supply chain models. At the end of the chapter there is a scheme diagram that describes the relationship and interconnections between Operational Capability Improvement and Collaborative Performance System, theoretical base for the proposed collaborative improve coordination model.

2.1 Principles of Supply Chain Management

Supply Chain management (SCM) has become an important focus of competitive advantage for organizations and firms. The effect of supply chain management has increased steadily, drawing on developments in information systems, management science, logistics, operations management, and other fields. The promise of supply chain management is better use and deployment of resources across the entire enterprise. While it has long been a goal to consider the impacts of managerial decisions across the complete organization, the tools, concepts and computing environment have only been available for the past years to realize this potential on a large scale

A classical nomenclature of Supply Chain is the set of value-adding activities that connects a firm's suppliers to the firm's customers *(Forrester, 1961)*. The basic unit of a supply chain activity is:

Receive input from supplier ⟶ Add value ⟶ Deliver to customer.

Here a "supplier" may be an external vendor or an upstream process within the firm. Correspondingly, a customer may be the final customer of the finished product or service, or a downstream operation that uses the output of one process as the input to another.
Three types of flows happen throughout the supply chain: (1) product, (2) information, and (3) funds. These flows travel both upstream and downstream within the supply chain.

Effectively coordinating these three kinds of flows is the overarching goal of supply chain management.

M. Christopher complete the classical definition including and taking account the relevant and target group: the ultimate customer. The object of SCM obviously is the supply chain which represents a ". . . network of organizations that are involved, through upstream and downstream linkages, in the different processes and activities that produce value in the form of products and services in the hands of the ultimate consumer" *(Christopher, 1998).* In an extensive sense a supply chain consists of two or more legally separated organizations, being linked by material, information and financial flows. These organizations may be firms producing parts, components and end products, logistic service providers and even the ending customer himself.

Managing the supply chain requires a wide range of methods and principles. One way of classifying supply chain management analysis *(Harrison, 2005)* is to divide the area into the strategic component: Supply Chain Design (SCD), and the tactical/operational piece: Supply Chain Operations or execution (SCE).

Supply chain design is the process of determining the supply chain infrastructure the plants, distribution centers, transportation modes and lanes, manufacturing processes, etc. that will be used to satisfy customer demands. These studies are strategic in scope, use a time horizon of many months or years, and typically assume little or no uncertainty with the data.

Supply chain execution is the process of determining solutions to more tactical and operational issues such as local inventory polices and deployment, manufacturing and service schedules, transportation plans, etc. In these instances, production and transportation data are usually assumed to vary according to a known probability distribution, while the infrastructure is assumed fixed (like our study case). The time period for the analysis typically spans weeks, months or years and focuses on implementing detailed short and middle term plans.

The research, application and execution of improvement model will be presented and discussed in the chapter four and five.

2.2 Supply Chain Architecture Design

Supply chain design is concerned not only with the configuration of a network, but also with the prioritization of the capabilities to be developed and retained internally, and the forging of new partnerships with other entities along a supply network. Supply chain design should be viewed as the "capability to design and assemble assets, organizations, skill sets, and competencies for a series of competitive advantages, rather than a set of activities held together by low transaction costs" *(Fine, 1998)*.

2.2.1 Distinctive features of the supply chain architecture design

Supply chain design decisions are frequently made in an environment that is rich with uncertainty, filled with multiple, conflicting objectives and incomplete information. *Harrison* identifies the following aspects that he considers like part of this environment.

• Supply chain redesign. In practice, supply chain design decisions are rarely focused on "green field" situations. More characteristically supply chain design questions are the result of mergers, acquisitions, downsizing, or a significant shift in corporate strategy. In these situations, questions are centered on rationalizing the supply chain in response to incremental changes to the supply chain infrastructure.

• A novel process. Many firms are inexperienced at examining changes to the supply chain when the metrics span the entire organization.

• Impacts affect multiple groups. Changes in the design of a supply chain often lead to impacts that span large parts of the organization. Often there is no one person or group that has deep experience with measuring or assessing these impacts. On the plus side, the largest positive impacts of supply chain design frequently occur at the boundary of organizational units.

• Organizational incentives may work against change. The outcome of a supply chain design may require changes that cause one group to have a decrease in existing measures of performance while resulting in an improvement of firm-level measures.

• Coordination across functional boundaries. A key benefit of supply chain design is that it often requires coordination between groups that typically do not interact. This collaboration leads to a better understanding of cross-functional issues.

• Data needs are difficult to satisfy. Since supply chain design spans many areas of the organization, the data required to support analysis must be drawn from many sources. The data may be measured at different frequencies, may use different scales or may be contained in "private" sources that are difficult to obtain.

Applying these concepts to research case, we can clearly note that in Argentina high sum of duties are costs assessed for the importation of goods. The cost of the duty is typically based on the value of the imported good the type of good imported (foreigner raw materials), and the country of origin (mainly Chinese titanium Dioxide, European pigments and colorants, Asian silicon emulsion and slurries). But these fees are recovered as a fraction of duty drawback in the cases where the imported good is used to manufacture another product that is subsequently exported.

In addition, relating to organizational incentives aspects described above, in Colorin, carrying the end of fiscal year inventory at San Luis chemical Plant causes costs within that reporting area to increase, but would ultimately lead to a lower cost across the supply chain.

One of the most important design topics for our study case correspond to domestic manufacturing opportunities, Argentine forces a minimum local content before Colorin (or any other chemical firm) is permitted to sell a particular paint or coating product. This restriction requires that a specified fraction of the value added to the final product must occur within the country where the product is sold.

Like was presented in the introduction, the most relevant case is the tax and production fees benefit. Differing tax rates or fisco’s tax exceptions may greatly affect the choice of location for key operations to promoted industrial areas with tax tariffs benefits. The effect of differing tax rates is likely to concentrate the high value-added activities however; these effects are balanced against the costs procurement, manufacturing and mainly logistic distribution.

2.2.2 Characteristic types of supply chain architecture design analysis

Supply chain design addresses a wide range of strategic infrastructure issues for the firm. The following examples highlight many of the key issues that are typically considered.

Manufacturing Strategy:

- How many plants are needed?
- Where should each plant be located?
- What products should each plant make?
- What process technologies should each employ?
  (and how much of each process is needed?)
- What markets should each plant serve?

Supply Base Design:

- Simultaneously determine supplier selection for all parts within commodity groups.
- Allocate suppliers to plants.

Distribution Strategy:

- Should we ship direct or stock regionally?
- How many DC are needed and where should they be located?
- Which DC will server which customers?
- What transportation modes will be used?

Outsourcing:

- What portions of the supply chain remain in-house versus outsourced.
- Cost tradeoffs vs. service considerations.

New Product and Process Design:

- What infrastructure should be used when new products are added to existing lines?
- At what demand points are additional sources of supply needed and where should they be placed?

It is notorious for our research case that the location of the production plant was due to a political, financial and economic decision. The task is to redesign and rethink the architecture as the existing supply chain and optimize the infrastructure of those topics that do not relate directly to the geographic location of the chemical factory.

The optimization and improvement then be constituted of more than a single driver of the supply chain. Consequently will be necessary the conformation of improvement model in which their coordination and collaboration between the subsystems will be the key to success.

2.2.3 Data needs to define supply chain architecture

The most challenging aspect of a supply chain design project, other than the actual implementation, is collecting a complete and accurate set of data. The activities and data needs of supply chain management cover virtually all areas of the firm, which requires a comprehensive data collection effort. Data typically reside in a variety of locations and forms, from handwritten notes in someone's desk to large, enterprise wide databases. The outcome is that collecting and verifying data is a time consuming, difficult and iterative process. However, the quality of the analysis and the potential for substantial impact is directly linked to the quality and completeness of the data. Firms that use activity-based costing often can fulfill supply chain data needs more easily.

A representative strategic architecture design of a supply chain would include the following data types, at a minimum: locations, process, product and movements *(Simchi and Levi, 2002).*

Location data is the starting point for describing any supply chain network and would likely include:

- Fixed costs of opening, closing or maintaining a facility.
- Variable costs of operating the facility.
- Geo-referenced data to denote the facility's physical location.
- The location's country for determining tax effects.
- Trading alliances for assessing duty effects. (Mercosur In South America)
- Capacities and processes available at the facility.
- Inventories and inventory policies.
- Demand by product.

Process data provides a description of a location's ability for adding value. It includes manufacturing, service, retail or transportation capabilities, and packaging options.

Product data includes the list of stock keeping units, their physical attributes, revenue and cost, bill of material relationships, and structure.

Movement's data provides a description of the logistics network, and is often the most extensive and difficult data need. Every possible link that provides a movement between locations must be included. Each transportation link is described by a cost, a capacity, a transit time and a transportation mode. (Like has been shown in the description of the Thesis scope).

2.3 Lean and Agile Supply Chain strategies

Supply chain performance improvement initiatives strive to match supply to demand thereby driving down costs simultaneously with improving customer satisfaction. This invariably requires uncertainty within the supply chain to be reduced as much as practicable so as to facilitate a more predictable upstream demand *(Mason-Jones, 1999)*. Sometimes however, uncertainty is impossible to remove from the supply chain due to the type of product involved.

Hereafter, specific supply chains are faced with the situation where they have to accept uncertainty but need to develop a strategy that enables them to still match supply and demand.

According to *Christopher,* significant interest has been shown in recent years in the idea of 'lean manufacturing' *(Womack, Jones & Roos, 1990)*, and the wider concepts of the 'lean enterprise' *(Womack & Jones, 1996).* The emphasis of the lean approach has essentially been on the eradication of waste or muda.

The increase of interest in lean manufacturing can be found to the Toyota Production Systems (TPS) with its focus on the reduction and elimination of waste *(Ohno, 1988).* Though, the roots of lean manufacture are definitely visible in World War II, at the Spitfire aircraft production in the UK.

Lean concepts work well where demand is relatively stable and hence predictable and where variety is low. Conversely, in those contexts where demand is volatile and the customer requirement for variety is high, a much higher level of agility is required.

Lean manufacturing system is a production practice that considers the expenditure of resources for any goal other than the creation of value for the end customer to be wasteful, and thus a target for elimination. Working from the perspective of the customer who consumes a product or service, "value" is defined as any action or process that a customer would be willing to pay for. Essentially, lean is centered on *preserving value with less work*.

As described before, the origins of lean manufacturing can be found to the Toyota Production System (TPS), with its focus on the reduction and elimination of waste. Later it was associated with production processes and standards "Just in Time" (JIT) focused on reducing the variety of processes through methods "six sigma".

Lean manufacturing is a management philosophy focused on eliminating waste, reducing inventory, and increasing profitability. "Lean" concept works best in high volumes, low variety and predictable environments.

Mandyam Srinivasan (1992) has enumerated fourteen principles that companies should follow to build and manage lean supply chains:

1. Measure any improvements in subsystem performance by weighing their impact on the whole system.
2. Focus on improving the performance of the lean supply chain, but do not ignore the supply chain's business ecosystem.
3. Focus on customer needs and process considerations when designing a product.
4. Maintain inventories in an undifferentiated (unfinished) form for as long as it is economically feasible to do so.
5. Buffer variation in demand with capacity, not inventory.
6. Use forecasts to plan and pull to execute.
7. Build strategic partnerships and alliances with members of the supply chain, with the goal of reducing the total cost of providing goods and services.

8. Design products and processes to promote strategic flexibility.
9. Develop performance measures that allow the enterprise to better align functions and move from a functional to a process orientation.
10. Reduce time lost at a bottleneck resource, which results in a loss of productivity for the entire supply chain. Time saved at a non-bottleneck resource is a mirage.
11. Make decisions that promote a growth strategy and focus on improving throughput.
12. Synchronize flow by first scheduling the bottleneck resources on the most productive products, then schedule non-bottleneck resources to support the bottleneck resources.
13. Don't focus on balancing capacities—focus on synchronizing the flow.
14. Reduce variation in the system, which will allow the supply chain to generate higher throughput with lower inventory and lower operating

Agility is a business-wide capability that embraces organizational structures, information systems, logistics processes and in particular, mindsets *(Christopher and Towill, 2000).*

They say that a key characteristic of an agile organization is flexibility. In that respect, the origins of agility as a business concept lie partially in flexible manufacturing systems (FMS). Initially it was supposed that the way to manufacturing flexibility was through automation to enable rapid changeovers (i.e. reduced set-up times) and consequently enable a greater responsiveness to changes in product mix or volume. Later this idea of manufacturing flexibility was extended into the wider business context *(Nagel and Dove, 1991)* and the concept of agility as an organizational orientation was born. *Naylor* in 1999 gives up a useful definition of the two paradigms we are considering as follows: "Agility means using market knowledge and a virtual corporation to exploit profitable opportunities in a volatile marketplace." Meanwhile that: "Leanness means developing a value stream to eliminate all waste including time, and to enable a level schedule."

The word definition tells us that agility is the ability to respond quickly to unpredictable changes in demand. Agile means fast-moving.

Within the managerial approach, agility is not a concept encompassing a single party or alone enterprise, extending to both ends/extreme of the supply chain.

"Agility" is needed in less predictable environments where demand is volatile and the requirement for variety is high.

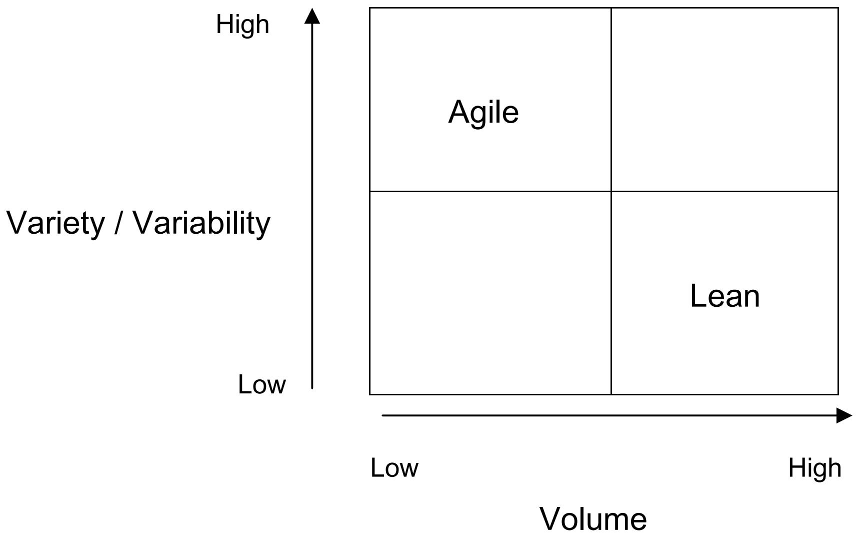


Figure 2.1

In Figure 2.1 it is possible see the positioning of agile and lean strategies based on production volumes and variability of production batches that compound this volume.

Furthermore, characteristics of offer and demand determine the strategy of the supply chain, as it is shown in Figure 2.2.

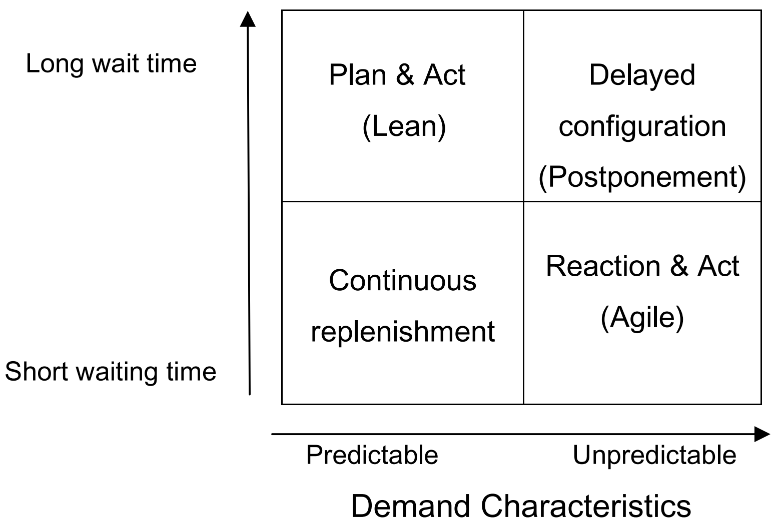


Figure 2.2

2.3.1 Attributes of Lean and Agile Supply Chain strategies

Both agility and leanness demand high levels of product quality. They also necessitate minimum total lead-times defined as the time taken from a customer request a purchase order for a product until it is delivered. Total lead-time has to be minimized to enable agility, as demand is highly volatile and thus difficult to forecast. If a supply chain has long end-to-end lead-time then it will not be able to respond quickly enough to exploit marketplace demand. Furthermore effective engineering of cycle time reduction always leads to significant bottom line improvements in manufacturing costs and productivity *(Towill, 1996).*

Lead-time needs to be reduced in lean manufacturing as by definition excess time is waste and leanness calls for the elimination of all scrap. The core of the difference among leanness and agility in terms of the total value providing to the customer is that service is the critical factor calling for agility whilst cost, and then the sales price, is clearly linked to leanness. However, whereas the Total Cycle Time Compression Paradigm *(Towill, 1996),* when effectively implemented, is a sufficient condition for achieving lean manufacturing, it is only one necessary condition for allowing agile supply.

Distinguishing attributes	Lean supply	Agile supply
Typical products	Commodities	Fashion goods
Marketplace demand	Predictable	Volatile
Product variety	Low	High
Product life cycle	Long	Short
Customer drivers	Cost	Availability
Profit margin	Low	High
Dominant costs	Physical costs	Marketability costs
Stockout penalties	Long term contractual	Immediate and volatile
Purchasing policy	Buy goods	Assign capacity
Information enrichment	Highly desirable	Obligatory
Forecasting mechanism	Algorithmic	Consultative

Figure 2.1: Distinguish attributes. Source Mason – Jones (2000)

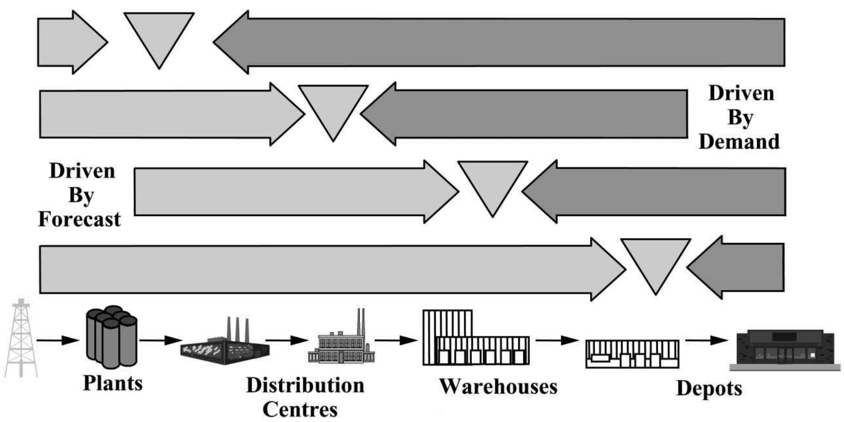
Figure 2.1 shows the comparison of attributes between lean and agile supply. In the volatile unpredictable marketplace with short cycle time of market (i.e. cell phones), both stockout and obsolescence costs are punitive. Subsequently the purchasing policy moves from placing orders upstream for products moving in a regular flow to that of assigning capacity to finalize products in quick response mode. As *Fisher et al. (1994)* have indicated this means forecasting via ``intelligent'' consultation so as to maximize inputs from ``rich'' marketplace insider sources. *Mason and Jones and Towill (1997)* argue that ``information enrichment'', i.e. immediate sharing of marketplace data throughout the chain is not merely desirable, but obligatory.

This must be achieved in a process integration state as we move towards the common Seamless Supply Chain (SSC) in which all ``members'' think and act as one *(Towill, 1997).*

2.3.2 Decoupling point and Hybrid strategies

A crucial and significant problem in most supply chains is their limited visibility of sales real demand. Because supply chains tend to be extended with several levels of inventory among the point of manufacture and final marketplace, they tend to be forecast driven rather than demand driven.

The point at which real demand penetrates upstream in a supply chain may be termed the decoupling point. The decoupling point should also command the form in which inventory and the stocks are held. Therefore, in the uppermost example in Figure 2.3, demand penetrates right to the point of manufacture and inventory is probably held in the form of components or materials.



Source: Hoekstra and Romme, 1992

Figure 2.3: Material flow decoupling points and strategic inventory

The question is not how far the order penetrates, but how far real demand is made visible. Orders are aggregations of demand, often delayed and distorted due to the actions and decisions of intermediaries.

On the other hand, demand reflects the ongoing requirement in the final marketplace in as close to real-time as possible.

Later inventory will be in the form of finished product. The purpose of the agile supply chain should be to carry inventory in a generic form – that is, standard semi-finished products awaiting final assembly or localization. This is the concept of ‘postponement’, a vital element in any agile strategy.

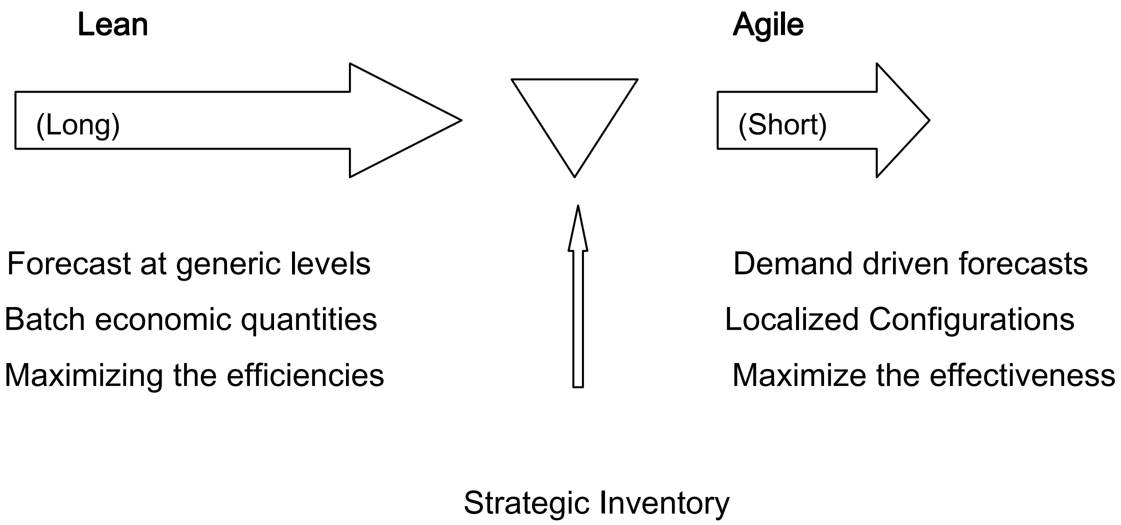


Figure 2.4: The decoupling point.

Key to the success of an agile supply chain is the speed and flexibility with which these activities can be accomplished and the realization that customer needs and customer satisfaction are the very reasons for the network. Customer satisfaction is paramount. Achieving this capability requires all physical and logical events within the supply chain to be enacted swiftly, accurately, and effectively.

The faster parts, information, and decisions flow through an organization, the faster it can respond to customer needs.

Shared information between supply chain partners can only be fully leveraged through process integration. By process integration is meant collaborative working between buyers and suppliers, joint product development, common systems and shared information.

This form of co-operation in the supply chain is becoming ever more prevalent as companies focus on managing their core competencies and outsource all other activities. In this new world a greater reliance on suppliers and alliance partners becomes inevitable and, hence, a new style of relationship is essential. In the ``extended enterprise'' as it is often called, there can be no boundaries and an ethos of trust and commitment must prevail. Along with process integration derive joint strategy determination, buyer-supplier teams, transparency of information and even open book accounting.

This idea of the supply chain as an association of partners linked together as a network provides the fourth ingredient of agility. There is a growing recognition that individual businesses no longer compete as stand-alone entities but rather as supply chains.

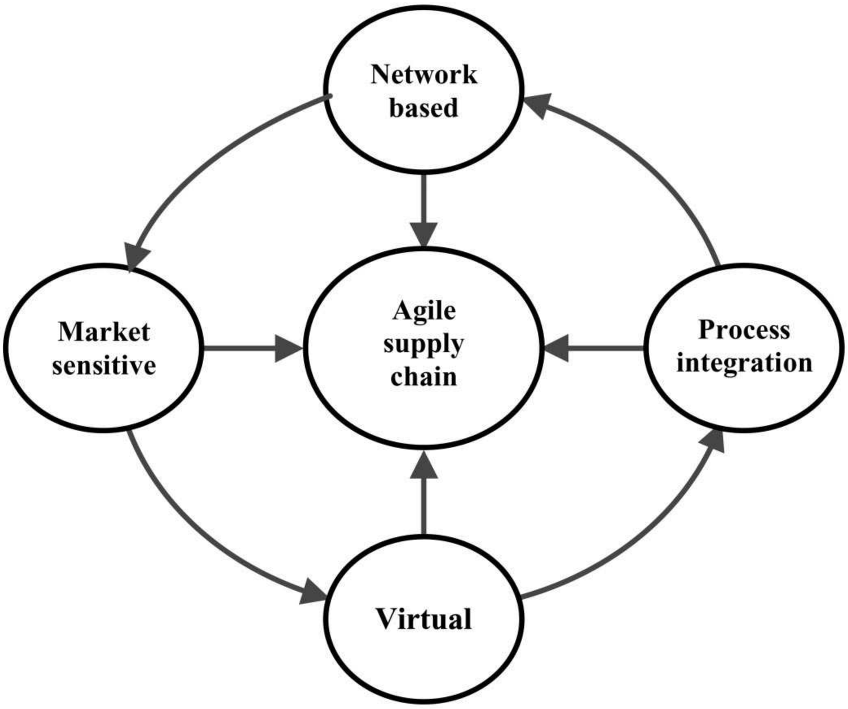


Figure 2.5: The information based agile supply chain. Source: Harrison (1999)

All physical events are enacted quickly and accurately. The faster materials, information, and decisions flow through an organization the faster it can respond to the demands of the market. The keys are flow and time.

By other hand, there will be occasions when either a 'pure' agile or lean strategy might be appropriate for a supply chain. However there will often be situations where a combination of the two may be appropriate i.e. a hybrid strategy. Hybrid strategies are often right.

Hybrid supply chain strategies recognize that within a mixed portfolio of products and markets there will be some products where demand is stable and predictable and some where the converse is true. *Fisher (1997)* has pointed out it is important that the characteristics of demand are recognized in the design of supply chains. However, it is not necessarily the case that a supply chain should be either lean or agile. Instead a supply chain may need to be lean for part of the time and agile for the rest.

Figure 2.6 shows *Towill (1998)* schematic hybrid system of Supply Chain management configuration taken as function of the volume to produce and the variety/variability ratio.

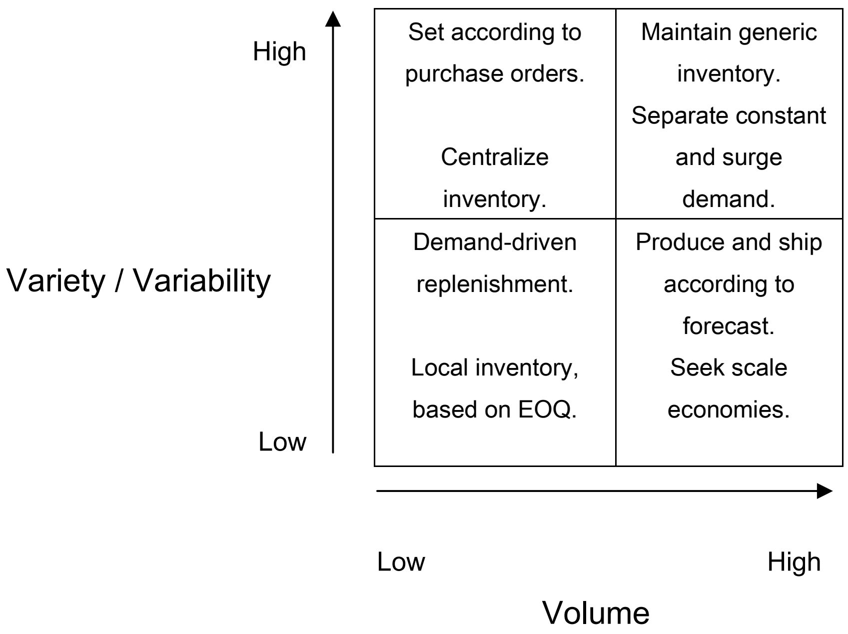


Figure 2.6: Hybrid strategies as function of Volume and variety/variability ratio.

2.4 Added value in Sales and Planning Operations (S&PO)

"Time waste differs from material waste in that there can be no salvage. The easiest of all wastes and the hardest to correct is the waste of time, because wasted time does not litter the floor like wasted material"

Henry Ford, 1927

Ford's words mentioned and cited in *Walker* publications and book are clear and convincing. Time management was another important theoretical background and significant issues identified in my whole research study of the supply chain management.

The most important part of this topic was to understand how to separate value-added while non-value added time. In this way and under this concept approach, begin to see and identify potential areas for improvement inside the proposed collaboration model.

The solution was in the end customer. A non-value added activity is one whose removal does not reduce the customer attributes seen in the product (i.e.: performance, functionality, quality, perceived value).

- An activity adds value if the client is interested in her.
- An activity adds value if changes physically the item in question.
- An activity adds value by creating time and useful space.

The most common tool used once defined that activity generates or adds value is the mapping. I do not think more convenient explain how it generates a streaming mapping. But I can confirm that in my research work was very valuable considers ant take on count the classification of vertical and horizontal time. And their uses on the Supply chain mapping.

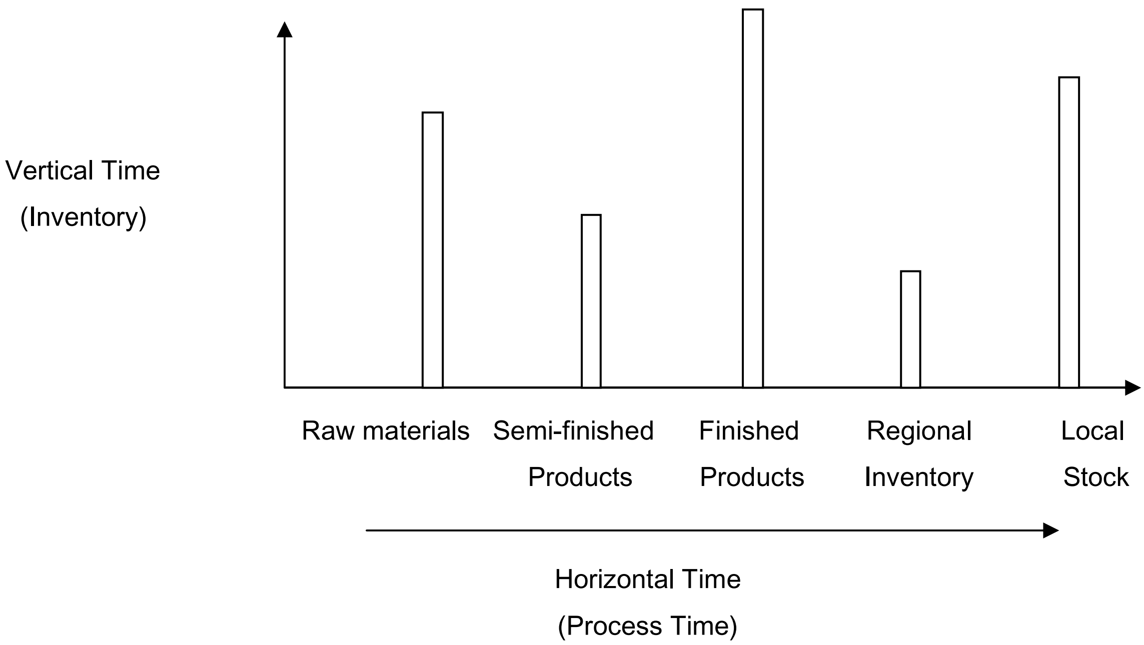


Figure 2.7: Typical Supply Chain mapping

In that way, we obtain:

Supply Chain Volume = Vertical Time x Horizontal Time

The horizontal time is the time of the processes, that means, time-consuming on logistic, transport, production, procurement, order processing, etc. It is a mixture of time with and without added value.

Vertical time is the idle time. It's the time it takes the inventory of one way or another. It is non-value added time in its entirety.

2.4.1 Ways to understand time

In the next figure (Figure 2.8) it is reproduced in a summary keys based on each agent in the understanding of time and its function in the extended business.

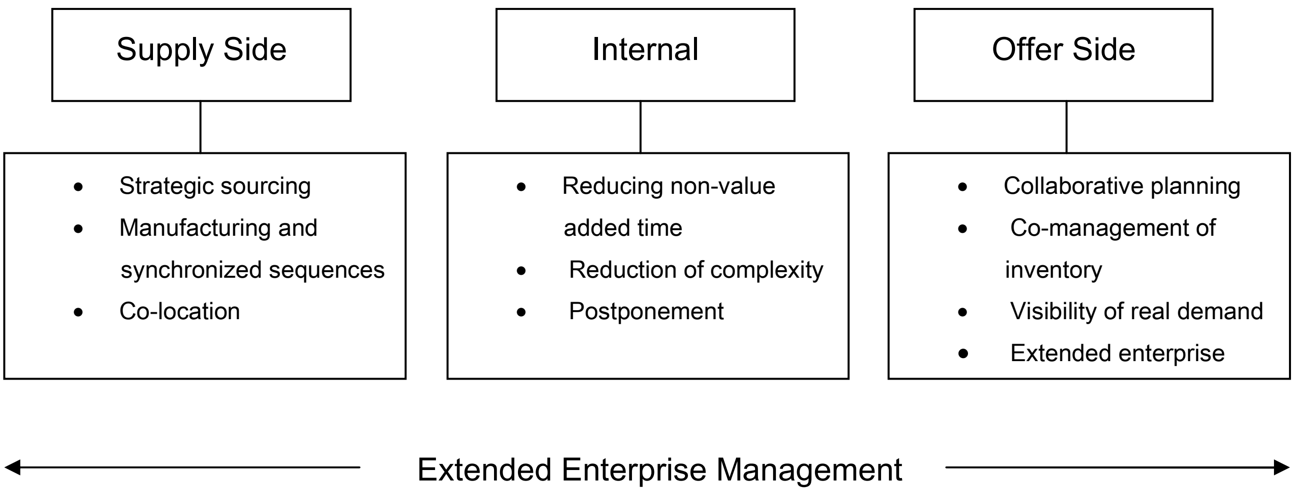


Figure 2.8: Three agent's scheme of time

Several authors agree on the time factor. This idea is supported on the significant importance of time as a key factor in the supply chain. Having analyzed and differentiated activities those ones add value and which not. Then, distinguishing at the vertical and horizontal times the volume up or travel path of the supply chain.

The concept of speed based on the relationship between the distances traveled and time elapsed. In order to increase the speed is necessary to compress the time.

From there we get a quick response to our processes and thus create a virtuous circle through a quick response, as it is shown at Figure 2.9.

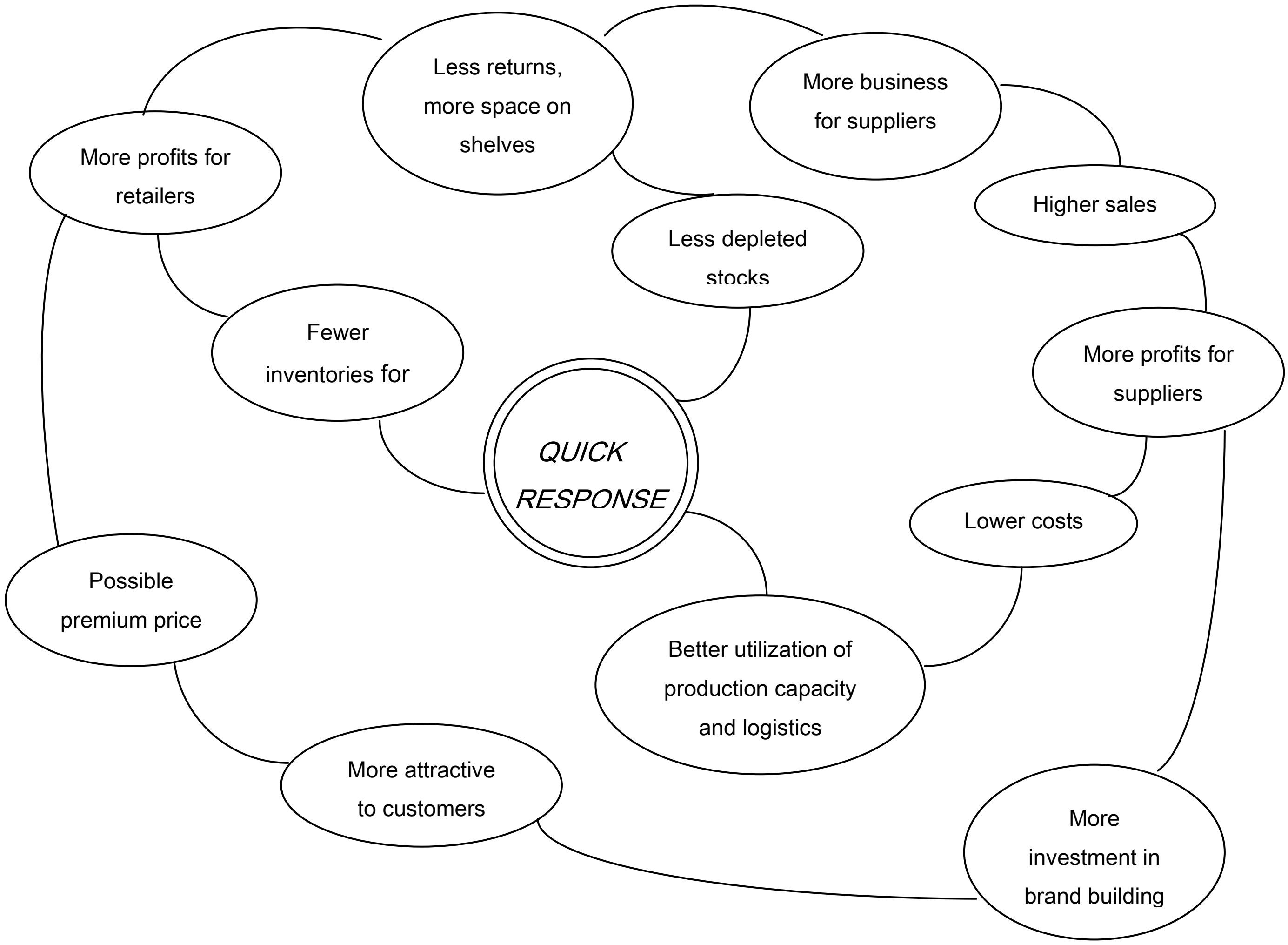


Figure 2.9: Virtuous circle of the quick response. (Clockwise Sense)

In the transition from traditional focus to modernity and the rapid response supply chain we see that in the traditional schemes multiple groups retain the stock, based on considerations of ownership and organizational legendary. Through the integration process we obtain that few bands retain the stock, in case you have some, for direct distribution to end customers.

In traditional approaches the replenishment is done in sequential function of momentum transfers from one group to another. Through virtual integration is the goal in all groups replenishment function is performed on real sales data collected in customer interface

Just as discrete units plan production according to the old standards. With integrated production networks is planned across functional boundaries buyers to customers, with short waiting times.

Many supply chains have biggest stock and this one is compound completely by finished product that is waiting to be sold. With a new system focused on the sensitivity of the final customers get most of the stock will consist of works in process of execution pending concretion or configuration instructions from the final customer

2.4.2 The type of supply chain and its effects on importance of Sales Planning and Operations (S&OP)

In the previous paragraphs were already descripted different ways architectures and ways to reach efficiency gains supply chain. Every author proposes their models different using various angles of view. We have seen the time factor as crucial variable in determining which patch or way to follow. Also how it affects the management of inventories and vertical and horizontal times.

Were few cases where I know exactly where the role of the sales forces and operations management in an integrated manner. In what environment is currently today the Manufacturing Plant, what is our approach and challenges to face?

Gattorna (2004) defines Sales and competition at these current turbulent markets:

- Life cycles of products and technology are shortening.
- The pressure of competition leads to more frequent changes in products.
- The greatest variety and the proliferation of products increase the business risk.
- The "chaos" in the supply chain is created through self-imposed measures.
- Forecasts based management is no longer viable: one must anticipate and implement the measures as a function of real demand.

According to supply chain strategy as it should be the adequacy of the structure concerned sales and operations. The benefits and that approach should be relevant to each one. The following table, Table 2.2, is drawn up according to this system.

Type of Supply Chain	Adaptation to S&OP	S&OP Approach	S&OP Benefits	S&OP Challenges
Continuous Replenishment	A natural environment for the S&OP – good cultural appropriateness and processes through the whole organization and customers and key suppliers	• Add material short and medium term	• The nature collaborative S&OP Promote the culture of replenishment continuous • It adapts naturally collaborative trend CR customer	• The participation of external parties can be challenging • Balance S&OP plan may involve taking to say no to some clients in some time.
Lean	An effective decision an alignment frame helping to integrate that otherwise would an organization's silo.	•Add material short and medium term • Long term capacity	S & OP provides a good frames structure on optimization decisions • S&OP helps to reduce functional barriers	• Analytical Culture can lead to S&OP to too much detail •The culture of management challenges meeting style S&OP
Agile	Effective capacity framework of management and decision-making to maximize ability to respond (or not) to demand increases.	• Capacity to feel and respond to circumstances changing in a an optimally way	• S&OP provides an effective communication media • S&OP can help the ability to manage ration and thinking.	• Need to S&OP as keeping an added level of capacity • Convincing investors that the Planning works!!

Totally Flexible (Business Event)	A useful analysis and decision-making framework that can be used to cope with the process with certain naturalness	Material and capacity planning in the short and medium term (duration dictated by the extent of the impact of the event)	Provides a proven framework (processes & tools) that can easily be mobilized to take effective decisions.	Tempering the reaction of senior management to negotiate S & OP with a "control room" ad hoc.

Table 2.2: Application of S&OP in different types of Supply Chain

Completing the study of different types of supply chain and previously to analyse the risks they face and how it manages its complexity. We are now ready to define from the entire spectrum consisting studied in each.

Lean supply chain: Demand predictable (for example, from an historic off-take) but the loose relationship does not necessitate an extreme service level. Focus on efficiency (efficiency/consistency customer segment type).

Agile supply chain: Unplanned or unforeseen demand and a sometimes loose relationship with customers – almost always demands an agile response at higher cost-to-serve. Focus on speed and capacity (demanding/quick response customer segment type).

Fully flexible supply chain: Responding opportunistically and managing yield. Focus on providing creative solutions for premium price (innovative solutions customer segment type).

Continuous replenishment supply chain: Predictable demand, easily managed through tight collaboration with customers. Focus on retention of customer relationships (collaborative customer segment type).

2.5 Complexity Management in Supply Chain

"Complex is the opposite of independent, while complicated is the opposite of simple." Theory of complex systems studies the relationships between parts generate collective behaviour of a system and how the system interacts and builds relationships with its environment.

The phenomenon of complexity within a supply chain is based and have their root causes in many of the aspects listed above when evaluating the current market environment and competition *(Gattorna, Christopher and Towill 2003).*

The outsourcing of secondary activities is a major increase in complexity factor. The globalization of supply chains as a logical consequence of the globalization of all the estates of big and medium companies is another factor in the equation of complexity.

In addition, we must take into account that final costumers are becoming more requirements on products. As well as the timing, terms and ways of delivery and shipment that this product will reach customers' hands.

The products themselves have increasingly reduced their life cycles. The learning curve and operational processes optimization ever end up before and is necessary to redesign and re-analyse the process of manufacturing and logistics distribution.

In this globalized world, mergers, fusion and acquisitions generate continuous changes and removals logistics groups. Nowadays, we have permanent process of restructuring of production lines, new layouts and geographical sites within an industrial plant or directly to the transfer of all manufacturing establishment increments to contribute to the complexity of a supply chain.

The problem with complexity is not only that it is a significant driver of cost within a supply chain but that it also contributes to variability and uncertainty. Because so many of the interactions between agents and entities within a network can have a cumulative and combinatorial effect, it is not always possible to predict the impact of these interactions. In its strictest sense, complexity does not mean complicated, but rather it describes a condition of inter-connectedness and inter-dependencies across a network where a change in one element can have an effect on other elements – often in unforeseen ways.

Christopher (2005) goes deep to complexity factors to refer this issue and focuses lists the various causes of the complexity and grouped into eight different items:

1. Network Complexity: The more nodes and links that exist in a network then clearly the more complex it becomes. As a result of out-sourcing non-core activities many companies are today much more reliant on external suppliers of goods and services. Those external

suppliers also are dependent upon a web of second tier suppliers and so on. There is a strong likelihood that the focal firm at the centre of the network will not even be aware of many of the second or third tier suppliers that feed their upstream supply chain. The potential for unexpected disruptions to the supply chain is clearly heightened by these extended networks.

2. Process Complexity: Underpinning every supply chain are innumerable processes – processes internal to the firm as well as those processes managed by upstream and downstream partners. Often these processes have been developed in a haphazard way and have been added to and modified to reflect current requirements and as a result have become more complex. This complexity is manifested in processes with multiple steps, often performed in series rather than in parallel.

3. Range Complexity: Most business organisations find that the range of products and/or services that they offer to the market has a tendency to grow rather than reduce. The rate of introduction of new products or services; new pack sizes or variants and brand extensions seems to outpace the rate at which existing products or services are eliminated. The general effect of this mushrooming of the product/service portfolio is to extend the 'long tail' of the Paretto distribution. Typically as more variants are added to a range, the demand per variant will reduce with a subsequent impact on forecast accuracy.

4. Product Complexity: The design of products can have a significant impact on supply chain complexity. It can be argued that the supply chain begins on the drawing board in that decisions on the choice of materials and components can directly or indirectly impact total life cycle costs as well as agility and responsiveness.

Product complexity can arise because the number of components or sub-assemblies is high, or because there is little commonality across the Bills of Material for different products. The less the commonality at the Bill of Material level the less is the flexibility to vary product mix or volume.

5. Customer Complexity: Customer complexity arises as a result of too many non-standard service options or customised solutions. The costs of serving different customers can vary significantly. Each customer will exhibit different characteristics in terms of their ordering patterns, e.g. frequency of orders, size of orders, delivery requirements and so on. These

differences will be increased further as a result of the availability of different service options or packages and/or customisation possibilities.

Even though from a sales and marketing perspective there may be advantages to be gained from offering a range of options to customers, these decisions must be tempered by a detailed knowledge of their cost and agility implications. Ultimately the only complexity that can be justified is that complexity which delivers real value for which customers are prepared to pay.

6. Supplier Complexity: The size of the supplier base can add to supply chain complexity by increasing the number of relationships that must be managed as well as increasing total transaction costs. Because one of the pre-requisites for agility is a high level of collaborative working with key suppliers, this implies a high level of active supplier management and supplier involvement in process integration. It is unlikely that this degree of closeness can be achieved across a diverse supplier base and hence the need for rationalisation

7. Organisational complexity: Furthermost businesses have traditionally organised around functions and departments and their organisation charts have many levels and tend to be hierarchical in their structure. Such ‘vertical’ organisational arrangements are no doubt administratively convenient in that there can be a ‘division of labour’ between functions as well as effective budgetary control. However, they tend to inhibit agility because they are, of necessity, inwardly looking with a focus on efficiency rather than customer facing with a focus on effectiveness. A further problem is that over time the functions have a tendency to become ‘silos’ with their own agendas and they can lose sight of the fundamental purpose of the business, i.e. to win and keep profitable customers.

8. Information Complexity: Today’s supply chains are underpinned by the exchange of information between all the entities and levels that comprise the complete end-to-end network. The volume of data that flows in all directions is immense and not always accurate and can be prone to misinterpretation. Visibility of actual demand and supply conditions can be obscured through the way that information is filtered and modified as it passes from one entity or level to another. The so-called ‘Bullwhip’ effect is a manifestation of the way that demand signals can be considerably distorted as a result of multiple steps in the chain. As a result of this distortion, the data that is used as input to

planning and forecasting activities is flawed and hence forecast accuracy is reduced and more costs are incurred.

We have seen in detail the factors involved in the complexity of a supply chain. As both products and customers combine to add more complexity.

Many of the authors studied were able to describe the problem. With more or less coincide are agreed and have identified the sources of complexity nowadays in business.

A rare and uncommon quantity could make us understood in concrete sustainable actions how to reduce the complexity effectively without reducing turn to the variety.

Of all the authors studied on this research work for doctorate program I have not completely agreed with neither. The personal understanding that I can make this part of the research is based on a sum-of-concept.

Gattorna (2002) declares that the first step to reduce complexity apparatus should be focused on analysing in more depth to the end costumer to identify the elements they valued, what is called "criterion of uptake of orders." It should be major focus on managing processes and not just functions. He is very close to my criterion, but not enough to be completely according with him.

Then, these processes must be aligned to the value proposition of the company. This alignment forced the transformation of multifunctional teams in motor activity. The field processes implementation in Chapter 4 may be help us complete the theoretical level of complexity reduction applied to this study.

By the use of appropriate KPIs to ensure that any reduction in complexity is a company business priority.

2.5.1 Supply Chain Risk Management (and its relationship with complexity)

"Risk" as well as the instrument that are used for risk measurement strongly depends on the chosen field of research. More commonly risks definitions are based on the volatility of possible return; the concept of information deficits and the willingness to accept a potential loss of positive return are expected. In traditional decision theory, risk is defined as the variation in the distribution of potential result, their probability of occurrence and their subjective value. In this case, variances an instrument for risk measurement that allows quantifying the deviation from an expected value. In that case, risk may indicate either positive or negative component in practical business, whereas positive deviations are considered as chances. Therefore, risk may be defined as the product of the probability of occurrence of a negative event and the resulting amount of damage.

In the supply chain field, risk it is defined as the damage assessed by its probability of occurrence that is caused by an event within a company, within its supply chain or its environment affecting the business processes of at least one company in the supply chain negatively *(Kersten, 1998).* This definition differs to general definition because this definition includes the origins and sources of potential risks as well as all affected companies of a value chain.

The risks of a company can be classified according to their sources. A literature review gives several classifications. *Peck (2000) common* classification is the most used, shown in Figure 2.10. It was identified five sets of sources of risks within three areas considered: company, supply chain and environment. The sources of process and control risks are positioned within the company. Process risks essentially comprise disruptions within the production processes, while control risks add management failures and wrong or inflexible decision rules that lead to irregularities. Risks within the supply chain are mainly generated by disruptions of the material, information or capital flow between supply and demand risks.

In contrast, environmental risks represent all potential damage caused by socio-political, macroeconomic o technical changes.

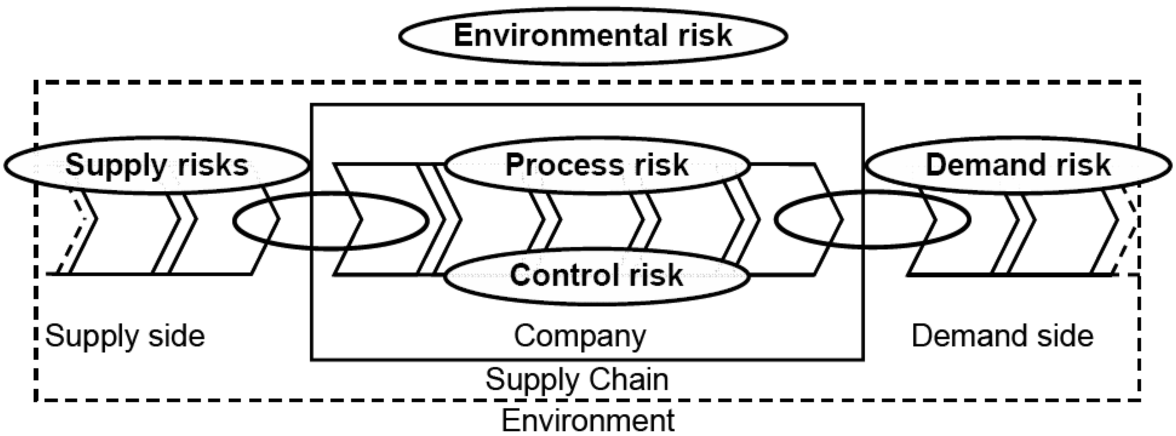


Figure 2.10: Peck Supply Chain’s risk categories

For this study case, at the South American regional context, we can resume the five sources of risk in the supply chain taking its functional causes or influences:

Demand risk:

- Loss of key accounts
- Demand volatility
- Concentration of customer base
- Short life cycles
- Innovative competitors

Supply risks:

- High dependence on key suppliers
- Consolidation in supply markets
- Quality and management problems from off-shore supply sources
- Potential disruption at the level of the second row
- Duration and variability of waiting times for replenishment

Processes risk

- Variability in production efficient
- Long-time processes and inflexible organization
- Equipment reliability
- Limited capacity and bottlenecks
- Key business process outsourcing

Control / Networks risk:

- Asymmetrical power relationship
- Poor visibility along the chain
- Inappropriate rules distort demand
- Lack of collaborative planning and forecasting
- Forrester (Bullwhip) effect due to multiple categories

Environmental risk:

- Natural disasters
- Terrorist acts and armed conflicts
- Regulatory changes

- Taxes, duties and fees (Argentina Constantly changes political scenarios)
- Strikes

It can be seen that in the area of risks relating to market demand context not unlike the global. And our case study behaved similarly to other global markets chemicals.

Then, by analysing supply risks of Colorin chemical plant and the whole Supply Chain network begin to notice certain salient and remarkable points.

Suppliers of raw materials placed in offshore countries present significant of reliability in their delivery times. Alternative suppliers speculate with that circumstance abruptly changing conditions of sale and delivery times. Already known and axis of this research is the high risk related to waiting times for replenishment. Lead times too longer may causes loss of firm commercial image and end customer's low compliance due to stockout.

Process risks will be facing in detail in chapter four. Focusing on the effects collaborative planning and forecasting loss of connection and lacks. Low level of outsourcing and manufacturing capacity limited due to operations poor management.

Environment risks are common in Argentina. Continuous changes in state political and economic plans. Uncertainly changes in tax rules and unstable trade's rules. Strong position of unions exerted negative influence on the operations scheduling due to frequent strikes.

Finally, some authors consider that supply chain management has to be extended by methods of complexity and risk management. However, to transfer these management concepts from the intra to the inter-organizational level, some modifications are required. Due to these modifications, we have two management concepts: Supply Chain complexity management and Supply chain risk management. This one's as the results from the combination between supply chain management and complexity and risk management

Using these concepts, changes of risks and complexity can be recognized, monitored and managed. This occurs because the design and the operation of a value chain on the inter -organizational level determine both the complexity and the risk within the value chain. The actual levels of risk and complexity are important inducing variables and affect supply chain management via the components of supply chain risk management and supply chain complexity management (Figure 2.11).

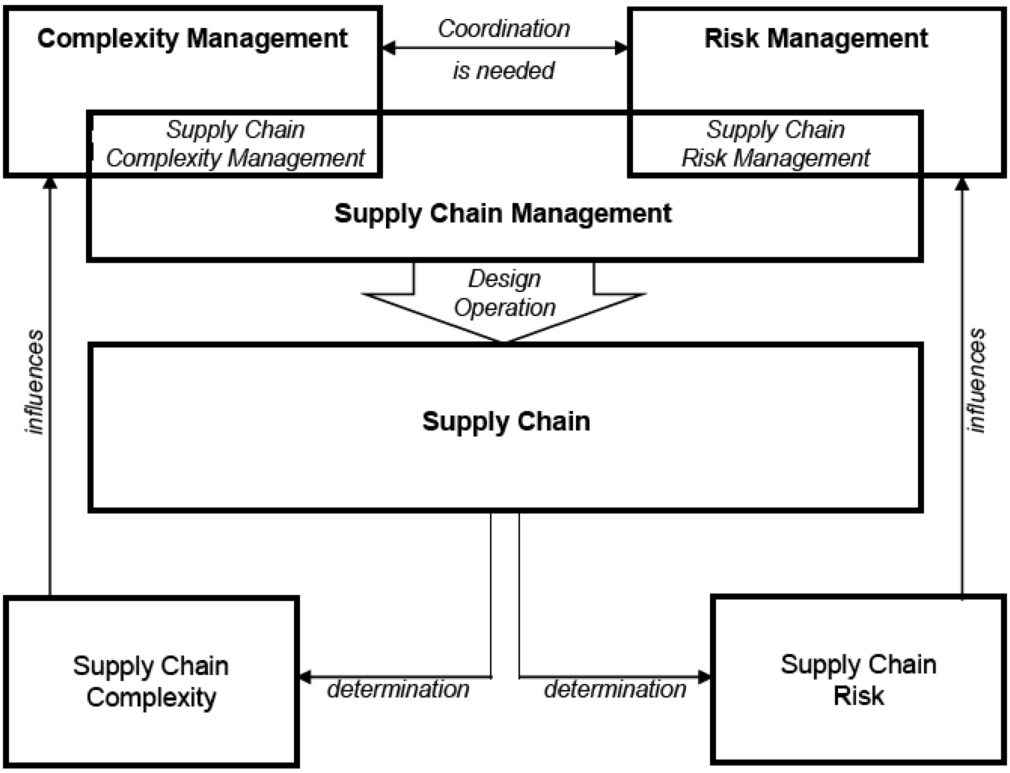


Figure 2.11: Supply Chain Risk and Supply Chain Complexity Management Scheme

Subsequently the management of risks affects not only the level of risks but also the level of complexity and vice versa, a need for coordination appears which goes beyond the simple integration of both concepts into supply chain management. Increased complexity of a system generally leads to the emergence of new or the intensification of existing risks. Congruently, a reduction of complexity often leads to decrease risks.

2.6 Supply Chain Coordination

Coordination is the management of dependencies between activities *(Malone and Crowston, 1994)*. The drive of coordination is to reach collectively goals that individual actors cannot meet. Coordination capability is affected by two main issues: information sharing and transfer decision rights across channel members *(Anand and Mendelson, 1997).*

Dependencies between activities are a prerequisite for coordination; if there are no dependencies, there is no need to coordinate. These dependencies stem from the lack of ability to control all the conditions necessary to achieve an action or a desired outcome

(Petersen, 1999). Activities may be firms, factories, organizations, processes, organizational units, or human beings that act in computational, human, biological, or other systems *(Whang, 1995).* Coordination may take place within operations, across functions: cross-functional coordination or between organizations: inter-organizational coordination.

Kypia (2007) remarks and ample the idea of the one made entity Supply Chain of *Gupta and Weerawat (2006)* that coordination is recognized when a decision maker in the supply chain, acting rationally, makes decisions that are efficient for the supply chain as a whole. Companies forming a supply chain are dependent on the performance of other organizations. The requirement to manage these dependences and different resource flows is important for a company's success. Supply chain coordination is an instrument for redesigning decision rights, workflow, and resources between supply chain members to influence improved performance (Lee, 2000).

High degree reached of coordination inside the members of the supply chain reduces problems of uncertainty in manufacturing networks *(Simatupang, 2004),* which in turn translates into reduced variability. Simatupang also provides the idea that uncertainty is the primary motivation for supply chain coordination.

Supply chain coordination offers a means to understand and analyze a supply chain as a set of dependencies. These dependencies exist both in physical flow, which is the flow and storage of goods, and informational flow, which deals with the storage and flow of information associated with those goods in the traditional design of interacting flows, when the physical flow has been the heart for designing the supply chain, information flow may result in inefficient decision-making and movement of information. Developments in information technology have made it possible to separate the design of information flow from the physical flow by, for example, shortening the information flow. By such changes, the number of decision points can be reduced and the quality of decisions can be improved.

Coordination mechanisms provide tools for effectively managing interactions between persons, processes, and machines and systems that interact in order to execute supply chain objectives. According to *Wang (2007),* an important supply chain coordination-mechanism is an operational plan to coordinate the operations of individual supply chain members and improve system profit.

2.7 Collaboration in Supply Chain

Collaboration is the basis of effective supply chain management. As firms continue to narrow their strategic focus to a smaller number of core competencies, the skills and talents of outside partners become more critical. This creates a growing reliance on resources that you may not control directly and on strategies that you may have no hand in developing.

An effective collaborative relationship can have major operational, strategic and financial benefits. It can accelerate entry into a new manufacturing and logistical process, increase flexibility, and provide access to expertise not available within plant and the whole Supply Chain. It can deliver cost savings or increased revenues—or a combination of both. Collaboration is a business arrangement that changes the overall dynamics between two or more partners.

Drivers of collaboration include the desire to access:

- A technology owned by another company.
- A technology that is too capital-intensive for one company to invest in alone.
- A competency and capabilities that is too costly to acquire, develop, or maintain.
- A new supplier’s network effectively closed off by high entry costs or preconditions (trade barriers, legislation).

Collaborating with a partner that focuses on the production of specialized materials similar to the component might allow this company to offload some of its fixed costs, but with an accompanying increase in variable costs associated with the increase in the level of external sourcing.

To make this approach pay off, the company must be willing to share any proprietary technology needed to manufacture the component, and its collaboration partner must be willing to invest in developing the additional capabilities needed to produce it. Since breakeven volume is lower, the company can compete across a wider range of volumes—albeit at the expense of gross margin at high volume *(Cohen and Rousell, 2005)*.

Ongoing collaboration on product designs and production planning can make the company even more agile while continuing to add volume to the specialized manufacturer's business. Both collaboration partners will benefit economically.

Collaboration is not an altruistic activity. While it may seem a best practice to provide "seamless integration" and "extended visibility" to supply chain partners, the fact is that true collaboration is very hard to reach, and there's no point in doing it unless you can achieve financial or strategic gain. For collaboration to be truly successful, therefore, it must deliver quantifiable economic benefit to all partners.

A collaborative Supply Chain simply means that two or more independent companies work jointly to plan and execute supply chain operations with greater success than when acting in isolation. Many researchers have proposed equivalent definitions to the collaborative Supply Chain. *Lambert (1999)* suggest a particular degree of relationship among chain members as a means to share risks and rewards that results in higher business performance than would be achieved by the firm individually. *Bowersox (1990)* reports that logistics alliances offer opportunities to dramatically improve customer service and at the same time lower distribution and storage operating costs. *Narus (1996)* define like collaboration to the cooperation among independent but related firms to share resources and capabilities to meet their customer essential needs.

While collaboration is based on a mutual objective, it is a self-interested process in which firms will participate only if it contributes to their own existence. Each member pursue to reach individual benefits such as eliminating redundant benefits functions, reducing transactions, achieving lower inventory, increasing responsiveness. The focus of a collective objective should be on the outcome and experience of joint offers to end customers. By sharing their resources and capabilities, participants can exploit profit making opportunities that they cannot create alone *(Simatupang, 2002).*

A system that adopts a collaborative model is commonly differentiated in terms of its structure horizontal, vertical and lateral.

Vertical collaboration happens when two or more organizations such as manufacturer, the distributor, the carrier and the retailer share their responsibilities, resources, and performance information to serve relatively similar ends customers (i. e.: Vendor Managed

Inventory, Efficient Customer Response, Collaborative Planning, Forecasting, and Replenishment) .

Horizontal collaborations occur when two or more unrelated or competing organizations co-operate their private information or resources, such as joint distribution centers.

Lateral collaboration aims to gain more flexibility by combining and sharing capabilities in both vertical and horizontal ways.

Simutapang (2005) classifies collaboration has a life cycle from time of engagement to disengagement. This contains four primaries and major processes. The first one aims to identify the strategic needs of collaboration, find the right partners with the correct capabilities, and set mutual agreements concerning performance. The second process involves forward looking planning to manage interdependencies of resources, tasks and capabilities for future requirements. A forward looking plan should be robust to face disturbance like demand fluctuations and rush sales orders and realistic the genuine resources insufficiency. Third, the chain members make daily operations to effectively meet the requirements of short and long-term goals. This is the implementation process in which the chain members execute the planning including how to handle exceptions and to assess the overall performance. Fourth, the analyses process is to calculate and decide either to modify or to terminate the agreements. These four basic processes apply to any kind of collaborative relationship.

A collaborative supply chain develops shared initiatives to ensure that each partner has a stake in success. It is proposed that the chain members should simultaneously consider appropriate performance measures, integrated policies, information sharing, and incentive alignment. The initiatives of correct performance measures and integrated policies address orientation issues and the initiatives of information sharing and incentive alignment address enables issues.

If orientation and enabling issues are aligned across the chain members, then potential benefits can be reaped successfully from an effective collaboration.

Implementing and maintaining a collaborative supply chain often means being confronted with resistance to change. Collaboration with multiple partners means that there is a need to identify and overcome sources of resistance to change. The collaborative supply chain can be used as a background to identify some causes of the managerial inertia that contribute to resistance to change. Furthermore, by viewing resistance to change in different layers, the participating members need to mutually understand core problems, proposed solutions, negative consequences, obstacles, real supports from partners, and fears. Based on these layers, they can focus on ongoing improvement that has a direct impact on chain performance.

Figure 2.12 try to briefing all the concepts described previously in a schematic diagram that shows the interconnections between the different actors included within the collaborative Performance System.

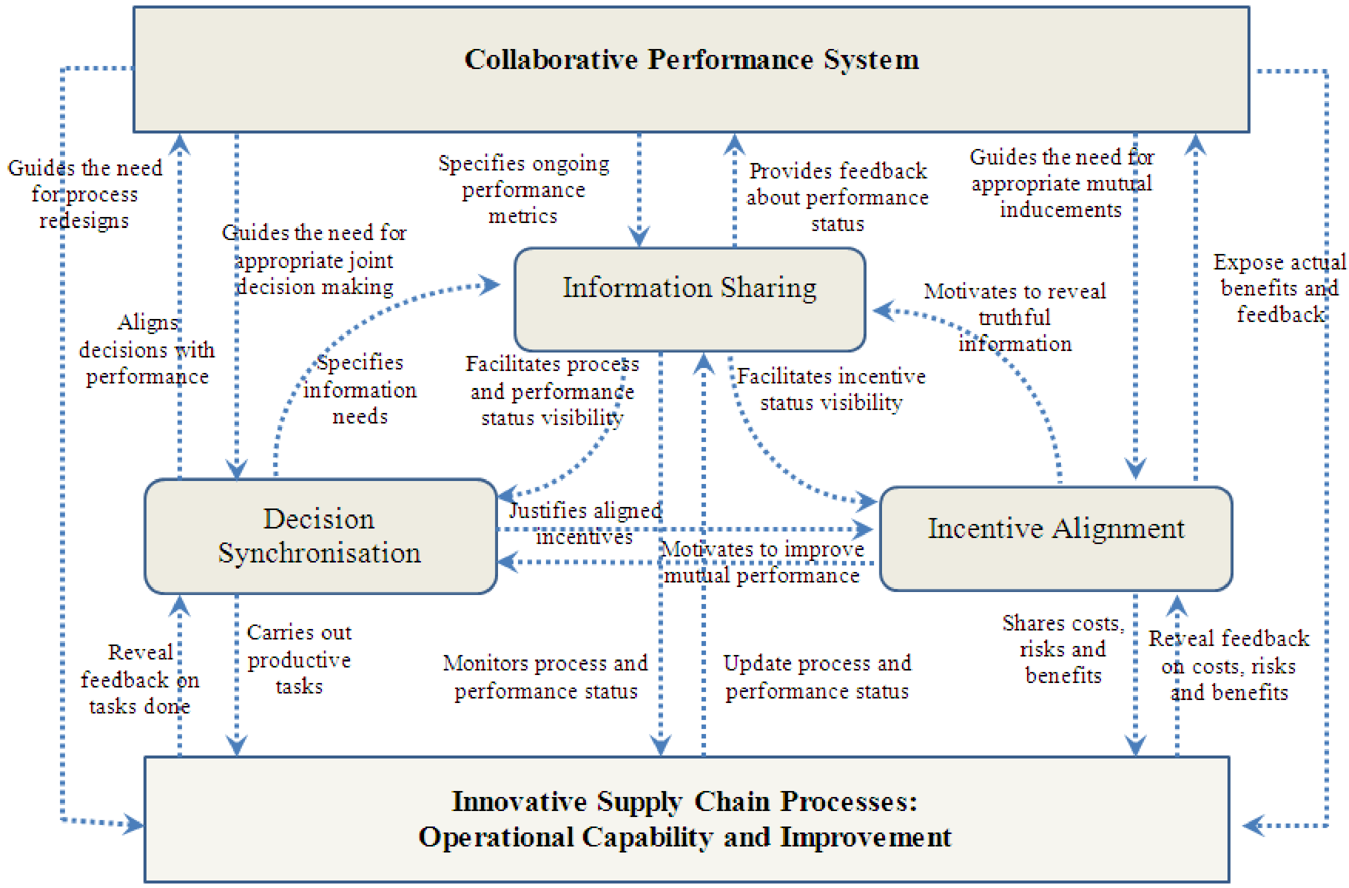


Figure 2.12: Relationship and interconnections between Operational Capability Improvement and Collaborative Performance System

3. METHODOLOGY

This chapter describes how the research was designed and conducted. It starts with SWOP analysis of chemical plant at the beginnings of the research. Following, an integral study of existing and desired supply chain structure is performed. Then, are presented the research questions (RQs).

RQ1 tries to identify the processes which will be possible to apply the SC new architecture and management system emerged from the theoretical study and practical benchmarking cases. The research design is then presented by the implementation at Plant's field level of the proposed innovative develop scheme using a coordinated collaborative improvement model.

RQ2 asks whether the chosen cases are adequate. Selecting the best alternative proposed for each thread. The applied methodology for any chosen field case of study is discussed at a generalized level. Choice a method of evaluation and performance measurement study clearly allowing proper performance.

The final section describes the interaction between the chosen processes within the practitioner's performed model.

3.1 SWOT Matrix of the Chemical Plant

SWOT matrix shown us as strength evidenced the high degree of technical knowledge related to the type of industry. The company had been for decades a leader in the chemicals market, with a high degree of innovation and product development. After losing market position and market share in business participation still maintained this competitive advantage. There were still within the human resources staff with high level of knowledge and skills of innovation and learning.

The biggest and evident limitation within the environment of the supply chain is one that gave origin to this research thesis is its very complex Supply Chain network. The industrial plant is located 800 kilometers from its unique distribution center (internal customer) .The suppliers of packaging and its accessories are also at the same distance. Raw material suppliers are a vast majority (86%) located more than 800 kms. In Argentina, the biggest industrial areas are placed in Buenos Aires and its surrounding areas.

The reasons for this distance of the plant are the tax benefits granted by the government of the San Luis region. This is a purely economic and financial profit. But these tax paybacks are excluded from the supply chain performance analyses. This geographic limitation gives origin to the strategic Supply Chain constraint. Then, starting from this restriction the research work consists in how redesign and rethink the architecture of the existing supply chain and optimize the processes inside the chemical plant trying to minimize the cost disadvantages related directly to the physical location of the factory.

Opportunities for improvement were identified in the number of processes that were made in the traditional manner. Each Area and Department inside the supply chain worked independently without any coordination and with a very low level of information and communication. No mediate their performances and there was a process of continuous improvement. There was a common strategy and had not studied the limitations or degrees of flexibility.

The most salient threats were internal at the company and consisted successfully implement coordinated actions to improve the management of processes and to take practical level. Fighting against the cultural change of the sectors involved and achieves the expected results and required by general management and corporation CEO.

3.2 Colorin actual Supply Chain against desired Supply Chain

While the initial analysis itself often helps to identify potentials and opportunities it may well be used for target-setting, on the other hand, the supply chain analysis should evolve in parallel to the changes in the real world. In this way the associated performance measures keep track of the current state of the supply chain and may be used for supply chain controlling.

An accurate analysis of the supply chain serves several purposes and is more a continuous task than a onetime effort. In today's fast changing business environment, although a supply chain partnership is intended for a longer duration, supply chains keep evolving and changing to accommodate best to the customers' needs. In the beginning or when a specific supply chain is analyzed for the first time in its entirety the result can be used as a starting point for improvement processes as well as a benchmark for further analyses.

3.2.1 Supply Chain management levels

The strategic level deals with decisions that have a long lasting effect on the company. This includes decisions regarding the number, location and capacity of warehouses and manufacturing plants, and the flow of material through the logistics network. The tactical level includes decisions which are typically updated anywhere between once every week, once every month or once every year. These include purchasing and production decisions, inventory policies, and transportation strategies including the frequency with which customers are visited. The operational level refers to day-to-day decisions such as scheduling, lead time quotations, routing, and truck loading.

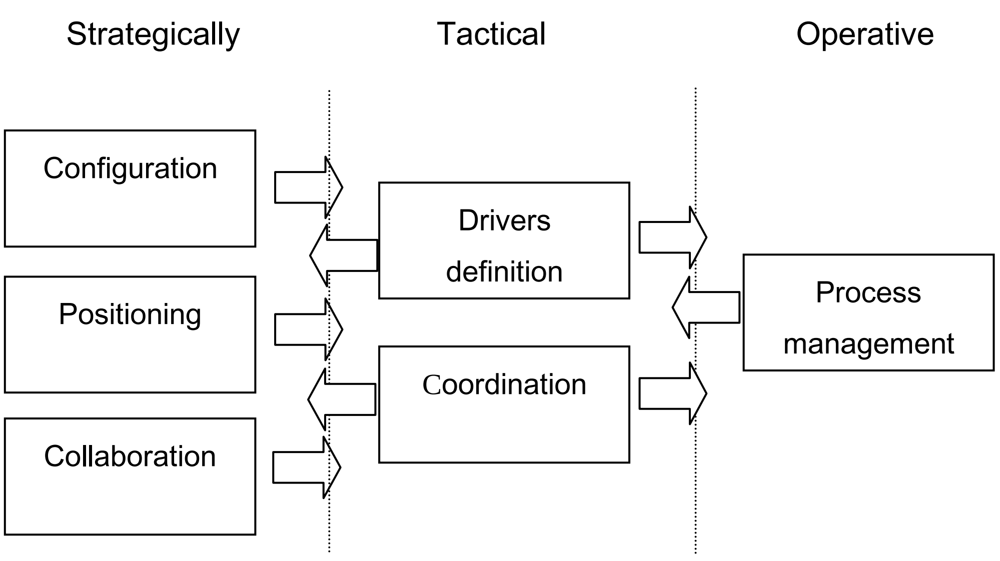


Figure 3.1: Supply Chain management level and structure

With this analysis for the Colorin manufacturing plant and its link into the supply chain was clear that the major limitation was undergoing a strategic issue in their level of analysis of the supply chain. In which us could not operate and change decisions. This chance it is only available to the top management.

So that, we can change and have influence was in the following levels. That situation gives the stimulus to this research work. Was shown that the opportunity was within a tactical level of coordination and strength pair problem solving, the increased flow of information was one of the drivers defined.

The combination of these tactical levels interacting with operating levels of process management and coordinated actions was a road that was worth studying, researching and developing.

3.2.2 Firm Supply Chain situation

The study of the theoritical background descrpted at the chaper two give us the tools to frame the study the chemical plant situation inside company Supply Chain. Being able to locate the plant and supply chain under a real context. Knowing and understanding its settings, areas of upstream, midstream and downstream. Its networking type, complexity and degree of collaboration.

Making a summary table, using *Walker* scheme, we could classify our case of research of the supply chain as follows:

From a single manufacturing site will produce all the goods of finished product is transferred to a single distribution center, which one distributes to different clients.

The plant is located on the upper and middle level (echelon) from where the raw materials received from the highest level through the Upstream. These components are transformed into finished products and capital gods, Midstream. Those are sent to the distribution center and from there to each end consumers giving rise to Downstream.

The Upstream works with a single source. The manufacturing plant is the only one that has the technological processes of transformation for the finished product. These are enamels, resin, paints, varnishes coatings and protective lacquers.

The product shipped from the manufacturing plant suffers no alterations to the ending costumer.

Inside Midstream, The type of bills of materials (BOM) corresponds to a type called "T". A limited number of raw materials: calcium carbonats (solids and emulsion), titanium dioxide, alkyd resins, mineral y vegetal pigments and two subproducts of oil refining: xylene and toluene.

With these basic components and their various processes of incorporation, chemical combination and variations in their reactions times born twenty families of finished products (paints & coatings) comprising over 750 sku.

Focusing on Downstream area, that one adopts the configuration of an indirect channel. Where all finished products leave the distribution center, from there to the different distribution centers of each retailes (Castorama, Leroy Merlin, Home Depot, Carrefour) and from there to the different shops and sales sites (Figure 3.2).

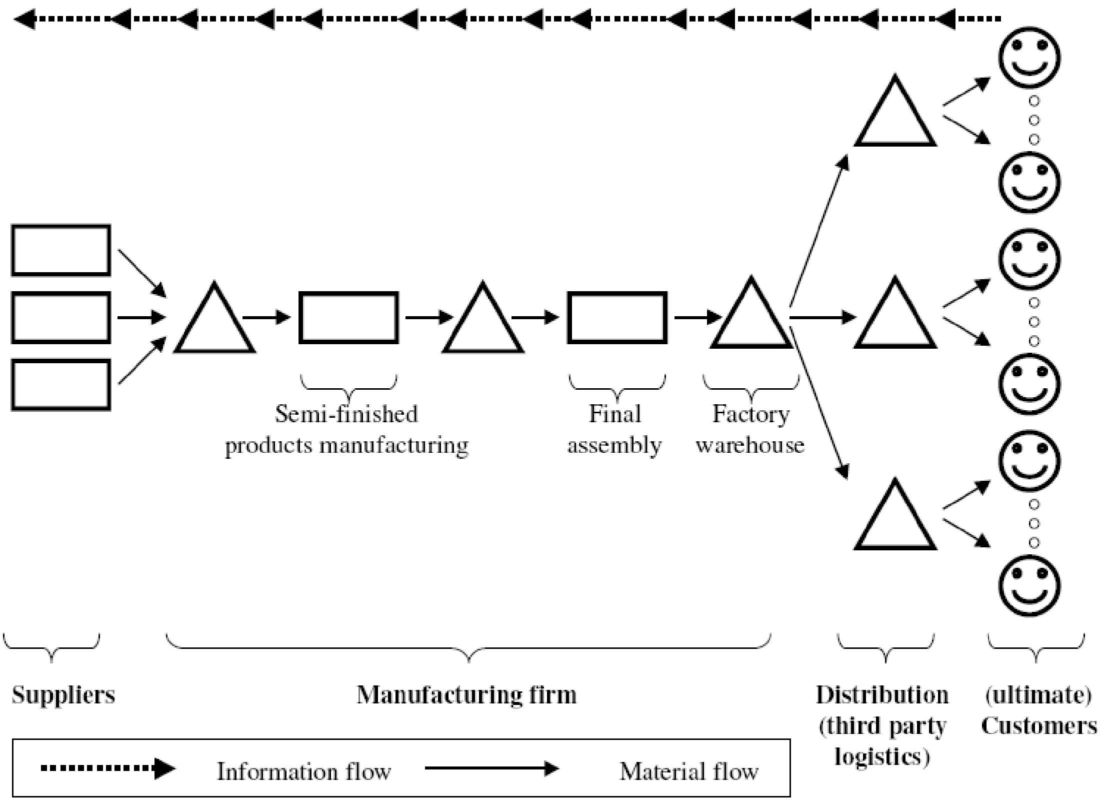


Figure 3.2: Serial network of Supply Chain scheme.

In what is the role of the plant in the Reverse Stream zone, only those products with high added value and filled in large containers (big cans) return to the manufacturing site for a recycling reprocessing and / or adaptation of formula.

Small defective units are not feasible to send a plant becauses higher logistic cost goes up compared to the recyclaying processes. This undesired actions, waste and metallic scrap, takes three parallel disavantages: the profit that it sales could may generates, the monetary loss of the finished product and the cost of special and final disposal being chemicals of medium level of toxicity and flammability. The ones made using solventborne.

About production and processing of chemicals which expiration in the ending consumer through retail sales areas. We are facing a typical serial network typology.

And where the greatest impact on competition focuses on knowledge and emphasis on key process. The added value comes mainly from the manufacturing process, the quality management and the Planning and Demand forecasting accurancy.

With any instrument spectrophotometer or chemical mass composer can deduct any product. The percentages and composition of each of its components. And , from these data reconsctruc a recipe or paint formula. You can also buy industrial reactors, filling machines and complex systems of piping. There are even companies that are involved in selling turnkey industrial plant for production capacity requested.

What differs to a painting of another are the quality levels, performance and delivery lead times. The competitive advantage is the adding value through production, internal logistics and better planning processes and its implementation in each batch of finished product.

Surely to give base support base to the supply chain and the manufacturing plant in particolar there must be advanced technology. According to the process requirements. Then, as a result of sustained maintenance of the quality and level of service is a channel generates loyalty and confidence with the consumer.

Colorin has on intelligent relationship with its partner inside its supply chain network. Strong suppliers belong to other multinationals chemical companies (Basf, Dow, DuPont, Clariant and Shell Oil) with a strong market position.

Each one is focused to seek its industry leadership in business and market share. They trying to grow into his blue oceans' of offered services and products.

At the previous years, the information exchanged between partners and communication channels were poor and only obeyed to monitor and review schedule truck unloads, product specifications to be reviewed or extraordinarily provision of temporary exclusivity for the use of any new product developed in the laboratories of each.

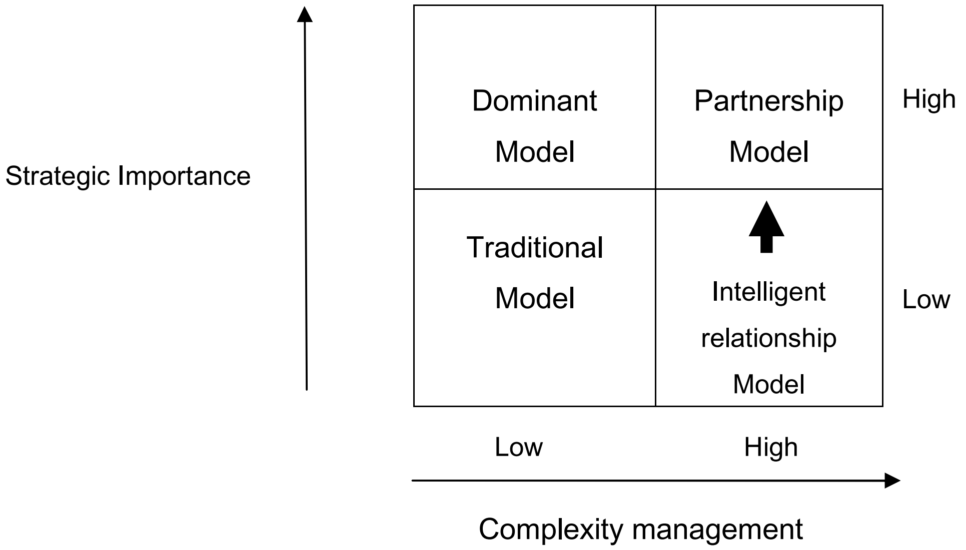


Figure 3.3: Relationship matrix

When starting this research work, positioning and relationships between different organizations, areas and departments, objects of our study case was appropriate for intelligent relationship model.

Three years later, still continues in that quadrant. But the evolutionary status continues to grow resulting in a major strategic importance. While growth has shifted toward the partnership model, with implement improvements process. This evolution can be viewed later when are shown the results of the chosen elements of our coordinated model of improvement.

Similarly, to identify the state of the art for measuring the degree of collaboration and integration level to measure the level of coordination.

We talked about the disadvantages of institutional factors of influence related to the physical location of the manufacturing plant and its huge distance to distribution center. Moreover, within the institutional factors should be highlighted to the context of the economics of Argentina limitations on imports of foreign raw materials and an inflation rate approaching 30% yoy.

These factors outside the influence of the SC will be a decision of the focus arguments for the choice of some of the processes that become part of the coordinated model.

During these three years the supply chain passing a configuration based on a criterion manageded vendor replenishment (VMI) to a transformation to a synchronous SC architecture. This evolutive change and its causes and argoments will be descripted in details in the next chapter refering to field case results.

While much remains to be done, it was changed the structure and the way of work. As can be seen below when presenting the case studies implemented. It could happen in a scheme where the plant took full responsibility for the management of the stock and its production programmed based on the most demanding customers. Regardless of medium and small customers who had to wait to meet production plans dedicated to large customers. In the months of demand but had no response. That motivated his escape towards competition.

Production volumes and sales remained at their values and objetives defined by the top management. The plant was down complexity by reducing the mix of orders. Increasing its efficiency indicators to make more batches of the same product.

But it rising concentrated in a few customers who by increasing their purchasing volumes were demanding conditions increasingly advantageous sale for themseleves.

At the end of this research case, SC is working with a different way that has involved all customers, not only the larges.Trying to diversify the range of sales and therefore taking in count production and logistics for any type of customer. This can be more resilient to changes and improving conditions of sale.

While the complexity of the production plans has increased, this was balanced with some of the processes implemented in the coordinated improvement model.

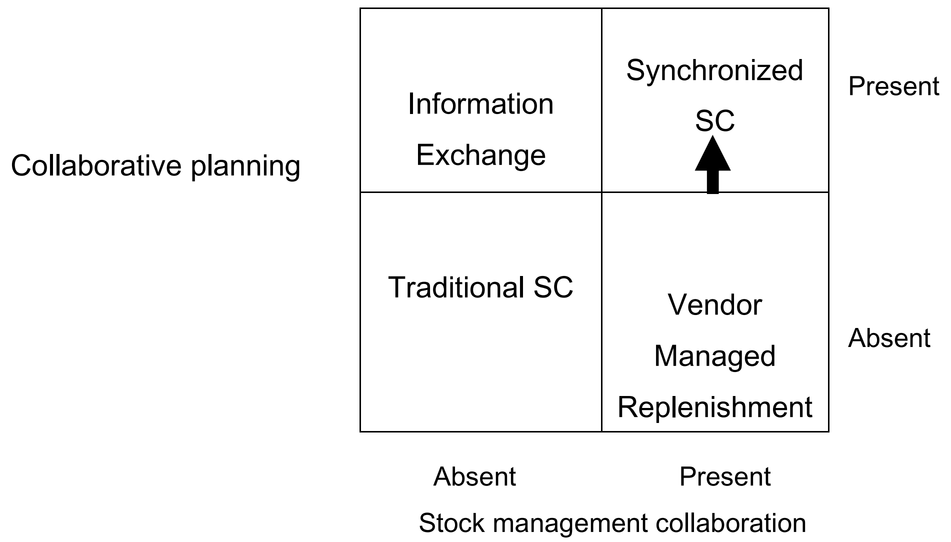


Figure 3.4: Collaboration matrix

3.3 Research Questions

How to improve the performance of a complex Supply Chain network in chemical manufacturing company, at the operational level, is chosen as the focus of this thesis. The first research question is expressed based on the identified gaps in the literature.

The first gap is related to the selection of approaches taken in supply chain models. How to select a suitable supply chain strategy according to sales demand and market product features has been investigated in several studies.

The authors do not consider complex schemes of supply chain and proposed practitioner field solutions to support the supply chain efficiency. There are insufficient cases of study of how supply chains with different levels of complexity and uncertainty can be sustained with operational improve processes.

Based on these definitions the first research question (RQ1) is expressed like:

How to identify an operational plan to improve Supply Chain performance with the descripted structure and environments restrictions?

What is the scope when managing this complex network of facilities and material? We define supply chain management as follows: Supply chain management is a set of approaches utilized to efficiently integrate suppliers, manufacturers, warehouses 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 costs while satisfying service level requirements.

This explanation leads to some notes. First, supply chain management takes into consideration every facility (Manufacturing Plant included) that has an impact on cost and plays a role in produce the product conform to customer requirements; from supplier and manufacturing facilities through warehouses and distribution center to retailers and sales stores.

Definitely, in some supply chain analyses, it is necessary to account for the suppliers' suppliers and the customers' customers because they have an impact on supply chain performance.

Second, the objective of supply chain management is to be efficient and cost effective across the entire system', total system wide costs, from transportation and distribution to inventories of raw materials, work in process and finished goods, are to be minimized. Accordingly, the accent is not on simply minimizing transportation cost or reducing inventories, but rather, on taking a systems approach to supply chain management.

Third, supply chain management orbits around efficient integration of suppliers, manufacturers, warehouses and stores.

In conclusion, there is no precise method to directly confront our case. A supply chain with a complex network due to not closely manufacturing Plant must be studied and focused like any other supply chain network.

Each supply chain will have its particularities. Their points of strength and weaknesses and opportunities will be different. Even if you were to find a case in the bibliography that has a high percentage of matching items, this may not be directly applied due to fluctuating market context, the country economic situation and the evolution of supply chain members and partners have changed.

We know that there is no specific performance improvement plan for our case study. It must come from a generic model and be us who would add value to the application of the boundary conditions that distinguish it.

Then, based on literature and benchmarking practical case studies we define the structure of an improvement plan. There are four major steps to putting a performance-management program in place:

1. Setting of supply chain strategy objectives. Start with company’s business strategy, and then develop supply chain objectives that support this strategy.
2. Select supporting metrics and targets. Identify the specific metrics and targets that will be used to track progress toward our supply chain objectives.

3. Identify supporting initiatives. Develop performance-improvement programs to help meet the supply chain objectives.
4. Implement the programs. Collect data and develop tools for reviewing the data and to support decision making.

Compatibly, in our research case was created supply chain objectives and priorities that supported Colorin's business strategy. Although senior management may agree with the supply chain strategy overall, opinions have may vary as to which supply chain performance criteria are most important. This is where a standard framework for performance management.

To validate the supply chain priorities was developed sessions of interview with managers, team leaders and operating coordinators. A good tool, also, will be conduct workshops. Once key objectives expressed during these sessions was pronounced then can be validated them with the entire management team and with other stakeholders inside and the organization.

Once we've agreed on the key objectives of chemical firm supply chain strategy, was identify the metrics that will use to gauge progress toward those objectives. The best place to start is with an assessment of current performance levels on each Supply Chain driver selected.

It was very important group the metrics according to which aspect of the Supply Chain strategy they support. Then, have been used the standard definitions to determine the baseline performance level and internal benchmarking to set the three years targets.

Achievable targets were chosen in order to have results inside the duration of the doctorate program.

Starting with limited metrics and insist on widespread use before adding other metrics. Begun by looking at all existing initiatives, their expected impact, and how well they're aligned with the objectives of our supply chain strategy. Eliminate any initiatives that are redundant or misaligned, identify gaps that might prevent achieving the stated objectives, and develop programs to address those gaps.

Then update performance targets, securing targeted improvements to specific activities to clearly show the cause and effect.

Figure 3.5 summarizes and outlines how it is carried out the methodology chosen for the improve plan to our study case inside the supply chain.

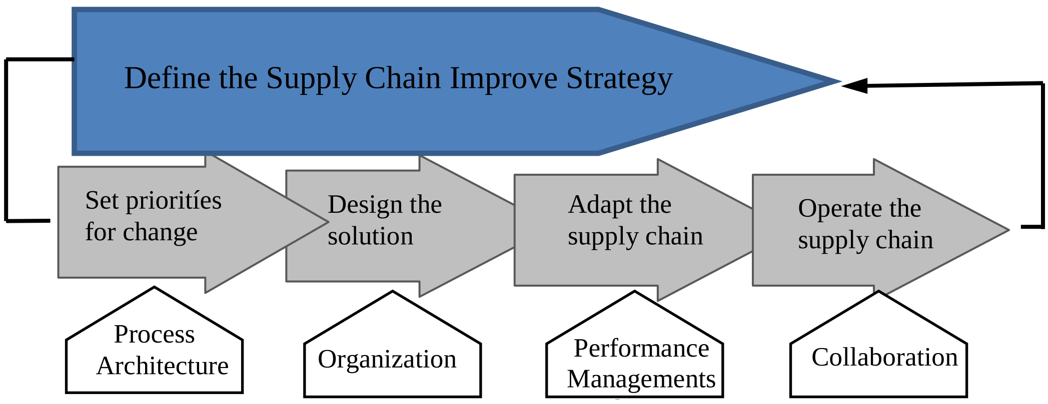


Figure 3.5: Supply Chain continuous improving cycle methodology.

At this point there were several models to try to address the problems identified by using the methodology explained above.

Was analyzed several alternatives to focus on issues related to the management of the warehouses, the serious problems that originated in the wake of low accuracy of sales forecasts. Which then caused high volumes of purchases of raw materials in some cases and in other offices absences finished product in the distribution center, stockouts.

We also had the serious problem of high complexity of the manufacturing batches with high tank cycle times (production times). Complexity that was born in longer manufacturing processes that contained numerous internal semi-finished productions that increased the amount of quality controls. And, at the same time increased the warehouse management of more raw materials and semi-finished inside the plant.

Due to plant's localization, lead times, both for the reception of packaging and raw materials needs up to the delivery of finished products was big trouble to face.

With this background, the question was: Which process address? With what level of detail and scope?

The answer came from the experience and academic guidance. The idea and concept of a coordinated model of process improvement was instructed by my tutor, Professor Di Gravio. In order to performing a network interconnected processes, to which not only improves its efficiency benefits to the simple process in itself, but its contribution reaches that entire coordinated network. In this manner, it is possible achieving a synergistic result and benefits for the whole Supply Chain network.

The plan was not to focus on a single aspect or topic of study. The main idea consist to plan that would be based on the selection and implementation of process improvements in various drivers of supply chain, all of them related to the plant.

Upgrading actions implemented in the practical field and the contribution of each of the selected processes **converging ended optimized to improve performance of the chemical plant**. And this one, was our fundamental objective when were defined the scope and motivation of the doctorate research.

Moreover, it must take on count, to should consider that even against any scheme or approach a correct methodology and appropriate implementation sometimes is present a critical gap between the theoretical and the actual field daily work.

Already knowing the methodology for optimization and knowing how to implement the program is coordinated process improvement, comes the second research question RQ2:

How to select processes for greater impact on the plant performance?

Once again, the answer is in the same development of this research. No book, paper or benchmark study case can analyze this situation in particular and say us which proposed processes are more sensitive or in need of a redesign. But bibliography can show the basic principles to recognize them. From there, begin to identify Colorin's environmental factors that most influence. To get to a scheme proposed by *Chopra & Meindl*, which classifies the driver of the supply chain and which are selected operational processes which will work to create this coordinated model improvement.

- Plant & Warehouse:
  - Place/Location
  - Capacity
  - Production/manufacturing management
  - Materials management

- Transport:
  - Transportation
  - Networks and routes
  - Outsourcing

- Stocks:
  - Elemental stocks
  - Safety stocks
  - Seasonal stocks
  - Supplying

- Information:
  - Push against pull
  - Coordination and sharing
  - Forecasting and Planning
  - Prices and profit
  - Technologies

Here begin the practical limitations of case research. Not all processes and sub processes each driver could access or direct participation. Some areas were not initially inclined to the original idea of this research and even less at first rejected the collaboration and information sharing.

Each company is made up of men; sometimes these men work and live with prejudices that cause limitations in the implementation of collaborative improvement case.

Finally it was decided to choose a process of improvement of at least any different driver. Those ones are development mainly inside the chemical plant, where the researcher had the highest degree of responsibility at the decisions that were made relating plant processing. So the conditions were guaranteed to applied the proposed changes and then measure the results.

The processes chosen were finally five. Trying to follow a logical endpoint whose convergence in a scheme to improve overall plant performance. Also, it took into account the increased complexity, poor production scheduling, high logistics costs, inventory levels. Plant points of improvement those were too susceptible against external tools of decision like index of inflation, Argentine economic uncertainty and limits on imports of foreigner raw materials.

1. Planning forecasting method.
2. Standardization of logistics truck system between plant and distribution center.
3. Outsourcing strategic plan in order to identify and develop local suppliers at San Luis and surrounding areas.
4. Program management to waste reduction in Plant operational areas.
5. Manufacturing batch complexity and outsourcing program to semi-finished processes.

3.4 Research approaches used in study cases

Planning forecasting method: This field research first case corresponds to the driver information. Initially due to my education, training and my knowledge before starting this doctoral program (structural designer and then laboratory quality manager) was that it had less knowledge. From there I went to work intensively in a systematic and comprehensive theory concerning of this driver in particular, specially about systems of coordination and collaboration information sharing. Like it has been expressed in the chapter two dedicated to the study of the theoretical foundations.

In this sub process the ultimate goal coincided with the assignment of priorities. These were to improve sales forecasts accuracy which was causing serious difficulties in managing the firm purchasing area and consequently the master plan of production.

Also brought with it the low efficiency in the plant warehouses where raw materials and packaging had leftover fabrications that were not in the master production plan while awaiting the delivery of those supplies that were scheduled within the weekly and monthly manufacturing program.

The research was conducted in two stages. The first was made a detailed study covering each of the members involved in the making of the forecast and its internal customers. Knowing that forecast serves as a platform for the making of the manufacturing production program and then resulting the requirements of raw materials and packaging materials through MRP tool. Was identified the degree of collaboration between the actors in this process and the existing level of information sharing.

Then, as a second step, ran in parallel to the sales forecast rising from the marketing department, a more complex algorithm to forecast estimation. This one, was designed, programmed and executed by the researcher supporting by the collaboration of purchasing and planning technicians in a clear alignment joint effort and information sharing between Supply Chain areas.

Standardization of logistics truck system between plant and distribution center: Deep on transportation SC driver was addressing this sub process taking account the particular design of company industrial logistic. Since the plant does not perform any kind of end customer delivery. It is the only manufacturing facility of the company and all its finished products travel the 800 km to ship in the distribution center and followed gave place to logistics distribution to the customer.

This condition generates the opportunity to improve by standardization of the fleet of trucks that performs daily connection between the node of the plant and distribution center node.

Was studied and implemented an investment project in order to ensure the feasibility of the proposed changes. Coordinate with the financial area credits and cash flows for different stages of gradual replacement trucks fleet.

Then, once standardized internal logistics system, the implementation of procedures and work instructions for optimizing the load count, the decrease of the loading and unloading times. Besides, the consequent decrease in inventories of spare parts and systems improvement in predictive and preventive maintenance, with the logical increase of trucks reliability and dead times reduction.

Outsourcing strategic plan in order to identify and develop local suppliers at San Luis and surrounding areas: The benefits of outsourcing are already known and many authors have described its benefits. The opportunity for improvement for this sub process is based on two advantages. Outsourcing as a tool to complexity reduction of the plant and also the decrease of costs associated with the logistics.

The methodology for this process was conducted in an analysis of potential local partners. Identify which services and products for the plant would be beneficial and quantify that resources they needed to be able to supply their products in the quality levels that the plant needed.

Not many outsourcers found within the San Luis region. Most needed an upgrade technological, managerial or financial up to reach the standards required. The plan then was built on a second stage where Colorin performed knowledge transfer and financial assistance. These actions resulted in a benefit to both members where Colorin from its dominant position could retain strategic partners and ensure the provision of the components, packaging and new raw materials (former plant's semi-finished chemical's needs).

Program management to waste reduction in Plant operational areas: The objective was clear. Reach maximum reduction of all waste originating within the manufacturing system. From a Lean Management approach implement a process improvement to reduce the high levels of steel made crap and general waste inside packaging management.

The methodology was based on an initial stage of data collection extended for more than five months. By having a comprehensive description of what are the sources of waste in both the low and the high manufacturing annual seasons.

After that, with identified those incident sources propose an annual action plan to address the generation of waste and analyze its performance and evolution.

Manufacturing batch complexity and outsourcing program to semi-finished processes: this last sub process related to the plant driver was the most laborious of developing. It was also the one who had the most unexpected results. The objective and main scope was to reduce the plant production levels of complexity and thus adapt to Agile manufacturing scheme.

The methodology for the application is centered on the creation of an indicator for level of complexity. This was obtained as the result of a formulation where its components are the various factors affecting production. Then, work with common production recipe models and postponement manufacturing actions for colored waterborne paints and enamels.

These actions implemented joint with outsourcing program of products with low turnover and high margin of profit becomes the base for complex reduction.

3.5 Planned collaborative model vs. Practical collaborative model

As was stated in the previous section, there were gaps between those improvement proposals initially designed for coordinated and collaborative model and what was actually carried into practice.

Cultural, barriers, economic and financial limitations, low resources disposal for implementation and also time available to mature processes and demonstrate results.

But the idea of this research for the doctoral program was not getting all the data of the sub processes chosen, rather lay the foundation of a networked improvement model and analyze labor trends and influences between actors.

From then validate this proposed scheme as a performance improvement tool for the study of a generic supply chain.

4. COORDINATED IMPROVEMENT MODEL: RESEARCH CASES

This chapter discusses and shown answers to the question of how this chemical manufacturing company can implement operational coordination actions (RQ1). With these actions like a collaborative model that improve the efficiency of the selected plant's processes. Each one being part of an integrated system that converges in a Plant performance common goal, which is increase supply chain performance.

Their results are detailed as well as the percentage of the total impact on the management of plant performance (RQ2).

The next figure 4.1 shows the five selected processes model with interconnection, supply chain associated drivers and expected goals to achieve for each case:

	Collaborative Process Name	Related Driver	SC Members participant	Other firm areas involved	Key Processes addressed	Expected Goal
4.1	Planning forecasting method for Plant manufacturing optimization	Information	Planning - Plant - Purchasing	Marketing - Sales Commercial	Forecast Accuracy - MRP generation	Increase Fct. Accuracy in 15% at least
4.2	Standardization of logistics truck fleet system between plant and distribution center	Transportation -Plant	Plant Logistic - Maintenance - Dist. Center	Finance - Administration	Truck fleet standarization	Improve 5% overall logistic costs
4.3	Outsourcing strategic plan in order to identify and develop local suppliers at San Luis and surrounding areas.	Inventory - Transportation - Information	Enginnering - Manufacturing - Logistics	Research and development	New packaging development - Semifinished outsourcing	Add local suppliers in grade to guarantee Colorin specifications
4.4	Program management for packaging waste reduction in Plant operational areas	Plant - Inventory	Manufacturing - Logistics - Laboratory	Human resources	Sources and causes identification - corrective actions	Reduce waste generation in 30% yoy
4.5	Manufacturing batch complexity and outsourcing program to semi-finished processes	Inventory - Transportation - Information - Plant	Manufacturing - Logistics - Laboratory - Engineering	R&D - Finance	Manufactiring process upgrade - Semi finished Outsourcing - Postpoinment production model	Reduce production complexity - Increase 10% productivy in Liters by man hour.

Figure 4.1: Scheme summarizing the main characteristics of the five processes of improvement and their goals

4.1 Planning forecasting method for Plant manufacturing optimization

This first sub process was the first individuated in the beginnings of this research work. For a plant located over 800 km from their main suppliers and internal customers the proper planning of their productive requirements in function to forecast sales demand is a priority.

Planning supports decision-making by identifying alternatives of future activities and selecting some good ones or even the best one. The improvement starts with whole and exhaustive analyses of demand planning. According theoretical background of to *Domschke and Scholl* it was subdivided into the following phases:

- Recognition and analysis of a decision problem,
- Definition of objectives,
- Forecasting of future developments,
- Identification and evaluation of feasible activities (solutions), and finally
- Selection of good solutions.

The purpose of Demand Planning is to improve decisions affecting demand accuracy and the calculation of buffer or safety stocks to reach a predefined service level. All decisions in the whole supply chain should be based on already fixed (accepted) customer orders and planned sales or forecasts, the latter ones are determined in the Demand Planning process.

Therefore, the performance supply chain entity depends on the quality of the demand plan (accuracy). This also implies that these figures need to be the result of a collaborative effort.

It started from the study of the whole MRP process as it details the authors concerned and also as explained in the methodology of work. The critical step of this materials requisition program is for our study case demand planning and its level of accuracy.

Starting at 2010, was focalized the subject of long-term research during that first year to had a comprehensive mapping of all processes involved. On this multifaceted map was detailed each of the subsystems and their process and side supporting sub processes which are input MRP system, including our research focus target: demand planning.

These processes were grouped according to areas that were generated:

- ✓ Marketing (responsible for sales forecast estimation)
- Purchasing
- ✓ Planning (like forecasting data process stakeholder)
- Plant Operations

The process map details of such area require a consistent data collection work. Here begins the first values to analyse, understand and then try to correct. In the process of sharing information between different areas, plant operations carry out almost the half of the elapsed time. For an average duration of this process of 84 hours straight and continuous, the plant operations area in charge of flow information management consumed 37 hours.

As it was possible that half the time out to this sector which has to load only the formulas and production orders as defined in the master schedule manufacturing? While the area of marketing, responsible for making calculations and estimates of sales forecasting, consume only 18 hours on average.

Figure 4.1.1 shows process time compound by areas for total duration for the production scheduling procedure: 84.38 Hours. Average values emerged during ten months of data acquisition for a given month “N” taken in count the critical way of elapsed times.

	Area	HS	% o/Total
1.-	Marketing	18,1	21%
2.-	Planning	18,3	22%
3.-	Plant operations	37,8	45%
4.-	Purchasing	10,2	12%
	TOTAL:	84,4	

Figure 4.1.1: Process time composition.

This first value conformation obligate to took a step forward in the study of the composition of time to really know which sub processes were those who needed more time. For this purpose is now divided in the time of analysis and estimation, that means time for value-added tasks, from that time dedicated to data loading.

	Area	Analysis		Data entry	
		Hs.	% o/tot area	Hs.	% o/tot area
1.-	Marketing	14,5	80%	2,0	11%
2.-	Planning	15,1	82%	1,9	10%
3.-	Plant operations	19,0	50%	17,0	45%
4.-	Purchasing	4,0	39%	1,6	16%
	TOTAL:	52,6	62%	22,5	28%

Figure 4.1.2: Process time composition divided by data entry and value added tasks.

In this second scheme, Figure 4.1.2, it is shown times compositions. This Figure reproduced data entry elapsed times and data analysis for each area of the company. Although, as expected almost all of the time related to data loading correspond for plant operations. Still value of analysis for this sector remains very high and even above the times needed by the marketing sector.

Again repeats and restates the inquiry. Leaving aside times no added value: why should the operations plant area consuming much time in this process?

The first analysis conducted to answer this question was focused on knowing whether the availability of physical and information resources were appropriate for the required work. Trying to determine if this is a problem related to a human resource constraint, a problem in the loading process sequence or technical impossibility of using an IT sharing program under an unfriendly interface that delays efficiency times.

The answer came by the use of benchmark comparisons with other industrial plants belonging to the controller group (Materis Paints). Sharing Information with others responsible for the industrial sites in Italy (Porcari, Resana and Cassavatore) and France (Lyon, Dunquerke and Le Mans) it became clear that the allocations of personnel dedicated to these tasks were similar and that the information systems that were used in these European factories did not differ much from those used in Colorin.

Once these factors discarded, Now to the new instance of this first sub process to improve was attempt to uncover and analyze some of the causes that produce this lost efficiency in the final production master plans and consequential delayed on the purchase orders to the suppliers and the logical raw materials shipment and out of time delivery at the industrial plant. That is, poor chemical plant performance.

This analysis was conducted focusing on differences that arise between the initial production plan and final production plan settled and adjustment. The monthly production plan consists of two stages. The initial production plan is made and programmed fifteen days before the start of the month and where it becomes the first estimation and MRP running. Then, becomes settled five days before taking account the changes in marketing forecasting estimations, new strategic and market sales and operational failures that cannot guarantee the manufacturing in the current month ("N-1") due any kind of problems.

This second final schedule should contain only minimal changes but the reality shows other face. The changes listed in the report both for the volume produced by the plant (liters of paint) and for manufacturing batches of and their respective SKU's show some significant conclusions.

Then we will see the results for the ten months of data collection in 2010. They show a figure for the sales forecasts estimation process and then as the production schedule is determined as function of planning analyses. For both values of total production in liters and its composition and complexity in the different items that make up this volume of production (SKU's).

	Quantity of SKU						
	PLAN ORIG	FINAL PLAN	MODIFICATIONS			TOTAL	
			ARITMETIC	>0	<0	SKU	%/Orig.
JANUARY	533	533	0				
FEBRUARY	530	529	1	176	239	415	78%
MARCH	533	533	0	37	489	526	99%
APRIL	533	530	3	46	24	70	13%
MAY	530	529	1	56	448	504	95%
JUNE	531	531	0	177	212	389	73%
JULY	531	530	1	131	379	510	96%
AUGUST	532	534	-2	115	414	529	99%
SEPTEMBER	472	475	-3	129	280	409	87%
OCTOBER	476	476	0	216	116	332	70%
AVERAGES	520	520	0	120	289	409	**79%**

Figure 4.1.3: SKU's Forecast changes between first and second estimations.

	LITERS						
	PLAN ORIG	FINAL PLAN	MODIFICATIONS			TOTAL	
			ARITMETIC	>0	<0	Lts.	%/Orig.
JANUARY	917412	917412	0				
FEBRUARY	827221	841425	14204	35332	-21128	56460	7%
MARCH	1103166	1028806	-74360	3180	-77540	80720	7%
APRIL	955563	1029192	73629	87002	-13373	100375	11%
MAY	773242	600703	-172539	18280	-190819	209099	27%
JUNE	831145	790618	-40527	45264	-85791	131055	16%
JULY	1028871	956766	-72105	60971	-133076	194047	19%
AUGUST	1149395	1070575	-78820	56537	-135357	191894	17%
SEPTEMBER	915860	840788	-75072	49652	-91246	140898	15%
OCTOBER	1312611	1341261	28650	97551	-68901	166452	13%
AVERAGES	981449	941755	-39694	50419	-90803	141222	**15%**

Figure 4.1.4: Volume (liters of paints) Forecast changes between first and second estimations.

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In Figures 4.1.3 and 4.1.4 is shown the differences between the two sell plans for the variable liters and for each item of production (SKU). It also details the direct algebraic sum (net sum) from one sell plan to another and its decomposition between products that are added to the plan (>0) and those who were removed from the original plan of sell (<0). The last two columns show the total variation [>0 + <0] and its percentage relationship of the original marketing forecasting of sales.

It is remarkable to see that the variation of the relationship of total volumes (15%) is maintained in permissible values for this type of chemical industries; however variation in the SKU (near to 80%) reaches unexpected values hindering any try of plant planning to issue WO's in advance with the intention of improving response times and service level.

Analyzing the next phase of the process of manufacturing schedule generation we see the results for Planning, also divided to the total volume of planned paint to be manufactured and its categorization in manufacturing items (SKU).

	Quantity of SKU						
	ORIG PLAN	FINAL PLAN	MODIFICATIONS			TOTAL	
			NET SUM	>0	<0	SKU	%/Orig.
JANUARY	158	167	9	9	77	86	16%
FEBRUARY	189	192	3	85	87	172	91%
MARCH	183	191	8	77	78	155	85%
APRIL	185	184	-1	90	79	169	91%
MAY	153	173	20	72	49	121	79%
JUNE	189	191	2	48	55	103	54%
JULY	192	193	1	50	66	116	60%
AUGUST	189	178	-11	23	65	88	47%
SEPTEMBER	178	179	1	57	72	129	72%
OCTOBER	176	177	1	39	46	85	48%
AVERAGES	179	183	3	55	67	122	**64%**

Figure 4.1.5: SKU’s planning changes between first and second forecast estimations

	LITERS						
	PLAN ORIG	FINAL PLAN	MODIFICATIONS			TOTAL	
			ARITMET	>0	<0	Lts.	%/Orig.
JANUARY	761802	902600	140798	288446	-147648	436094	48%
FEBRUARY	1002800	928000	-74800	122000	-196800	318800	32%
MARCH	627400	764200	136800	96750	-153550	250300	40%
APRIL	878000	1020500	142500	290510	-148010	438520	50%
MAY	908150	855000	-53150	200150	-147000	347150	38%
JUNE	1005200	954100	-51100	80100	-131200	211300	21%
JULY	1114900	890700	-224200	80900	-305100	386000	35%
AUGUST	1114800	945200	-169600	42400	-212000	254400	23%
SEPTEMBER	878400	653200	-225200	86300	-347840	434140	49%
OCTOBER	1162300	1323400	161100	282400	-121300	403700	35%
AVERAGES	945375	923690	-21685	156996	-191045	348040	**37%**

Figure 4.1.6: Manufacturing volume planning changes between first and second forecast estimations

The problem caused by the variation of the SKU in the sales forecast estimation moves to the planning department. Where do a filter and managed to reduce the variation of the SKU, aided by the two months of stock accumulation and movement of high rotation inventory. However the values (64% for SKU and 37% for manufacturing volume) remain very high.

Month	ORIG.	FINAL	DAYS BTW PLANS	SKU CHANGED ORIG.	SKU CHANGED FINAL
JANUARY	14-12-09	07-01-10	24	118	85
FEBRUARY	09-01-10	06-02-10	28	243	114
MARCH	17-02-10	10-03-10	21	216	136
APRIL	23-03-10	01-04-10	9	292	120
MAY	08-04-10	11-05-10	33	209	167
JUNE	17-05-10	03-06-10	17	374	231
JULY	15-06-10	05-07-10	20	341	142
AUGUST	19-07-10	05-08-10	17	241	169
SEPTEMBER	20-08-10	06-09-10	17	209	171
AVERAGES			21	249	148

Figure 4.1.7A: Raw Materials requisitions variations due changes between first and second forecast estimations.

Month	DIFERENCES BETWEEN PLANS		% MODIF. O/ ORIG		%
	SKU MODIFIED BY QUANTITY	SKU MODIFIED BY DATES	BY QUANTITY	BY DATES	TOTAL MODIF.
JANUARY	82	31	69%	26%	96%
FEBRUARY	107	77	44%	32%	76%
MARCH	120	70	56%	32%	88%
APRIL	116	58	40%	20%	60%
MAY	162	112	78%	54%	131%
JUNE	208	51	56%	14%	69%
JULY	136	39	40%	11%	51%
AUGUST	159	92	66%	38%	104%
SEPTEMBER	161	81	77%	39%	116%
AVERAGES	139	68	58%	30%	**88%**

Figure 4.1.7B: Raw Materials requisitions variations due changes between first and second forecast estimations

We already have seen how these changes in the sales forecasts estimations affect planning master schedule of production. Then, continuing with the direction of flow of information, as affecting the order of raw materials and packaging materials arising from the production program. Figures 4.1.7A and B shown these changes at raw materials requisitions expressed in percentage of variation between first and second final forecast.

Month	ORIG.	FINAL	DAYS BTW PLANS	SKU CHANGED ORIG.	SKU CHANGED FINAL
JANUARY	14-12-09	07-01-10	24	337	83
FEBRUARY	09-01-10	06-02-10	28	244	108
MARCH	17-02-10	10-03-10	21	335	82
APRIL	23-03-10	01-04-10	9	131	114
MAY	08-04-10	11-05-10	33	188	73
JUNE	17-05-10	03-06-10	17	460	112
JULY	15-06-10	05-07-10	20	389	63
AUGUST	19-07-10	05-08-10	17	156	69
SEPTEMBER	20-08-10	06-09-10	17	203	165
AVERAGES			21	271	97

Figure 4.1.8A: Packaging requisitions variations due changes between first and second forecast estimations

Month	DIFERENCES BETWEEN PLANS		% MODIF. O/ ORIG		%
	SKU MODIFIED BY QUANTITY	SKU MODIFIED BY DATES	BY QUANTITY	BY DATES	TOTAL MODIF.
JANUARY	58	81	17%	24%	41%
FEBRUARY	74	88	30%	36%	66%
MARCH	62	72	19%	21%	40%
APRIL	47	60	36%	46%	82%
MAY	41	60	22%	32%	54%
JUNE	110	56	24%	12%	36%
JULY	58	49	15%	13%	28%
AUGUST	63	27	40%	17%	58%
SEPTEMBER	158	98	78%	48%	126%
AVERAGES	75	66	31%	28%	**59%**

Figure 4.1.8B: Packaging requisitions variations due changes between first and second forecast estimations

In Figures 4.1.8A and B are shown changes at packaging requests. Note that the impact on the packaging (59%) is lower than that reflected in the raw materials (88%). This is explained in the smaller variety of items that make productive needs and acceptable degree of standardization that has the packaging management of where it uses generic containers package (metallic and plastic cans) and its individualization comes through identificatory labels.

Anyway, both values of variation, both as raw materials as packaging are considerably higher and these are reflected in measuring the overall impact both together.

Month	ORIG.	FINAL	DAYS BTW PLANS	SKU CHANGED ORIG.	SKU CHANGED FINAL
JANUARY	14-12-09	07-01-10	24	455	168
FEBRUARY	09-01-10	06-02-10	28	487	222
MARCH	17-02-10	10-03-10	21	551	218
APRIL	23-03-10	01-04-10	9	423	234
MAY	08-04-10	11-05-10	33	397	240
JUNE	17-05-10	03-06-10	17	834	343
JULY	15-06-10	05-07-10	20	730	205
AUGUST	19-07-10	05-08-10	17	397	238
SEPTEMBER	20-08-10	06-09-10	17	412	336
AVERAGES			21	521	245

Figure 4.1.9A: Raw Materials and Packaging overall variations due forecast estimations.

Month	DIFERENCES BETWEEN PLANS		% MODIF. O/ ORIG		%
	SKU MODIFIED BY QUANTITY	SKU MODIFIED BY DATES	BY QUANTITY	BY DATES	TOTAL MODIF.
JANUARY	140	112	31%	25%	55%
FEBRUARY	181	165	37%	34%	71%
MARCH	182	142	33%	26%	59%
APRIL	163	118	39%	28%	66%
MAY	203	172	51%	43%	94%
JUNE	318	107	38%	13%	51%
JULY	194	88	27%	12%	39%
AUGUST	222	119	56%	30%	86%
SEPTEMBER	319	179	77%	43%	121%
AVERAGES	214	134	43%	28%	**71%**

Figure 4.1.9B: Raw Materials and Packaging overall variations due forecast estimations.

This integrated variation of all inputs incoming the manufacturing site and then transforms into a finished product is unsustainably high. This explains and answer to that operation plant information area must dedicate a lot of hours (19 + 17) and resources associated for the execution of the MRP and subsequent request of raw materials and packaging.

Clearly the root of these problems arises in the uncertainty and variability of sales forecasts by the marketing department. The answer is not based on what area is in charge of making this forecast, if it uses the right tools to reach those uncertainly values that are communicated. This is where begins the second stage of this first sub process where we propose a cooperation scheme with MKT area to find a new methodology for forecasting sales estimation. By reviewing existing models and finding one that best suits our type of market.

Forecasting and simulation models try to predict future developments and to explain relationships between input and output of complex systems. However, they do not support the selection of one or a few solutions that are good in terms of predefined criteria from a large set of feasible activities. This is the purpose of optimization models which differ from the former ones by an additional objective function that is to be minimized or maximized.

Forecasting methods were developed since the 1950's for business forecasting and at the same time for econometric purposes (e. g. unemployment rates etc.). The application in software modules makes it possible to create forecasts for a lot of items in a few seconds. Each of these methods tries to incorporate information on the history of a product/item in the forecasting process for future figures. But there exist two different basic approaches – time-series-analysis and causal models. The so-called time-series-analysis assumes that the demand follows a specific pattern.

Therefore, the task of a forecasting method is to estimate the pattern from the history of observations. Future forecasts can then be calculated from using this estimated pattern.

The advantage of those methods is that they only require past observations of demand. Within this scheme are first-degree algebraic models like: Level Model, Trend model and Sessional model.

The second approach to statistical forecasting is causal models. They assume that the demand process is determined by some known factors (weather, economic cycle, president election year). As for parameter estimation in causal models the demand history and one or more time-series with indicators are needed, the data requirements are much higher than for time-series analysis.

Like each demand history is distorted by random noise (stochastic fluctuation), the accurate estimation of parameters for the model is a crucial task. Also, the parameters are not fixing and might change over time. Therefore, it is necessary to estimate under consideration of actual observations and to incorporate enough past values to eliminate random fluctuations.

- Simple Moving Average: the simple or moving average (SMA) is used for forecasting items with level demand. The parameter estimate for the level is calculated by averaging the past n demand observations. This parameter serves as a forecast for all future periods, since the forecast is independent of time.

- Exponential Smoothing: The need to cut the time-series is permitted by the exponential smoothing method, so it assigns different weights to all observed demand data and incorporates them into the forecast estimation. The weight for the observations is exponentially decreasing with the latest demand getting the highest weight.

- Regressions Scheme: Where significant influence of some known factors is present, it seems to be straightforward to use causal models in the forecasting process. Regression analysis is the standard method for estimation of parameter values in causal models. Usually linear dependencies between the dependent variable (f/e the demand) and the leading factors as independent variables (f/ new releases, expenditures for promotions etc.) are considered.

- *ARIMA/Box-Jenkins-Method*: While both model-types described above assume statistical independence of demand values in various different periods, the autoregressive integrated moving average (ARIMA) models explicitly consider dependent demands. Therefore, these methods don’t make assumptions about the underlying demand pattern, but compose a function from different building-blocks which fits the observed data best.

Regressive models and the scheme of moving average weighting of Jenkins are requiring special software and the mere fact of working with them would necessitate the complete time dedicated for a thesis work.

Forecast errors: the word error refers to the difference between the forecast and what actually happened. In statistics, these errors are called residuals. While the forecast value is within safety limits, as discussed later in the "measurement error", it is not really a bug. But commonly called the error to this difference.

The demand for a product is generated through the interaction of a number of factors too complex to accurately describe a model. Consequently, the odds certainly contain an error. In analyzing the errors in the forecast, is to distinguish between the sources of error and measurement error.

Errors may come from a variety of sources. A common source that many ignore is the fact projecting past trends into the future. For example, when speaking of statistical errors in the regression analysis of these refer to deviations of observations based on the regression line.

It is common to attach a safety band (control limits) to the regression line to reduce unexplained error. But when using this regression line and device for forecasting, projecting into the future, the error cannot be properly defined by the guard band predicted.

This is because the guard interval is based on the above data; it might contain the projected data points, and hence cannot be used with the same security. In fact, experience has shown that the actual errors tend to be larger than those predicted by a forecast model.

Errors can be classified as systematic or random. Systematic errors occur when a consistent mistake. The sources of these errors are, for example, a failure to include the right variables, the use of wrong relationships between variables, the use of a trend line wrong, incorrect change seasonal demand normally occurs and where the existence of a secular trend undetected. Random errors are defined as those that cannot be explained with the forecasting model used.

Common terms used to describe the degree of error are:

• Standard error,
• Mean square error
• Mean absolute deviation.

In addition, tracking signals can be used to indicate any positive or negative risk in the forecast. The standard error is discussed in the section on linear regression. Since the standard error is the square root of a function, it is convenient to use the same function which is called mean square error.

The mean absolute deviation (MAD) was fashionable in the past but returned because of their simplicity and usefulness for tracking signals.

The MAD is the average error in the forecasts, using absolute values. It is valuable because, as the standard deviation measures the dispersion of any observed value based on a predicted value.

The MAD is calculated using the differences between the actual demand and forecasted demand regardless of the sign. Equals the sum of the absolute deviations divided by the number of data points, in equation form would be:

$$MAD = \sum_{i=1}^{n} \left| A_t - F_t \right| / n \qquad (1)$$

Where:

t = Number of Periods
A = Real demand during the period
F = Forecasted demand for the period
n = Total number of periods
| | = Symbol used to indicate whether the absolute value of the positive and negative signs.

When errors occur in the prediction normally distributed MAD mean absolute deviation is related to the standard deviation as follows:

$$1 \text{ standard deviation} = \sqrt{(\pi/2)} * MAD, \text{ or approximately} \qquad (2)$$
$$= 1,25\ MAD$$

Conversely, 1 MAD = standard deviation of 0.8

The standard deviation is the largest measure. If the MAD of a series of points out of 60 units, the standard deviation would be 75 units. In the usual statistical form, if the control limits were set at plus or minus 3 standard deviations (0 + - 3.75 MAD), 99.7 points would fall within these limits.

A tracking signal (TS) is a measure that indicates whether the forecast average is keeping pace with the actual changes in demand, whether up or down. When used in the forecasts, the tracking signal is the number of average absolute deviations in the forecast value is above or below the actual demand.

In a normal distribution with zero mean and MAD equal to 1. If calculated tracking signal and is equal to minus -2, it is possible to observe that the forecasting model forecasts being provided which are slightly above the average of the actual demands.

A tracking signal can be calculated by the arithmetic sum of forecast deviations divided by the mean absolute deviation:

$$TS = RSFE / MAD \qquad (3)$$

Where:

RSFE (Running Sum of Forecast Errors) is the sum of the forecast errors, considering the nature of them (i.e.: negative errors cancel out the positive and vice versa).

MAD is the average of all forecast errors (regardless of the fact that the deviations are positive or negative). It is the average of the absolute deviations.

Regression can be defined as a functional relationship between two or more correlated variables. It is used to predict a given variable another. The relationship develops normally based on the observed data. These should represent graphically first look to see whether linear or if at least parts of them are linear. Linear regression refers to the particular type of regression in which the relationship between the variables forms a straight line.

The linear regression line has the form: Y = a + bX, where Y is the value of the dependent variable being solved, a is the intercept of Y, b is the slope and X is the independent variable. (In the analysis of the time series, X is a unit time).

Linear regression is useful in the long-term prognosis of major occurrences and overall planning. For example, the linear regression would be useful to project the demands of product families. Although demand for each of a family of products can vary greatly over a period of time, demand for the entire product family is remarkably uniform.

The main restriction on the use of linear regression forecast is as its name suggests, the previous data and future forecasts, are assumed to be a straight line. Although this limits its application, if using a shorter period of time, linear regression analysis can be used. For example, there may be short segments that are longer period more or less linear.

Linear regression was used both for forecasting and time series forecasting relation to casual. When the dependent variable (usually the vertical axis of a graph) changes as a result of time (shown as the horizontal axis) is the analysis of time series. If a variable is changed by the variation in another variable, it is a causal relationship.

Method of minimum squares: the minimum square equation for the linear regression is the same as used previously:

$$Y = a + b\,x \tag{4}$$

Where:

Y = Dependent variable calculated by the equation

y = Number of dependent variables and real data

a = The source ordinate Y

b = Slope of the line

x = Time period

The method of minimum squares line is fit to the data to minimize the sum of squares of the vertical distance between each data point and its corresponding point on the line. The best line to use is the one that minimizes this total.

In the method of the minimum squares equations for a and b are:

$$a = y^* - b\,x^* \tag{5}$$

$$b = \frac{\Sigma\, x.y - n.x^*.y^*}{\Sigma\, x2 - n.\, x^*2} \tag{6}$$

Where:

a = intercept of y

b = slope of the line

y * = Average of all y

x * = Average of all x

x = Value of x in each data point

y = Value of y in each data point

n = Number of data points

Y = the dependent variable value calculated from the regression equation

At least we need to calculate the seasonal factor. This one is the amount of correction needed in the time series to fit a season.

Usually the term is associated with a seasonal period of the year characterized by a given activity. The word is used to indicate cyclical periods different from those in the year recurring repetitive activity.

The following examples are determined and when the indices used to project seasonal:

* A simple calculation based on the above data and seasonal
* The trend and seasonal index based on a manually fitted regression line.

Then, it is necessary to follow a more formal procedure for decomposing and forecast data using least squares regression.

During 2011, the intention of this doctorate researcher was to program in a Visual Basic language inside a common and free commercial program like Microsoft Excel one routine using the method of minimum squares, with linear regression and MAD model error formulation. By having the skills acquired during the time as FEA computational structure programmer and designer.

The study carried in parallel with the data providing by the marketing department, with the same collaborative and alignment objectives, focused on the five top-selling products in market share held by the Company. Which due to its high demand monthly variations and low forecast accuracy are more sensitive to fluctuations. That ones originate all the downstream problems in Planning, Purchasing and Plant Operations descripted previously.

Below are presented the results of the case studies with the comparison between the forecasting accuracy of the marketing area and compared with that obtained with the researcher's internal developed under this Supply Chain improvement process implemented.

Case 4.A: Decorative Wall Latex.

The case "A" is the largest family of paintings produced in the plant. They are water-based paints for decorative purposes and aesthetic appliances. These ones represent the largest sales volume and higher paint circulation in the global market.

The study methodology is based on the implementation of the proposed model for estimating sales forecast developed by the researcher. This uses a model approach for calculating MAD. The same weighted historical effects of changing demand and their stability, effects and seasonal anomalies also offset the impact of market deviations.

Demand Average = 1255; Month Average = 13

Y = a + bX

b = Sum(X) * Yd – n * X aver * Yd aver / [Sum (X2) –n * (X aver2)]

a = Yd aver – b * X aver

b = 36,43 and a = 781,41

Month	Forecast MKT		Month	Demand	Monthly Average	Seasonal Factor	Destabilized demand	x2	Sum. X * Yd		Destabilized demand	Steady Demand
jul-10	903		1	428	941	0,750	571	1	571	1	818	613
ago-10	600		2	688	588	0,469	1.468	4	2.937	2	854	400
sep-10	950		3	720	926	0,738	976	9	2.927	3	891	657
oct-10	780		4	672	1.148	0,915	735	16	2.939	4	927	848
nov-10	782		5	720	806	0,642	1.121	25	5.605	5	964	619
dic-10	666		6	928	962	0,767	1.211	36	7.264	6	1000	767
ene-11	817		7	624	912	0,727	859	49	6.011	7	1036	753
feb-11	1104		8	2136	1.672	1,332	1.603	64	12.826	8	1073	1429
mar-11	1830		9	2032	2.160	1,721	1.181	81	10.626	9	1109	1909
abr-11	1900		10	568	1.072	0,854	665	100	6.650	10	1146	979
may-11	2142		11	904	2.236	1,782	507	121	5.581	11	1182	2106
jun-11	1163		12	1464	1.800	1,434	1.021	144	12.249	12	1219	1748
jul-11	667		13	852	941	0,750	1.136	169	14.767	13	1255	941
ago-11	1200		14	488	588	0,469	1.042	196	14.582	14	1291	605
sep-11	1598		15	1132	926	0,738	1.534	225	23.013	15	1328	980
oct-11	1389		16	1624	1.148	0,915	1.775	256	28.406	16	1364	1248
nov-11	1200		17	892	806	0,642	1.389	289	23.611	17	1401	900
dic-11	1379		18	996	962	0,767	1.299	324	23.388	18	1437	1102
ene-12	1473		19	1200	912	0,727	1.651	361	31.375	19	1474	1071
feb-12	1500		20	1208	1.672	1,332	907	400	18.134	20	1510	2012
mar-12	1946		21	2288	2.160	1,721	1.329	441	27.917	21	1546	2662
abr-12	1733		22	1576	1.072	0,854	1.845	484	40.591	22	1583	1352
may-12	2397		23	3568	2.236	1,782	2.003	529	46.060	23	1619	2885
jun-12	1156		24	2136	1.800	1,434	1.489	576	35.742	24	1656	2375
jul-12	1604		25	1544	941	0,750	2.058	625	51.462	25	1692	1269

Figure 4.1.10: Demand values for case 4.A

										TS MKT			TS PPCI	
Deviatons	Absolut Deviatons	Errors accumulation	MAD		Deviatons	Absolut Deviatons	Errors accumulation	MAD		RSFE	TS = RSFE MAD		RSFE	TS = RSFE MAD
-475	475	475	475		-185	185,43	185,43	185,43		-475	-1		-185	-1
88	88	563	281,5		288	287,75	473,19	236,59		-387	-1,37477798		102	0,4324602
-230	230	793	264,33333		63	62,80	535,98	178,66		-617	-2,33417402		165	0,9241778
-108	108	901	225,25		-176	176,08	712,07	178,02		-725	-3,21864595		-11	-0,061619
-62	62	963	192,6		101	101,17	813,24	162,65		-787	-4,08618899		90	0,5545852
262	262	1225	204,16667		161	161,47	974,71	162,45		-525	-2,57142857		252	1,549228
-193	193	1418	202,57143		-129	129,16	1103,87	157,70		-718	-3,54442877		123	0,7769118
1032	1032	2450	306,25		707	706,67	1810,55	226,32		314	1,025306122		829	3,6638168
202	202	2652	294,66667		123	122,80	1933,35	214,82		516	1,751131222		952	4,4316433
-1332	1332	3984	398,4		-411	410,65	2343,99	234,40		-816	-2,04819277		541	2,3094898
-1238	1238	5222	474,72727		-1202	1202,19	3546,18	322,38		-2054	-4,32669475		-661	-2,049893
301	301	5523	460,25		-284	283,75	3829,93	319,16		-1753	-3,80879957		-945	-2,959618
185	185	5708	439,07692		-89	89,33	3919,26	301,48		-1568	-3,57112824		-1034	-3,429486
-712	712	6420	458,57143		-117	117,07	4036,33	288,31		-2280	-4,97196262		-1151	-3,992225
-466	466	6886	459,06667		152	152,24	4188,57	279,24		-2746	-5,981702		-999	-3,576716
235	235	7121	445,0625		376	376,03	4564,60	285,29		-2511	-5,64190423		-623	-2,182807
-308	308	7429	437		-8	7,59	4572,19	268,95		-2819	-6,45080092		-630	-2,343589
-383	383	7812	434		-106	105,62	4677,81	259,88		-3202	-7,37788018		-736	-2,831853
-273	273	8085	425,52632		129	129,16	4806,97	253,00		-3475	-8,16635745		-607	-2,398345
-292	292	8377	418,85		-804	803,74	5610,71	280,54		-3767	-8,99367315		-1411	-5,027952
342	342	8719	415,19048		-374	373,60	5984,31	284,97		-3425	-8,24922583		-1784	-6,260791
-157	157	8876	403,45455		224	223,94	6208,25	282,19		-3582	-8,87832357		-1560	-5,528768
1171	1171	10047	436,82609		683	682,94	6891,19	299,62		-2411	-5,51935901		-877	-2,927884
980	980	11027	459,45833		-239	238,75	7129,94	297,08		-1431	-3,11453705		-1116	-3,756536
-60	60	11087	443,48		275	274,77	7404,71	296,19		-1491	-3,36204564		-841	-2,840175

Figure 4.1.11: Case 4.A calculation MAD Forecasting values for PPCI model (researcher) and MKT model

Once completed the algebra calculations, we compare the results of the models for estimating sales forecast (PPCI = researcher) and (MKT = Marketing Department) and they were compared with the actual demand that has place in the period-month.

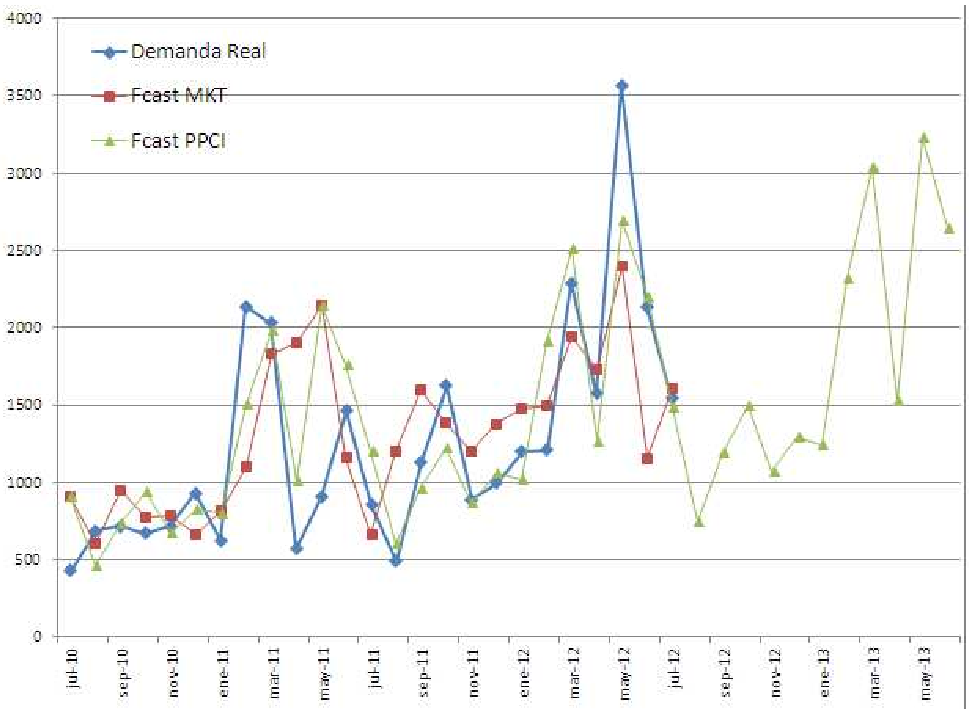


Figure 4.1.12: Forecasting Models vs. Actual Demand evolutions for case 4.A

For this case study can be seen as the proposed scheme (green line) is closer to actual sales demand marked in blue compared with that predicted by the marketing department (in red). In the months of March and April 2011 predicted the negative rebound (bullwhip effect) of fall while the linear scheme temporary marketing trend continued to grow.

Again this year 2012, the beginning of summer in Argentina, was adapted better to the sales high season peaks and calculate more about sales peak occurred in May of this year.

For the proposed and calculated in this research gave a MAD 300 to the value of 443 obtained by marketing. We achieved an improvement of 32.28%.

Having already been detailed formula and the calculation method proposed in the case study "A", for the following case studies will show directly the achieved values. Those ones used to obtained the forecasts MAD model values in order to show the comparison of the other families of chemicals paints analyzed for the two forecast models against actual demand.

Case 4.B: Decorative Wall Latex Premium

Month	Forecast MKT		Month	Demand	Monthly Average	Seasonal Factor	Destabilized demand	x2	Sum. X * Yd		Destabilized demand	Steady Demand
jul-10	1031		1	400	860	0,644	621	1	621	1	862	555
ago-10	750		2	1.024	936	0,701	1.462	4	2.923	26	1849	1296
sep-10	1100		3	1.072	1.088	0,814	1.316	9	3.949	3	941	766
oct-10	712		4	880	1.396	1,045	842	16	3.369	4	981	1025
nov-10	712		5	536	798	0,597	897	25	4.487	5	1020	609
dic-10	872		6	788	862	0,645	1.221	36	7.328	6	1060	684
ene-11	1138		7	1.248	1.188	0,889	1.403	49	9.824	7	1099	977
feb-11	1200		8	1784	1.780	1,332	1.339	64	10.712	8	1139	1517
mar-11	1450		9	1904	2.140	1,602	1.189	81	10.698	9	1178	1887
abr-11	1933		10	736	1.116	0,835	881	100	8.811	10	1218	1017
may-11	2142		11	776	1.972	1,476	526	121	5.783	11	1257	1855
jun-11	1610		12	1488	2.146	1,606	926	144	11.116	12	1297	2083
jul-11	717		13	760	860	0,644	1.181	169	15.348	13	1336	860
ago-11	700		14	848	936	0,701	1.210	196	16.946	14	1375	964
sep-11	932		15	1104	1.088	0,814	1.356	225	20.335	15	1415	1152
oct-11	900		16	1912	1.396	1,045	1.830	256	29.277	16	1454	1520
nov-11	950		17	1060	798	0,597	1.775	289	30.169	17	1494	892
dic-11	1296		18	936	862	0,645	1.451	324	26.112	18	1533	989
ene-12	1428		19	1128	1.188	0,889	1.269	361	24.102	19	1573	1399
feb-12	1300		20	1776	1.780	1,332	1.333	400	26.660	20	1612	2148
mar-12	1702		21	2376	2.140	1,602	1.483	441	31.150	21	1652	2646
abr-12	2039		22	1496	1.116	0,835	1.791	484	39.400	22	1691	1413
may-12	2100		23	3168	1.972	1,476	2.146	529	49.364	23	1731	2555
jun-12	1042		24	2804	2.146	1,606	1.746	576	41.895	24	1770	2844
jul-12	2335		25	1420	860	0,644	2.206	625	55.149	25	1810	1165

Figure 4.1.13: Demand values for case 4.B

Demand Average = 1336; Month Average = 13

b = 39,48; a = 822,71

										TS MKT			TS PPCI	
Deviatons	Absolut Deviatons	Errors accumulation	MAD		Deviatons	Absolut Deviatons	Errors accumulation	MAD		RSFE	TS = RSFE MAD		RSFE	TS = RSFE MAD
-631	631	631	631		-155	155,00	155,00	155,00		-631	-1		-155	-1
274	274	905	452,5		-272	271,61	426,62	213,31		-357	-0,78895028		-427	-2
-28	28	933	311		306	305,55	732,16	244,05		-385	-1,23794212		-121	-0,496077
168	168	1101	275,25		-145	144,69	876,85	219,21		-217	-0,78837421		-266	-1,21232
-176	176	1277	255,4		-73	73,33	950,17	190,03		-393	-1,53876273		-339	-1,784319
-84	84	1361	226,83333		104	104,33	1054,50	175,75		-477	-2,10286554		-235	-1,335729
110	110	1471	210,14286		271	270,66	1325,16	189,31		-367	-1,746431		36	0,1896631
584	584	2055	256,875		267	267,03	1592,19	199,02		217	0,844768856		303	1,5220991
454	454	2509	278,77778		17	16,98	1609,17	178,80		671	2,406935034		320	1,7892654
-1197	1197	3706	370,6		-281	281,05	1890,23	189,02		-526	-1,41932002		39	0,2055926
-1366	1366	5072	461,09091		-1079	1079,44	2969,67	269,97		-1892	-4,1033123		-1041	-3,854425
-122	122	5194	432,83333		-595	594,58	3564,24	297,02		-2014	-4,65306122		-1635	-5,505197
43	43	5237	402,84615		-100	100,00	3664,24	281,86		-1971	-4,89268665		-1735	-6,155982
148	148	5385	384,64286		-116	115,66	3779,91	269,99		-1823	-4,73946147		-1851	-6,85505
172	172	5557	370,46667		-48	48,31	3828,22	255,21		-1651	-4,4565413		-1899	-7,441301
1012	1012	6569	410,5625		392	392,23	4220,44	263,78		-639	-1,55640128		-1507	-5,712758
110	110	6679	392,88235		168	167,66	4388,11	258,12		-529	-1,34645905		-1339	-5,188337
-360	360	7039	391,05556		-53	53,38	4441,49	246,75		-889	-2,27333428		-1393	-5,643835
-300	300	7339	386,26316		-271	270,66	4712,15	248,01		-1189	-3,07821229		-1663	-6,706533
476	476	7815	390,75		-372	372,24	5084,39	254,22		-713	-1,8246961		-2036	-8,006916
674	674	8489	404,2381		-270	269,96	5354,35	254,97		-39	-0,09647779		-2305	-9,042178
-543	543	9032	410,54545		83	83,16	5437,51	247,16		-582	-1,41762622		-2222	-8,991414
1068	1068	10100	439,13043		613	613,20	6050,71	263,07		486	1,106732673		-1609	-6,116585
1762	1762	11862	494,25		-40	39,65	6090,36	253,76		2248	4,548305513		-1649	-6,497214
-915	915	12777	511,08		255	255,00	6345,36	253,81		1333	2,608202238		-1394	-5,491257

Figure 4.1.14: Case 4.B calculation MAD Forecasting values for PPCI model (researcher) and MKT model

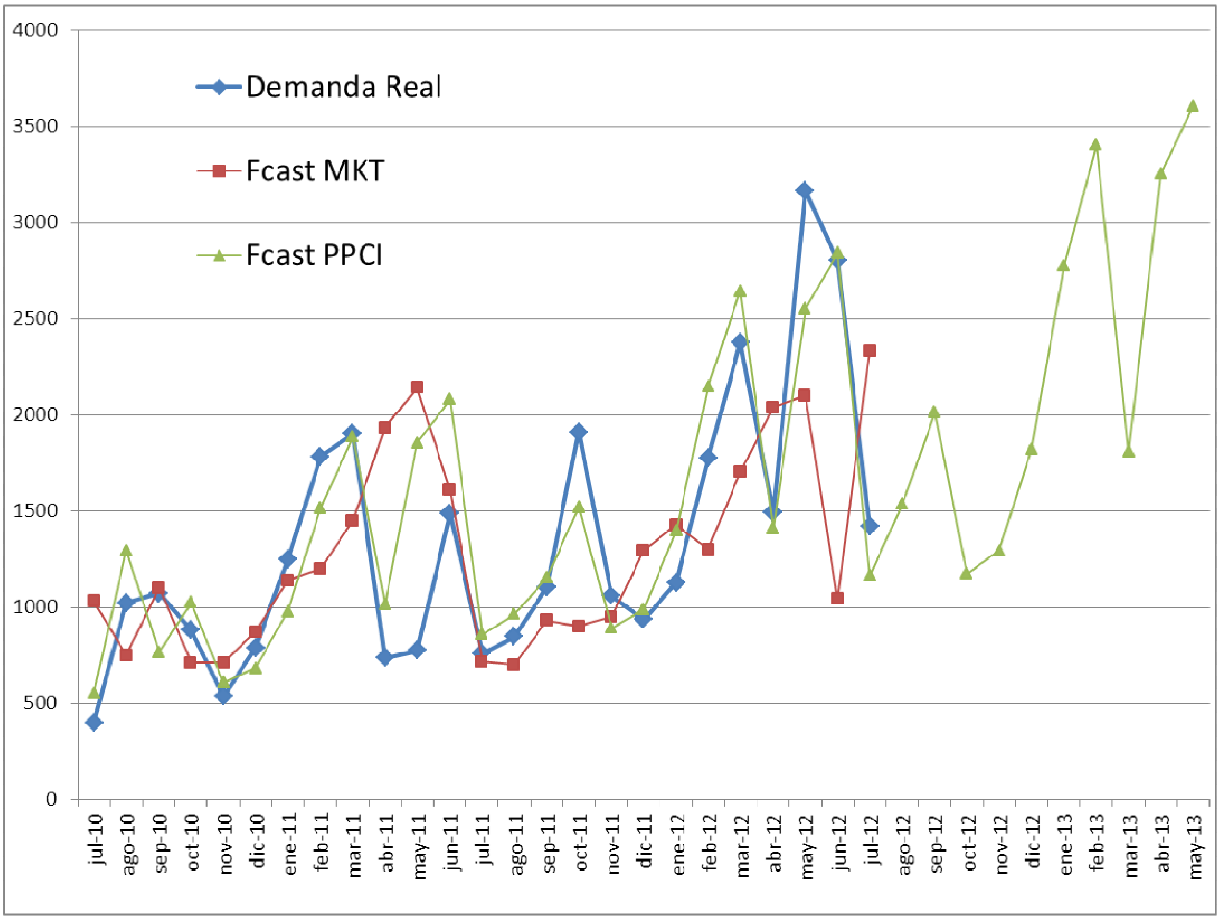


Figure 4.1.15: Forecasting Models vs. Actual Demand evolutions for case 4.B

Case 4.B again looks like the market for premium paints the proposed model is closer to fluctuations in demand. Also in relation to the previous case is set with a high degree of approximation to the high peak demand resulting in high season.

Case 4.C: White enamels

The family of enamels and glazes has minor variations in demand since its products are used in both the esthetic and decorative paint in homes and buildings in general and also in those industry applications.

Epoxy coatings and solvent-based paints have a manifest use in the protection of facilities under corrosive environments and which makes preventive maintenance tasks are periodic conservation, thus selling their demand is more stable than other products.

Month	Forecast MKT	Month	Demand	Monthly Average	Seasonal Factor	Destabilized demand	x2	Sum. X * Yd		Destabilized demand	Steady Demand
jul-10	1049	1	336	647	0,508	661	1	661	1	784	398
ago-10	680	2	888	888	0,698	1.273	4	2.546	2	825	575
sep-10	1050	3	808	832	0,654	1.236	9	3.709	3	865	566
oct-10	783	4	1.992	1.608	1,263	1.577	16	6.308	4	906	1145
nov-10	784	5	1.248	1.460	1,147	1.088	25	5.441	5	947	1086
dic-10	593	6	544	792	0,622	874	36	5.246	6	988	614
ene-11	786	7	1.008	1.524	1,197	842	49	5.894	7	1028	1231
feb-11	1100	8	1400	1.440	1,131	1.238	64	9.901	8	1069	1209
mar-11	1530	9	520	1.404	1,103	471	81	4.243	9	1110	1224
abr-11	1500	10	568	1.072	0,842	675	100	6.745	10	1151	969
may-11	1632	11	976	2.272	1,785	547	121	6.015	11	1191	2127
jun-11	1163	12	1184	1.660	1,304	908	144	10.896	12	1232	1607
jul-11	566	13	688	647	0,508	1.354	169	17.607	13	1273	647
ago-11	500	14	888	888	0,698	1.273	196	17.822	14	1314	916
sep-11	800	15	856	832	0,654	1.310	225	19.646	15	1355	885
oct-11	1000	16	1224	1.608	1,263	969	256	15.504	16	1395	1762
nov-11	650	17	1672	1.460	1,147	1.458	289	24.783	17	1436	1647
dic-11	1003	18	1040	792	0,622	1.672	324	30.089	18	1477	919
ene-12	1026	19	2040	1.524	1,197	1.704	361	32.376	19	1518	1817
feb-12	1050	20	1480	1.440	1,131	1.308	400	26.167	20	1558	1763
mar-12	1216	21	2288	1.404	1,103	2.075	441	43.565	21	1599	1764
abr-12	1427	22	1576	1.072	0,842	1.872	484	41.173	22	1640	1381
may-12	1500	23	3568	2.272	1,785	1.999	529	45.980	23	1681	2999
jun-12	744	24	2136	1.660	1,304	1.638	576	39.313	24	1721	2245
jul-12	1320	25	916	647	0,508	1.803	625	45.080	25	1762	895

Figure 4.1.16: Demand values for case 4.C

Demand Average = 1273; Month Average = 13

b = 40,76; a = 743,14

								TS MKT		TS PPCI	
Deviatons	Absolut Deviatons	Errors accumulation	MAD	Deviatons	Absolut Deviatons	Errors accumulation	MAD	RSFE	TS = RSFE MAD	RSFE	TS = RSFE MAD
-713	713	713	713	-62	62,21	62,21	62,21	-713	-1	-62	-1
208	208	921	460,5	313	312,75	374,96	187,48	-505	-1,09663409	251	1,3363671
-242	242	1163	387,66667	242	242,39	617,35	205,78	-747	-1,92691316	493	2,3953927
1209	1209	2372	593	847	847,36	1464,71	366,18	462	0,779089376	1340	3,6602261
464	464	2836	567,2	162	161,97	1626,68	325,34	926	1,6325811	1502	4,6175716
-49	49	2885	480,83333	-70	70,49	1697,17	282,86	877	1,823916811	1432	5,0617167
222	222	3107	443,85714	-223	223,23	1920,40	274,34	1099	2,476021886	1209	4,4052043
300	300	3407	425,875	191	190,53	2110,93	263,87	1399	3,285001468	1399	5,3021776
-1010	1010	4417	490,77778	-704	704,19	2815,11	312,79	389	0,792619425	695	2,2215352
-932	932	5349	534,9	-401	401,03	3216,15	321,61	-543	-1,01514302	294	0,9136536
-656	656	6005	545,90909	-1151	1150,51	4366,66	396,97	-1199	-2,19633639	-857	-2,158021
21	21	6026	502,16667	-423	422,85	4789,51	399,13	-1178	-2,34583472	-1280	-3,205802
122	122	6148	472,92308	41	41,33	4830,84	371,60	-1056	-2,23292128	-1238	-3,332007
388	388	6536	466,85714	-28	28,43	4859,27	347,09	-668	-1,43084455	-1267	-3,649234
56	56	6592	439,46667	-29	29,28	4888,55	325,90	-612	-1,39259709	-1296	-3,976313
224	224	6816	426	-538	538,45	5427,00	339,19	-388	-0,91079812	-1834	-5,408059
1022	1022	7838	461,05882	25	25,02	5452,02	320,71	634	1,375095688	-1809	-5,641695
37	37	7875	437,5	121	121,21	5573,23	309,62	671	1,533714286	-1688	-5,452169
1014	1014	8889	467,84211	223	223,23	5796,46	305,08	1685	3,601642479	-1465	-4,801716
430	430	9319	465,95	-283	282,74	6079,20	303,96	2115	4,539113639	-1748	-5,749546
1072	1072	10391	494,80952	524	524,38	6603,57	314,46	3187	6,440862285	-1223	-3,890069
149	149	10540	479,09091	195	195,09	6798,67	309,03	3336	6,963187856	-1028	-3,327061
2068	2068	12608	548,17391	569	568,56	7367,22	320,31	5404	9,858185279	-460	-1,434863
1392	1392	14000	583,33333	-109	108,64	7475,87	311,49	6796	11,65028571	-568	-1,824274
-404	404	14404	576,16	21	20,88	7496,74	299,87	6392	11,09414052	-547	-1,82538

Figure 4.1.17: Case 4.C calculation MAD Forecasting values for PPCI model (researcher) and MKT model

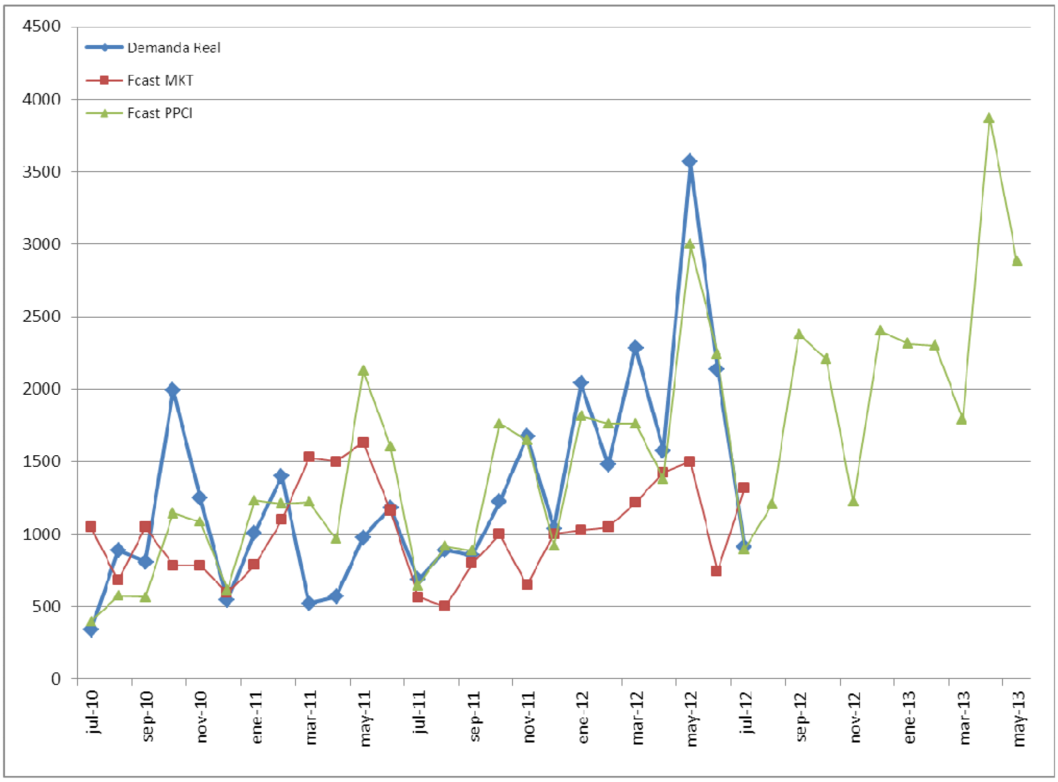


Figure 4.1.18: Forecasting Models vs. Actual Demand evolutions for case 4.C

Case 4.D: Black/Dark enamels

Month	Forecast MKT	Month	Demand	Monthly Average	Seasonal Factor	Destabilized demand	x2	Sum. X * Yd		Destabilized demand	Steady Demand
jul-10	1210	1	464	713	0,706	657	1	657	1	719	508
ago-10	750	2	640	548	0,543	1.180	4	2.359	26	1325	719
sep-10	1050	3	664	896	0,887	748	9	2.245	3	767	681
oct-10	712	4	624	804	0,796	784	16	3.136	4	792	630
nov-10	712	5	480	744	0,737	652	25	3.258	5	816	601
dic-10	598	6	1.000	936	0,927	1.079	36	6.474	6	840	779
ene-11	714	7	856	896	0,887	965	49	6.754	7	864	767
feb-11	1100	8	1240	1.104	1,093	1.134	64	9.075	8	889	971
mar-11	1135	9	1504	1.620	1,604	938	81	8.439	9	913	1464
abr-11	1230	10	616	996	0,986	625	100	6.247	10	937	924
may-11	1473	11	1040	1.820	1,802	577	121	6.349	11	961	1733
jun-11	1117	12	960	1.192	1,180	813	144	9.761	12	986	1163
jul-11	557	13	496	713	0,706	702	169	9.130	13	1010	713
ago-11	500	14	456	548	0,543	840	196	11.766	14	1034	561
sep-11	800	15	1128	896	0,887	1.272	225	19.073	15	1059	939
oct-11	1000	16	984	804	0,796	1.236	256	19.778	16	1083	862
nov-11	550	17	1008	744	0,737	1.368	289	23.263	17	1107	816
dic-11	919	18	872	936	0,927	941	324	16.937	18	1131	1048
ene-12	982	19	936	896	0,887	1.055	361	20.047	19	1156	1025
feb-12	1150	20	968	1.104	1,093	886	400	17.712	20	1180	1290
mar-12	1216	21	1736	1.620	1,604	1.082	441	22.729	21	1204	1931
abr-12	1325	22	1376	996	0,986	1.395	484	30.698	22	1228	1211
may-12	1420	23	2600	1.820	1,802	1.443	529	33.186	23	1253	2257
jun-12	694	24	1424	1.192	1,180	1.207	576	28.958	24	1277	1507
jul-12	1320	25	1180	713	0,706	1.671	625	41.769	25	1301	919

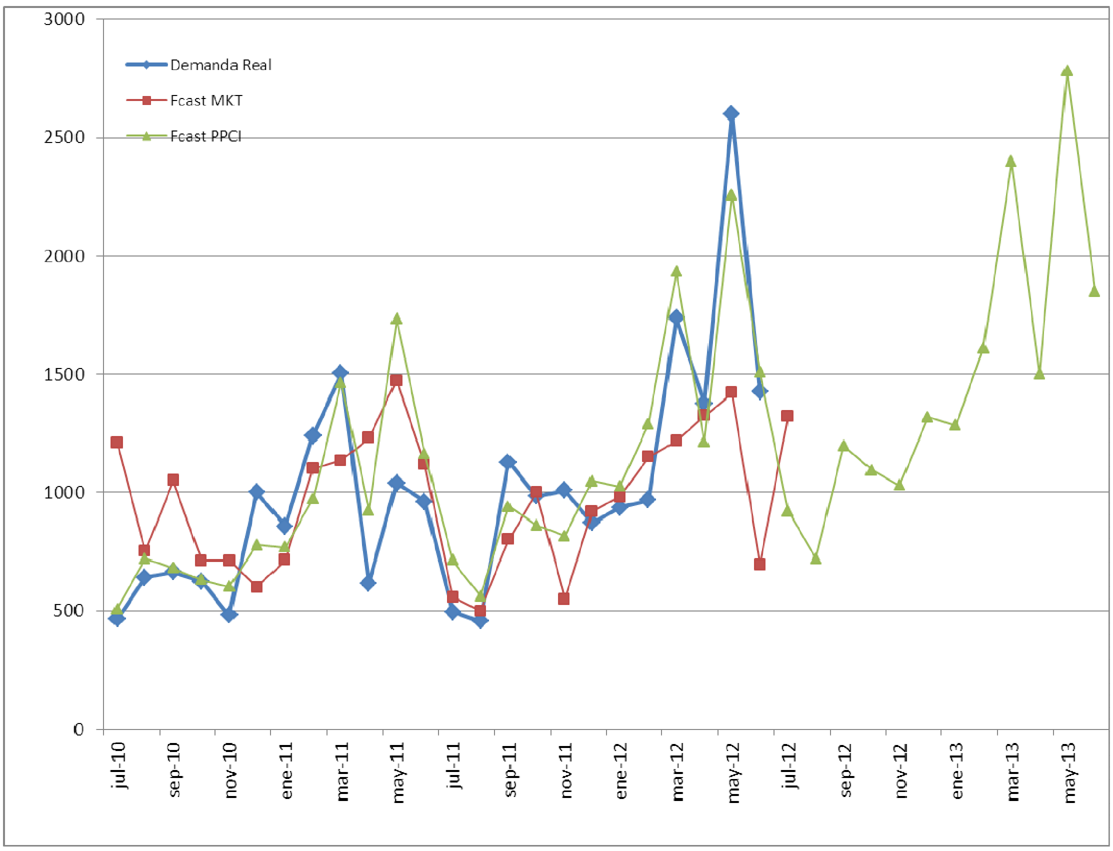
Figure 4.1.19: Demand values for case 4.D

Deviatons	Absolut Deviatons	Errors accumulation	MAD	Deviatons	Absolut Deviatons	Errors accumulation	MAD	TS MKT RSFE	TS MKT TS = RSFE MAD	TS PPCI RSFE	TS PPCI TS = RSFE MAD
-746	746	746	746	-44	43,66	43,66	43,66	-746	-4,4986512	-44	-5,593163
-110	110	856	428	-79	79,17	122,83	61,42	-856	-3,7697842	-123	0,3687816
-386	386	1242	414	-17	16,72	139,55	46,52	-1242	-3,0543380	-140	-4,891841
-88	88	1330	332,5	-6	6,14	145,69	36,42	-1330	1,4579384	-146	-4,932519
-232	232	1562	312,4	-121	120,99	266,68	53,34	-1562	-5,9438144	-267	-6,81586
402	402	1964	327,33333	221	221,42	488,11	81,35	-1160	-3,54378819	-45	-0,556335
142	142	2106	300,85714	89	89,17	577,28	82,47	-1018	-3,38366572	44	0,5324506
140	140	2246	280,75	269	268,63	845,90	105,74	-878	-3,12733749	313	2,9557826
369	369	2615	290,55556	40	39,69	885,60	98,40	-509	-1,75181644	352	3,5796091
-614	614	3229	322,9	-308	308,21	1193,81	119,38	-1123	-3,47785692	44	0,3687816
-433	433	3662	332,90909	-693	692,54	1886,35	171,49	-1556	-4,67394866	-649	-3,781743
-157	157	3819	318,25	-203	203,36	2089,71	174,14	-1713	-5,38256088	-852	-4,891841
-61	61	3880	298,46154	-217	217,33	2307,04	177,46	-1774	-5,94381443	-1069	-6,024915
-44	44	3924	280,28571	-105	105,17	2412,21	172,30	-1818	-6,48623853	-1174	-6,81586
328	328	4252	283,46667	189	188,94	2601,15	173,41	-1490	-5,25634995	-985	-5,682672
-16	16	4268	266,75	122	122,05	2723,20	170,20	-1506	-5,64573571	-863	-5,072774
458	458	4726	278	192	192,50	2915,70	171,51	-1048	-3,76978417	-671	-3,911633
-47	47	4773	265,16667	-176	176,45	3092,14	171,79	-1095	-4,12947832	-847	-4,932519
-46	46	4819	253,63158	-89	89,17	3181,31	167,44	-1141	-4,49865117	-937	-5,593163
-182	182	5001	250,05	-322	321,68	3502,99	175,15	-1323	-5,29094181	-1258	-7,183489
520	520	5521	262,90476	-195	195,39	3698,38	176,11	-803	-3,05433798	-1454	-8,253627
51	51	5572	253,27273	165	164,62	3863,00	175,59	-752	-2,96913137	-1289	-7,340641
1180	1180	6752	293,56522	343	342,71	4205,71	182,86	428	1,457938389	-946	-6,81586
730	730	7482	311,75	-83	83,04	4288,75	178,70	1158	3,714514836	-1029	-5,759889
-140	140	7622	304,88	261	261,00	4549,75	181,99	1018	3,33901863	-768	-4,221576

Figure 4.1.20: Case 4.D calculation MAD Forecasting values for PPCI model (researcher) and MKT model

Demand Average = 1010; Month Average = 13

b = 24,27; a = 694, 53



(On previous page) Figure 4.1.21: Forecasting Models vs. Actual Demand evolutions for case 4.D

In the case of the enamels, glazes and solvent borne protective coating used both in decorative purposes and industrial maintenance works also shows the improvement. This segment is more stable than the latex market to have a significant portion of the construction market. This has an almost constant demand in the summer and autumn, months of major activity.

Case 4.E. Wood Varnishes and Lacquers

The market for wood varnishes and lacquers is the least impact on the business of paints as these have been replaced by solvent-free compounds that have been made more attractive to consumers because of their zero risk of flammability.

Month	Forecast MKT	Month	Demand	Monthly Average	Seasonal Factor	Destabilized demand	x2	Sum. X * Yd		Destabilized demand	Steady Demand
jul-10	596	1	288	487	0,639	451	1	451	25	1059	676
ago-10	400	2	336	476	0,625	538	4	1.076	26	1083	677
sep-10	590	3	432	686	0,900	480	9	1.440	3	515	464
oct-10	498	4	480	668	0,877	548	16	2.190	4	540	473
nov-10	499	5	280	316	0,415	675	25	3.376	5	564	234
dic-10	392	6	504	548	0,719	701	36	4.205	6	589	424
ene-11	496	7	552	704	0,924	597	49	4.182	7	614	567
feb-11	660	8	1512	1.188	1,559	970	64	7.759	8	638	995
mar-11	1450	9	1184	1.352	1,774	667	81	6.006	9	663	1177
abr-11	1000	10	400	720	0,945	423	100	4.233	10	688	650
may-11	1122	11	520	1.160	1,522	342	121	3.757	11	713	1085
jun-11	698	12	736	980	1,286	572	144	6.867	12	737	948
jul-11	410	13	368	487	0,639	576	169	7.491	13	762	487
ago-11	520	14	616	476	0,625	986	196	13.806	14	787	491
sep-11	693	15	940	686	0,900	1.044	225	15.662	15	811	730
oct-11	800	16	856	668	0,877	976	256	15.623	16	836	733
nov-11	750	17	352	316	0,415	849	289	14.430	17	861	357
dic-11	752	18	592	548	0,719	823	324	14.817	18	886	637
ene-12	803	19	856	704	0,924	927	361	17.604	19	910	841
feb-12	900	20	864	1.188	1,559	554	400	11.084	20	935	1458
mar-12	1167	21	1520	1.352	1,774	857	441	17.990	21	960	1703
abr-12	1121	22	1040	720	0,945	1.101	484	24.215	22	984	930
may-12	1296	23	1800	1.160	1,522	1.182	529	27.196	23	1009	1536
jun-12	643	24	1224	980	1,286	952	576	22.841	24	1034	1330
jul-12	1269	25	804	487	0,639	1.259	625	31.472	25	1059	676

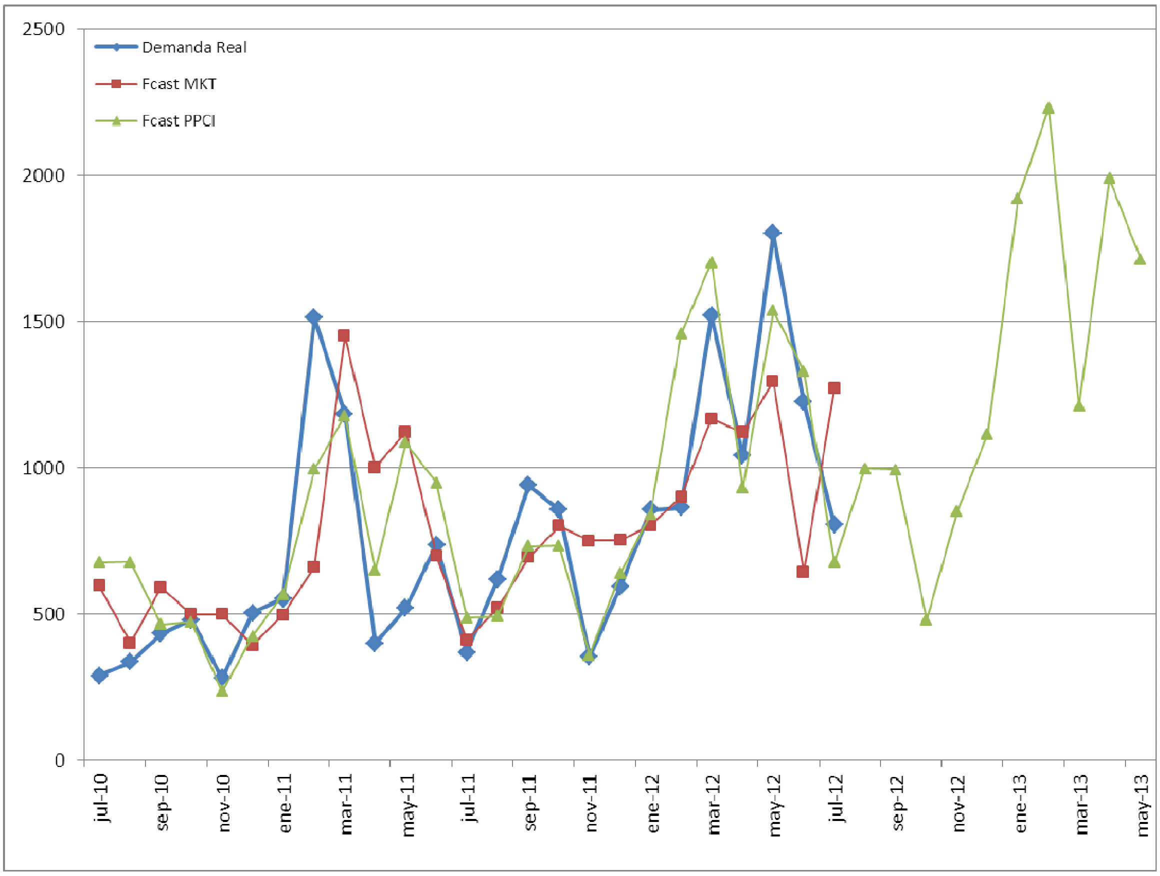
Figure 4.1.22: Demand values for case 4.E

								TS MKT		TS PPCI	
Deviatons	Absolut Deviatons	Errors accumulation	MAD	Deviatons	Absolut Deviatons	Errors accumulation	MAD	RSFE	TS = RSFE MAD	RSFE	TS = RSFE MAD
-308	308	308	308	-388	388,04	388,04	388,04	-308	-4,4986512	-388	-5,593163
-64	64	372	186	-341	340,66	728,70	364,35	-372	-3,7697842	-729	0,3687816
-158	158	530	176,66667	-32	31,55	760,25	253,42	-530	-3,0543380	-760	-4,891841
-18	18	548	137	7	6,95	767,20	191,80	-548	1,4579384	-753	-4,932519
-219	219	767	153,4	46	45,97	813,17	162,63	-767	-5,9438144	-707	-6,81586
112	112	879	146,5	80	80,39	893,56	148,93	-655	-4,47098976	-627	-4,20968
56	56	935	133,57143	-15	15,03	908,59	129,80	-599	-4,48449198	-642	-4,945844
852	852	1787	223,375	517	516,61	1425,21	178,15	253	1,13262451	-125	-0,703613
-266	266	2053	228,11111	7	7,36	1432,57	159,17	-13	-0,05698977	-118	-0,741233
-600	600	2653	265,3	-250	249,96	1682,53	168,25	-613	-2,31059178	-368	-2,18685
-602	602	3255	295,90909	-565	564,77	2247,30	204,30	-1215	-4,10599078	-933	-4,565416
38	38	3293	274,41667	-212	212,22	2459,52	204,96	-1177	-4,28909809	-1145	-5,586141
-42	42	3335	256,53846	-119	118,67	2578,19	198,32	-1219	-4,75172414	-1264	-6,371466
96	96	3431	245,07143	125	124,56	2702,75	193,05	-1123	-4,58233751	-1139	-5,900107
247	247	3678	245,2	210	209,51	2912,26	194,15	-876	-3,5725938	-930	-4,787654
56	56	3734	233,375	123	123,02	3035,28	189,70	-820	-3,51365828	-807	-4,251392
-398	398	4132	243,05882	-5	4,99	3040,27	178,84	-1218	-5,01113262	-811	-4,537581
-160	160	4292	238,44444	-45	44,85	3085,12	171,40	-1378	-5,77912395	-856	-4,996325
53	53	4345	228,68421	15	15,03	3100,14	163,17	-1325	-5,79401611	-841	-5,156219
-36	36	4381	219,05	-594	593,66	3693,81	184,69	-1361	-6,21319333	-1435	-7,769646
353	353	4734	225,42857	-183	182,73	3876,53	184,60	-1008	-4,47148289	-1618	-8,763454
-81	81	4815	218,86364	110	109,87	3986,41	181,20	-1089	-4,97570093	-1508	-8,321347
504	504	5319	231,26087	264	263,85	4250,26	184,79	-585	-2,52961083	-1244	-6,81586
581	581	5900	245,83333	-106	105,56	4355,82	181,49	-4	-0,01627119	-1350	-7,435801
-465	465	6365	254,6	128	127,96	4483,78	179,35	-469	-1,84210526	-1222	-6,81111

Figure 4.1.23: Case 4.E calculation MAD Forecasting values for PPCI model (researcher) and MKT model

Demand Average = 762; Month Average = 13

b = 24,71; a = 440,78



(On previous page) Figure 4.1.24: Forecasting Models vs. Actual Demand evolutions for case 4.E

This market is the lower sales volume and also to be products for outdoors and external environments have therefore has a strong tendency to high peaks in spring and summer.
Improvements in the forecasting accuracy are clear are repeated and more precise levels of demand estimation using quadratic integration method.

In addition, the varnishes market follows the trend of sustainable environmental development that prioritizes new green products, even having to pay a higher price.
These sales are becoming lower yet still important enough to be included in this research study.
Figure 4.1.25, shows us the increment of forecast accuracy of each researched studied case.

Case	MAD Mkt	MAD GL	Improvement %
A	443	300	32,28%
B	511	254	**50,29%**
C	576	300	**47,92%**
D	305	182	40,33%
E	255	179	29,80%

Figure 4.1.25: MAD Values comparison

Remarking it was clearly demonstrates that the proposed method and process system of calculation of sales forecasts as tools for improved planning is viable.
This will enable significant impact, as explained in the theoretical, lower inventory levels, scheduling and procurement of raw materials to adapt to the budget allowed by the department of finance and anticipate problems and low service level and stock outs.

4.2 Standardization of logistics truck fleet system between plant and distribution center

Logistics management, from this total systems viewpoint, is the means whereby the needs of customers are satisfied through the co-ordination of the materials and information flows that extend from the marketplace, through the firm and its operations and beyond that to suppliers.

To achieve this company-wide integration clearly requires a quite different orientation than that typically encountered in the former conventional Colorin organization.

In this scheme of things, logistics is therefore essentially an integrative concept that seeks to develop a system-wide view of the firm. It is fundamentally a planning concept that seeks to create a framework through which the needs of the marketplace can be translated into a manufacturing strategy and plan, which in turn links into a strategy and plan for procurement. Ideally there should be a 'one-plan' mentality within the business which seeks to replace the conventional stand-alone and separate plans of marketing, distribution, production and procurement. Perform a research study that has to identify areas for improvement logistics along the supply chain involve a doctorate thesis work itself. This is not the purpose. Within the model improvement coordinated all stages studied logistics and the focusing on major monetary impact ones.

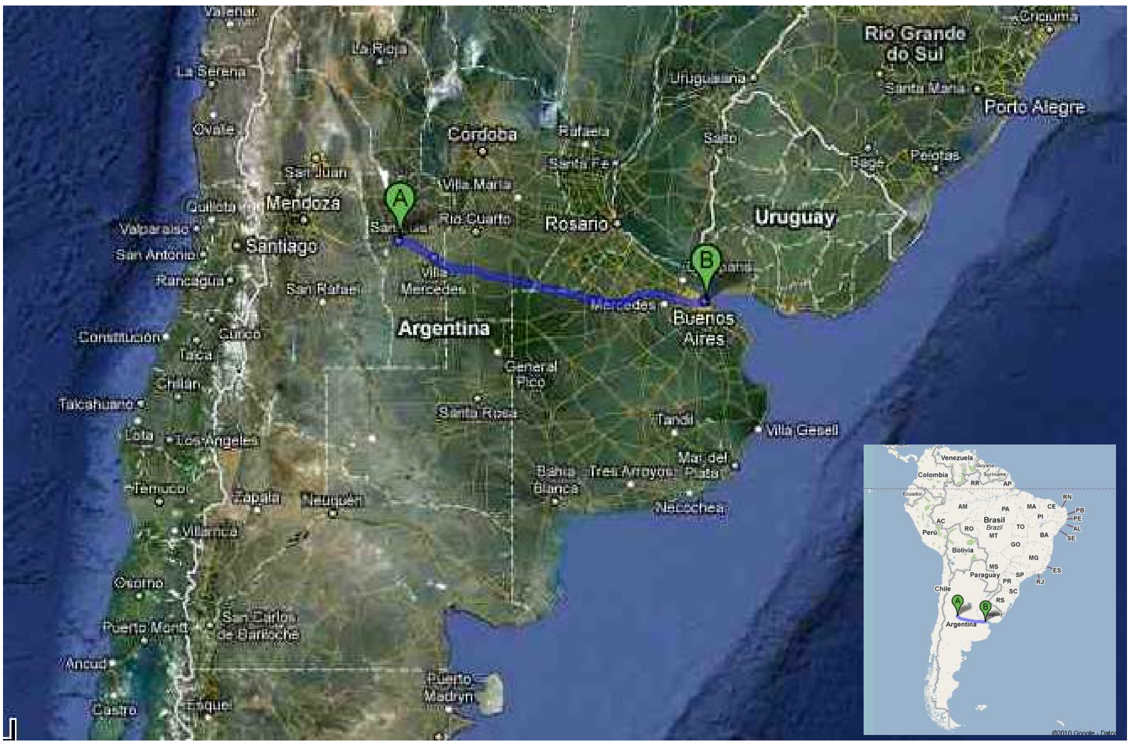
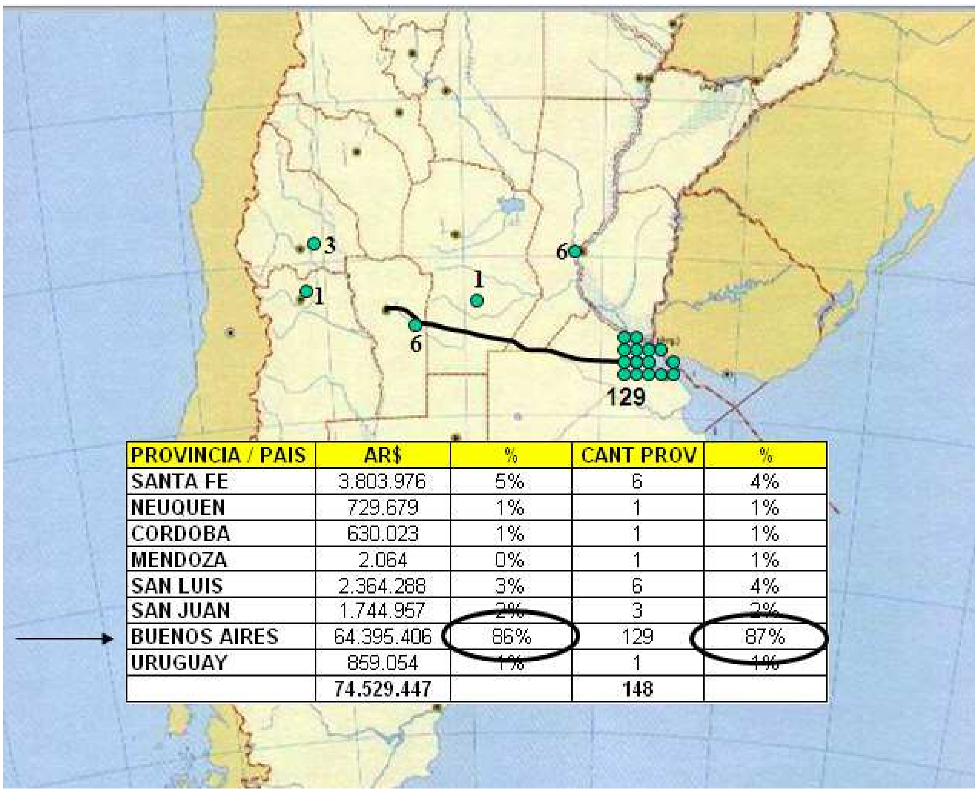


Figure 4.2.1: Colorin facilities location Plant (A) and Distribution Center (B).



PROVINCIA / PAIS	AR$	%	CANT PROV	%
SANTA FE	3.803.976	5%	6	4%
NEUQUEN	729.679	1%	1	1%
CORDOBA	630.023	1%	1	1%
MENDOZA	2.064	0%	1	1%
SAN LUIS	2.364.288	3%	6	4%
SAN JUAN	1.744.957	2%	3	2%
BUENOS AIRES	64.395.406	86%	129	87%
URUGUAY	859.054	1%	1	1%
	74.529.447		148	

Figure 4.2.2: Suppliers (quantity and $ incidence) – Manufacturing Plant Logistic State of Art.

Again, factor manufacturing plant location with distribution center with their 800 kms of distance, covers more than half of logistic costs surpassing even shipment costs to ending customers. Besides, as illustrated in the Figure 4.2.2, 87% of all in economic terms of the logistics of supply to the plant comes from Buenos Aires. The 100% full, finished products are directed towards the distribution center also located in Buenos Aires.

The new process proposed will focus on implementing the circuit of trucks arrive daily from Buenos Aires to the plant with raw materials and packaging. After unloading, loading finished product back to Buenos Aires.

Analyzing case studies and publications relating to logistics iterative by common step, we took the idea that could be comparable to that used in the european low-cost airlines (Ryanair, Comet). Standardization of equipment, a circuit path defined and focus on optimizing the loading and unloading times.

- ✓ All trucks now have the same configuration and brand model.
- ✓ All have the same type of trailer that allows for a single fixed amount of pallets.

- ✓ All pallets used in internal logistics operations will be the same and must be certified by the supplier.
- ✓ The pallets will be tested under these specification internal quality controls in each site.

The root idea is based on converting a strategic disadvantage and real influence factor as is the reception in node San Luis of raw materials and packaging along with the delivery of finished products to and from the same logistic node (Buenos Aires) into an opportunity for improvement through standardization network.

Figures 4.2.3 A and B: Truck fleet standardization for finished product delivery

Figures 4.2.3 C and D: Truck standardization for packaging and raw material reception

This change in logistical processes was summarized in the foregoing description. Behind this implementation were fatigued months of negotiations with suppliers, outsourcing partners and logistics staffing themselves to change the behavior culture installed to this new proposed procedure.

As rejection factors initially we can mention the internal change of the managing director and CFO Chief Financial officer of the company to get support financial and serve as guaranteed collateral for capex credits in the renewal of the fleet of trucks.

The primary challenge of this second improvement sub process was to ensure that the financial sector understand that Logistics and supply chain management can provide a multitude of ways to increase efficiency and productivity and hence contribute significantly to reduced unit costs.

Traditionally, financial areas have been submitted that the main way to cost reduction was by gaining greater sales volume and there can be no doubt about the close linkage between relative market share and relative costs.

However, an increasingly powerful route to achieving a cost advantage comes not necessarily through volume and the economies of scale but instead through logistics and supply chain management. In this kind of chemicals industries with largest distances among facilities, logistics costs represent such a significant proportion of total costs that it is possible to create major cost reductions through fundamentally re-engineering logistics processes.

Finally, it was a balance of monetary costs and their cash flow availability. Was due to present an investment project to argue the purpose of the development plan and the economic benefits that this capital investment was required.

On one hand we had the costs related to the gradual renewal of the fleet of trucks, plus the standardizations of the associated processes:

- Unique pallet system and reverse logistic management.
- Forms, work instructions and procedures.
- Maintenance shop common spare parts inventory.
- Training programs for all operators involved.

On the other hand we had a feasibility study implemented in other industries that guaranteed positive results. Besides all the risk management associated with this new venture. This idea becomes very hard to put in practice.

Logistics by its very nature tends to be fixed asset exhaustive. Trucks, distribution centers and automated handling systems involve considerable investment and, consequently, will often depress return on investment. In conventional multi-echelon distribution systems, it is not unusual to find factory warehouses, regional distribution centers and local depots, all of which represent significant fixed investment.

One of the main drivers behind the growth of the third-party logistics service sector has been the desire to reduce fixed asset investment. At the same time the trend to lease rather than buy has accelerated. Decisions to rationalize distribution networks and production facilities are increasingly being driven by the realization that the true cost of financing that capital investment is sometimes greater than the return it generates.

Within this above descripted scheme was the answer. Colorin financially degree was not running this project but could be a strategic partner if he found any entrepreneur who would like to associate.

Once again, at 2011 we had a relevant case of collaboration and coordination with a strategically new partner. This one, Gadea S. A., would take care of the existing fleet of trucks, would provide capital for renewal in a standardized system and guarantee a dedicated service to the company.

Colorin, meanwhile, would support the actions of the partner providing the technology and maintenance shop facilities for the process of maintenance tasks and refurbishment of the fleet. Give the knowledge to the logistics partner about how is the logistic procedure for transportation these toxic and flammable products. Also serve as financial guarantee for loans requested by the partner.

And basically factory Plant opens to share their information systems with its logistic partner, doing available its finished products warehouses management and manufacturing schedule evolutions. And the shareholder suits truck demand based on production levels.

Now the partner with the access to plant information is able to adapt the demand for trucks and logistics planning based on production levels of the plant.

This drastic change in logistical architecture and their processes was summarized in the foregoing description. Behind this implementation were months of negotiations with outsourcing partner, new suppliers, and logistics Colorin and Partner staffs themselves to change the behavior culture to this new structure. This great paradigm have took place when was demolished this biggest cultural barrier placed within the supply chain. The three new supply chain foundations were:

- ✓ Open the information systems of the plant and distribution center.
- ✓ Working with suppliers markedly in their on line systems of kan - ban.
- ✓ Sites Logistic Partner is able to see every time our “in transit” products traffic under shared information system.

This collaborative partnership process implemented to improve plant managing logistics with a fleet of trucks standardized, it becomes a first step to a larger goal of making this manufacturing system in push into pull.

According to *Christopher* it is presented the idea of moving from a production push (for our case site/nodes logistic) model which seeks to optimize operations through level scheduling and long planning horizons to a ‘demand pull’ philosophy in which, ideally, nothing is made, sourced or moved until there is a demand for it. This in essence is the Japanese kan - ban principle, with the modification that the quantities caused by the kan - ban should be variable depending on demand (for this case plan manufacturing). Clearly the success of such a system requires the highest level of flexibility of all the supply chain’s resources, including people.

And just talking about the people, then the execution of the process is detailed the most salient problems of its implementation:

- Training from zero to the maintenance shop operators in the unification and standardization of spare truck components.
- On suppliers to respect the use of certified pallets.
- Coach partner truck drivers on new preset routes and places and times for loading and unloading.
- Train logistical partner operators on flammable and toxic transportation procedures.

The implementation of a unique system of pallets was more laborious than it was supposed. Not always this system was managed in right way, to get the correct use found intermediate steps to achieve adherence of suppliers and partners workers.

Figure 4.2.4: Plant finished product kan ban ready to be shipment (Left)

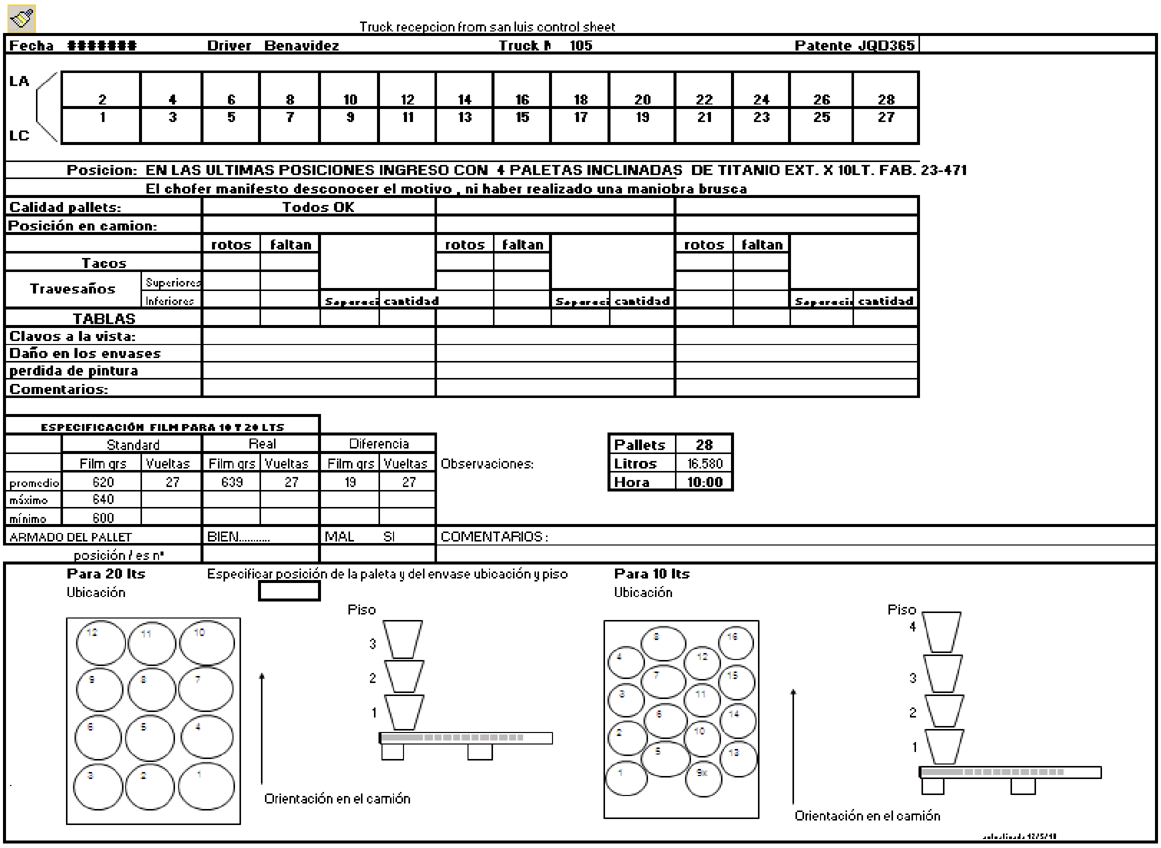
Figure 4.2.5: Plant external warehouse of standardized pallet (Right)

Figure 4.2.6 and 4.2.7: Distribution center deficient truck loading due to use of unstandardized pallet

Figure 4.2.8 and 4.2.9: Distribution center leakages due to use of unstandardized pallet (On previous page)

Even with the use of written procedures, standardized fleet of trucks and pallets exceptionally same problems happen again.

Figure 4.2.10 and 4.2.11: Fallen pallets, leakage and waste material losses even with standardized pallet



Truck recepcion from san luis control sheet

Fecha ####### Driver Benavidez Truck N 105 Patente JQD365

LA	2	4	6	8	10	12	14	16	18	20	22	24	26	28
LC	1	3	5	7	9	11	13	15	17	19	21	23	25	27

Posicion: EN LAS ULTIMAS POSICIONES INGRESO CON 4 PALETAS INCLINADAS DE TITANIO EXT. X 10LT. FAB. 23-471
El chofer manifesto desconocer el motivo , ni haber realizado una maniobra brusca

Calidad pallets:		Todos OK											
Posición en camion:													
		rotos	faltan			rotos	faltan			rotos	faltan		
Tacos													
Travesaños	Superiores												
	Inferiores			Separaci	cantidad			Separaci	cantidad			Separaci	cantidad
TABLAS													
Clavos a la vista:													
Daño en los envases													
perdida de pintura													
Comentarios:													

ESPECIFICACIÓN FILM PARA 10 Y 20 LTS

	Standard		Real		Diferencia	
	Film grs	Vueltas	Film grs	Vueltas	Film grs	Vueltas
promedio	620	27	639	27	19	27
máximo	640					
mínimo	600					

Observaciones:

Pallets	28
Litros	16.580
Hora	10:00

ARMADO DEL PALLET	BIEN..........	MAL SI	COMENTARIOS :
posición / es n°			

Figure 4.2.12: Plant & Distribution Centre Nodes data sheet of shipment control.

To solve these problems at the Plant and Distribution Center were demarcated areas of work, footpaths (pedestrian) and truck angles of rotation. Loading and unloading limited areas were defined using maximum measurements of single and unique type of truck.

The transit control datasheets leaves were also standardized and assigned positions to each of the locations of the pallets in the truck (Figure 4.2.12).

With this datasheets the idea is to leverage the unification of transport system between company nodes (facilities) and create a base of information shared between the partner in charge of outsourcing and logistics managers of the plant and distribution center. All of them must use the same workflow, procedures and work instructions.

On the data sheet are controlled:

- Finished products assigned position (separate waterborne to solvent borne).
- Manufacturing lot numbers matching.
- Assuring the stowage procedures
- Compliance of fixed positions related to each pallet
- State and integrity of certified pallets.

Also, logistical data values are included: time of departure from shipment node and reception on the other node. Total transportation elapsed times. The times elapsed for the operations of truck loading and unloading. And any other comments that modifies or is considered as process deviation.

The next figure, Figure 4.2.13, shows the layout logistics trucks standardized system:

- Point "A" illustrates the place of reception, control and approval of the truck with packages or raw materials to be unloaded.
- Point "B" shows the delimited zone for unloading tasks.
- Point "C" positioned us in the loading area of the finished product.
- Point "D" displays the big scale weighing place and waiting area for subsequent permission to leave the site.

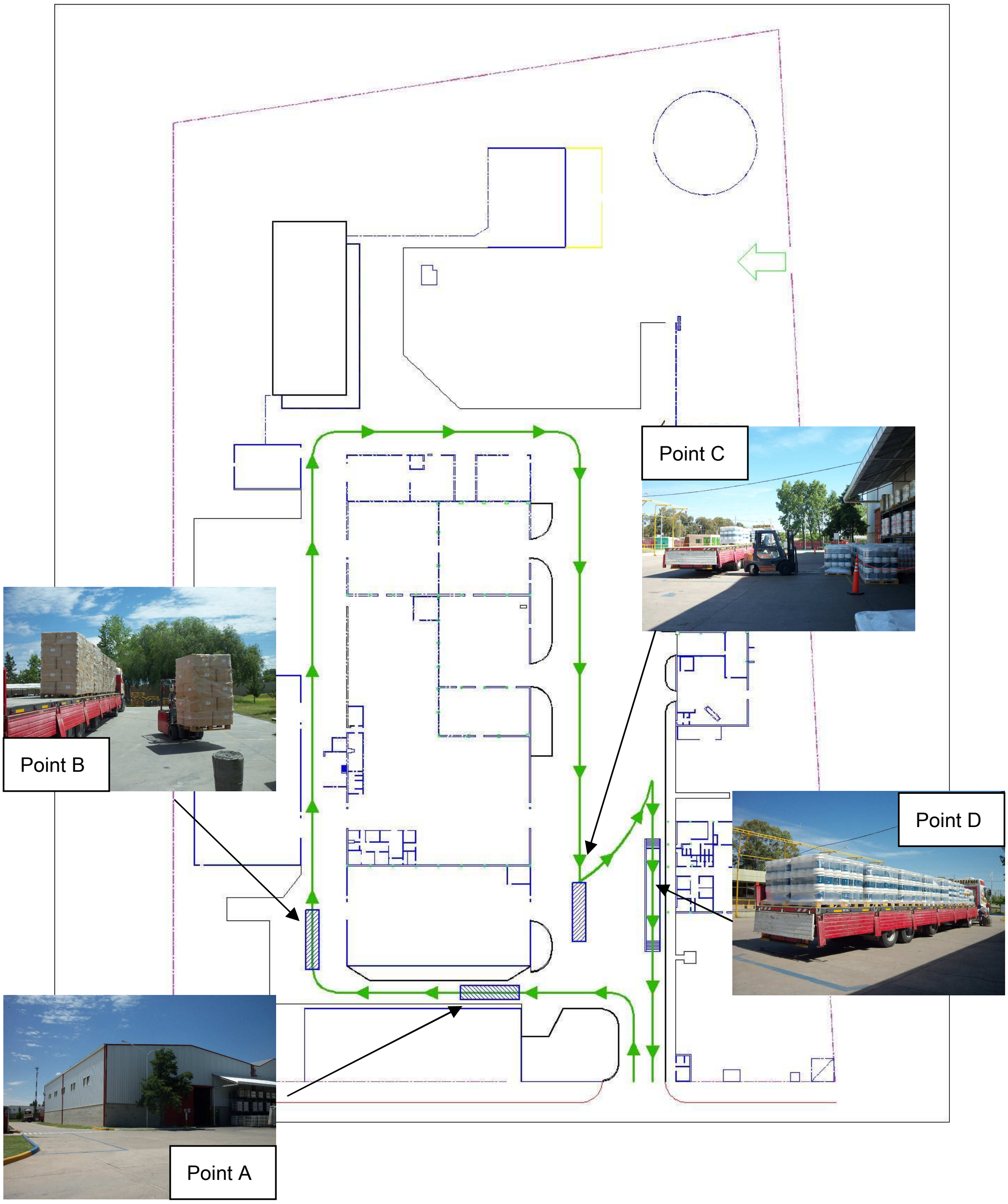


Figure 4.2.13: Chemical Plant Logistic Layout.

This unique system of shared information is used both to direct industrial logistics and reverse logistics. In which reverse sense were re-processing defective or quality non-conforming products came back to the plant unfilled tasks, re-packaging for directly its treatment and recycling.

The graphics related to the time measured of loading and unloading at the chemical plant are shown below:

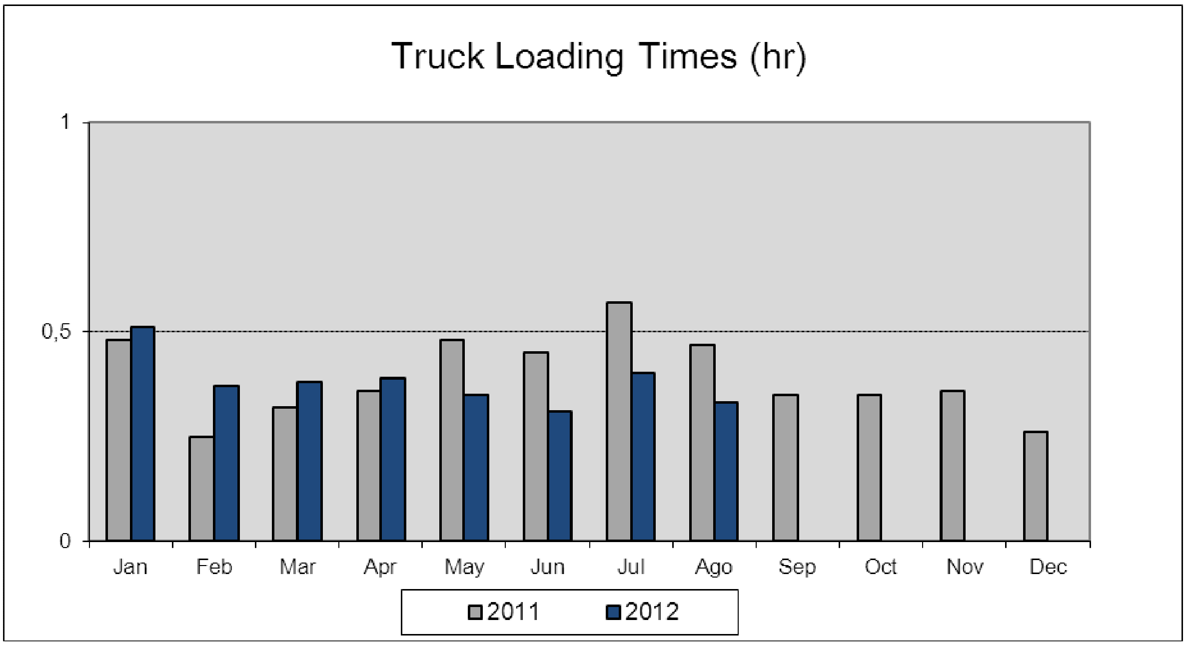


Figure 4.2.14: Truck load at San Luis Chemical Plant

After a period of adaptation and learning the new procedure can already see evidenced the improvement of the load times of finished products. From May this improvement is very clear. Operational improvement is 8.4% yoy in net time, with a trend to continue to increase even more by the end of this year.

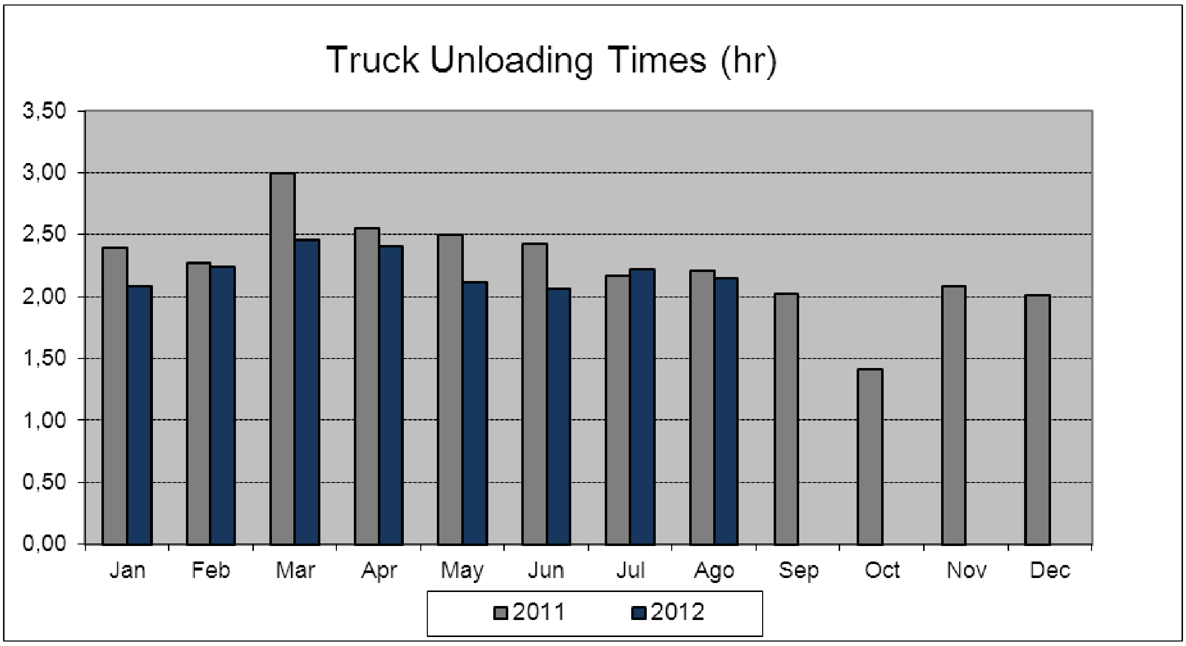


Figure 4.2.15: Truck unloading elapsed times at San Luis Chemical Plant

For unloads and bulk discharges of raw materials times show also an improvement but if you can see a reduction of time may be still greater. Actually near to 10% yoy.

It is explained that in the unloading operations are greater time and unloading procedures must comply with those specified for flammable products. The operation is more risky from the level of security and then the impact on operational improvement is reduced by the minimum time of discharge required by law health and safety.

4.3 Outsourcing strategic plan in order to identify and develop local suppliers at San Luis and surrounding areas

We have seen in the previous two cases of process improvement and initiatives with the inclusion of strategic partners. But one of the critical points of improvement was the development of strategic partners and outsourcing scheme within the region around San Luis. Optimize processes within the supply chain with the inclusion of strategic partners this very well and beneficial are known and have been shown. Adding partners and create a win-win relationship with suppliers located in San Luis region is much better even. This local partnerships integration so has been considered as an improvement process itself.

Find potential suppliers in the San Luis region were so difficult. The amount was relatively low and did not have development and quality levels needed to qualify as such.

For that reason was to add an intermediate process of auxiliary, training and sustainable development of these new partners.

This improved process is divided into two. The first part will show the developments and process with those partners and suppliers of raw materials and in a second part shows the design project, manufacturing and industrial employment undertaken jointly with the plastic packaging supplier.

4.3.1 Raw materials new alliances

At the part of the chemicals raw materials we worked with a collaboration of technology transfer and use of knowledge. One small company dedicated to resins manufacturing placed in San Luis with limited batch process received technical assistance from Colorin to increase its production capacity and approach their standards to the plant requirements.

In return, Colorin ensured the supplying and provision of required quantities of this new critical raw material (former plant semi-finished product) to the manufacturing processes of the plant.

The foreigner raw material is A-C® 405S, manufactured by Honeywell (USA). It is Ethylene-Vinyl Acetate (EVA) Copolymer for use in hot melt and solvent-based adhesives. When used as a component of an EVA resin-based hot melt adhesive, this low molecular weight copolymer provides viscosity control, improved set speed, open time, and functional diluent properties.

RAW MATERIAL SPECIFICATION						
PAGE		DATE		COD1	COD2	COD3
1 of 1		26/09/2011		165	C	6
COLORIN NAME	AC COPOLYMER 405 S WAX					
RAW MATERIAL	WAX AC COPOLYMER 405 S					
MANUFACTURER		SUPPLIER		Denomination		
Honeywell		Kemix		AC ® 405 S		
Shipment units.		Depletion		DRUM	BAG	BULK
KG.		2,00%			X	
COMPOSITION						
Copolimer etilen - vynil acetate						
OBSERVATIONS						
Specific weght:		0,942				
Softening ponit:		94ºC				
TESTING BATTERY "A"			LIMITS		N°	
APPEARANCE			Similar to STD			
COLOUR			White/Ivory			
SOFTENING POINT			96ºC +/- 2ºC			

Figure 4.3.1.1: A-C® 405S properties data sheet

The outsourcer partner (Crilen S.A.) receives from Colorin technology transference related to this component not only for its manufacturing transformation process, but also gives training program and quality laboratory tests best practices methods, right rules to logistics secure and healthy manipulation in its small warehouse and process production recommendations appropriated to their facilities.

RAW MATERIAL SPECIFICATION						
PAGE		DATE		COD1	COD2	COD3
1 of 3		12/09/2012		165	C	12
COLORIN NAME	Wax Solution to Primer Coat					
RAW MATERIAL						
MANUFACTURER		SUPPLIER		Denomination		
Crilen S.A.		Crilen S.A.		EZ - 310		
Shipment units.		Depletion		DRUM	BAG	BULK
Kg		2,00%		X		
COMPOSICION						
Xilol (92G21)			38,50	%		
Isobutyl Acetate (97F9)			47,50	%		
Isobutanol (95G15)			8,00	%		
AC Copolymer 405X (165C6)			6,00	%		

Figure 4.3.1.2: EZ 310 new raw material properties data sheet

Figure 4.3.1.1 shows the data sheet for strategic imported raw material for the manufacture of the new raw material EZ-310. This one was previously produced inside the plant like a semi-finished product. Then, Figure 4.3.1.2 shows the 310 EZ -310 raw material data sheet necessary for the manufacturing of the family products for the primer wax coatings for automotive applications.

TESTING BATTERY "A"	LIMITS	N°
% Sólids	6.3 +/-0,3	MES 1C
Specific weight	0,87 +/- 0,01	EF 1-1A
Colour	= STD	VS. STD
Aspect	= STD	VS. STD
Limpidity	= STD No points	VS. STD (1)
Drained	= STD	VS. STD (2)
% of Water	0,40 max.	MES 11A
Hegman milling	7 Minimum	17A
(1) Apply on glass vs. STD Bird applicator of 0.0015 "(1.5 mils)		
(2) Place 1 ml (pipette to ensure equal amount of solution)		
manufacturing sample vs. STD, on one glass of approximately 20 x 20 cm		
placed horizontally, then vertically and puts shows the		
drained over, it should not be excessive and no greater than STD.		

Figure 4.3.1.3: EZ 310 properties requisition and laboratory testing methods

Product: Wax Solution to Primer Coat EZ - 310			Internal Code 165C12
Manufacturing Procedure	%	Raw material	Especifications
In heating equipment			% Sólids 6.0%
	40	Xilol	Specific Weight (25°C): 0,87 +/- 0,01
Give agitation and without interrupting the same add:			
	6	AC Copolymer 405 X	(Allied Chemical)
Close the equipment and bring warmth to 100 ° C			
After reaching this temperature maintained for 60 minutes			
Remove sample and observed Hot transparency. It should			
be perfectly transparent.			
Cut the heat, open water passage to the cooling jacket.			
When reaching 70 ° C, always with stirring and cooling,			
immediately dilute the mixture:			
	37,2	Isobutyl Acetate	
	8	Isobutanol	
Full flow to complete the addition in 15-20 minutes.			
Add Isobutyl acetate			
	8,82	Isobutyl Acetate	
As soon cut ends added cooling and stirring.			
Less than 35 ° C tank sending Gaff with filtering by filter			
monofilament Nylon bag # 400			
Store at room temperature.			
WARNING: The prolonged agitation affects may cause			
tixotropic effects			
It is important to respect the cooling times for			
the wax does not generate points: must be dispersed as			
microflocs			
End product: at rest is slightly thixotropic			
with Turbidity / Opalescence			

Figure 4.3.1.4: EZ 310 manufacturing process procedure

Besides this case of (165C12) were already outsourced other three types of acrylic resins to this supplier. In 2013 a second phase is scheduled for a set of four polystyrene resins. This gradual process outsourcing will go as the process of partnership continues to evolve sustainably.

The collaboration with Crilen continued when the Argentine government began to put limits on imports of foreigner raw material. This small company could not obtain import quotas due to their low operating and financial movements.

Colorin use its capacity to acquire the raw materials necessary for them to ensure and even increases the agreed volumes. Small businesses still operating in this way and Colorin ensured the provision of these inputs components by others. The costs of produce this type of Acryl and Xilol –Isobutyl Acetate resins within Colorin plant were high that should reactivate out of order reactor and pipelines.

4.3.2 Plastic packaging joint development

On the side of packaging came the most important collaboration of this procedure. This occurs with the release of a new package for water-based paints. This release was not due to a new product on the market or any order of the marketing department.

Building on the benchmarking of successful European plants, San Luis plant engineering staff proposes to marketing department changing four liters packaging design for the premium paints waterborne family.

- This proposal could design a suitable container for packaging machines in existing plant, winning filling performance and reducing non added value times.
- Transfer to a rectangular design that enables higher performance liters per pallet, logistics efficiency benefits.
- The positioning at the pallet of this rectangular packaging according to a brick pattern gave greater structural stability. Thereby reducing cracks, leakages, wall cavities, in the travel to DC. Reducing scrap and Quality Non conformities.

One obtained Marketing area approbation, the second challenge was to find a company that was in San Luis in degree of manufacturing this package. Finally found a company, Cabelma S.A, which makes plastic bottles for soda and natural juices. They had possibilities and feasibility. But Cabelma have no an engineering technical department to develop the model, the ending adjustments and model steel dies for the polypropylene thermal inkjet.

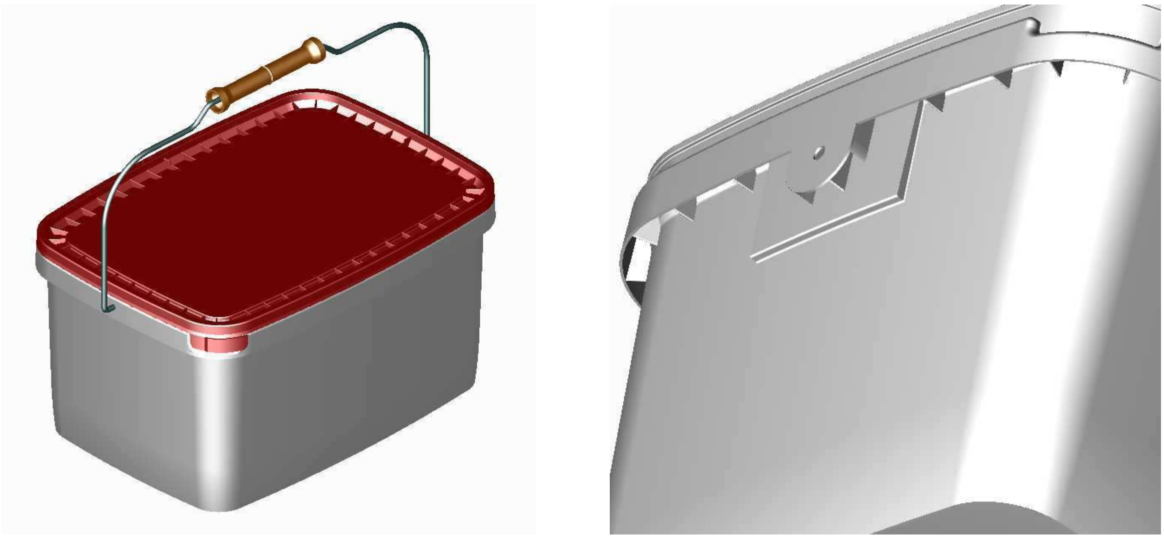
The coordinated improvements have placed which collaborative actions between the researcher and outsourcer team leaders. By use of the skills learned during the years like a structural composite designer was presented the root design ideas, project constraints and numeric simulation to measure the feasibility model. By the other hand, Cabelma’s maintenance responsible and productions worker have been developed the steel made die for this rectangular packaging new model.

Open and share confidential technical information, conduct workshops within the plant to demonstrate the use of these packaging, and learn the pneumatic and thermal mechanisms of plastic injection process was integrated and coordinated experiences performed during those eleven months, from all points of view.

Then, make investments presentation for cost analysis structure to Cabelma and Colorin CFOs. After that, pass and reach the approval of prototype exhibition to marketing and sales managers. And finally, start the production at partner facility, plan local transport and program production filling process inside plant.

The model patent and its design is as authorship of both partners (Colorin and Cabelma) and for a period of five years shall not offer the product to other brands of paint and coatings.

Following, will be illustrated with some photos and drawings the various stages of this process and its implementation.



Figures 4.3.2.1A and B: computational design stage of new packaging

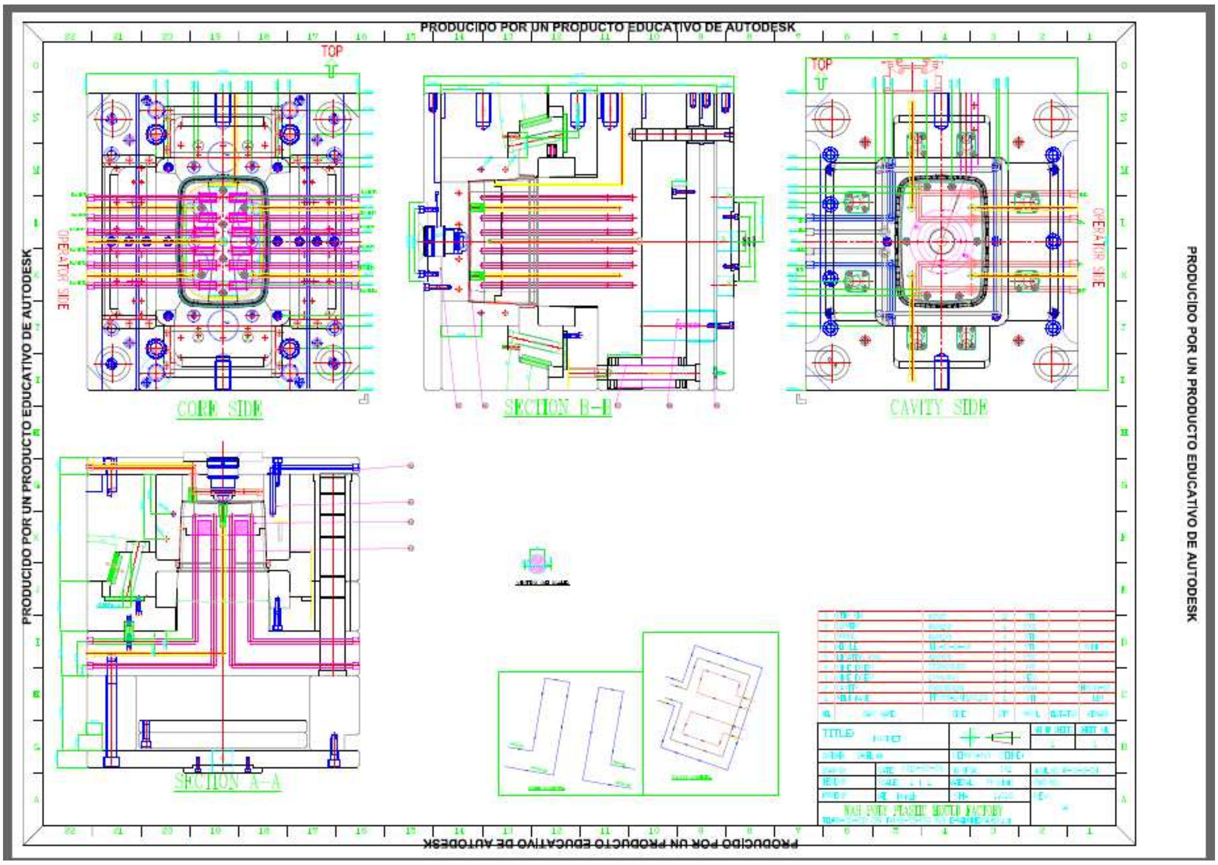


Figure 4.3.2.2: Cad design of steel made die to use in container injection

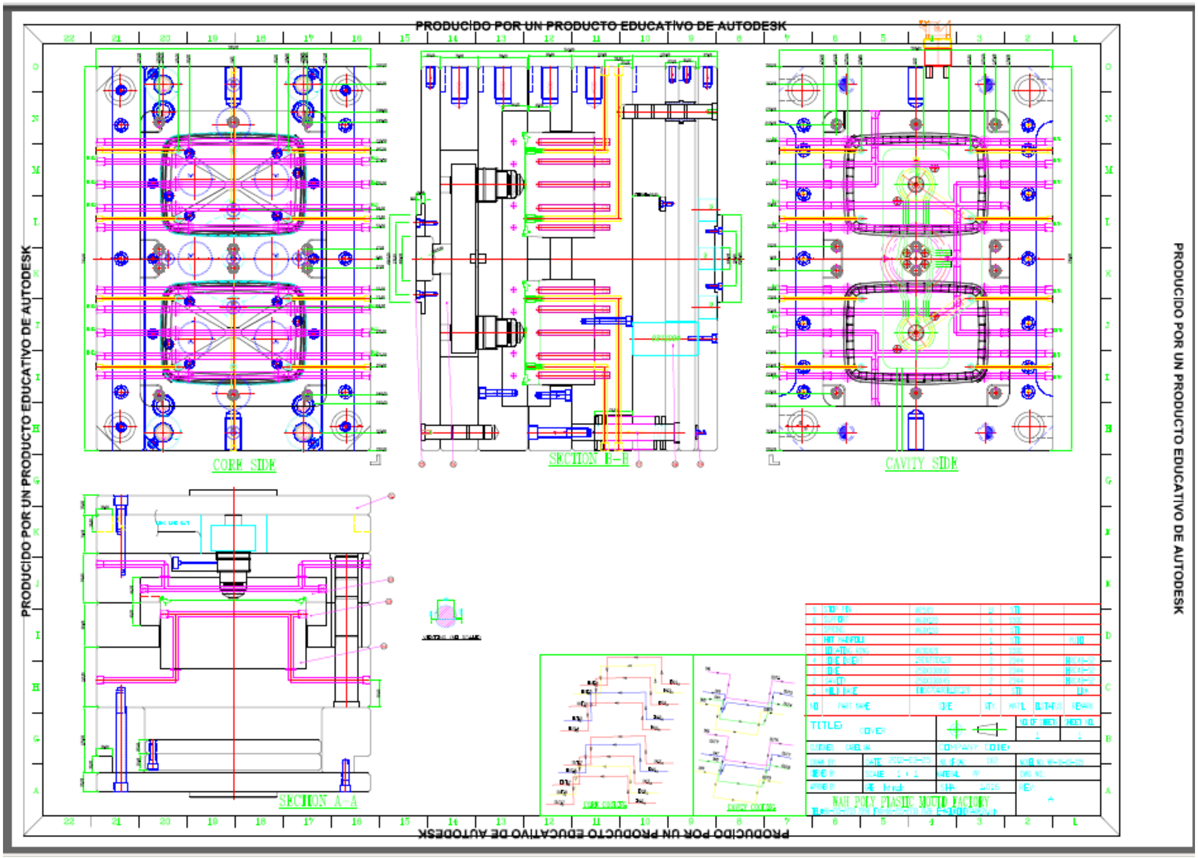


Figure 4.3.2.3: Cap final design. Molybdenum Steel Die Cad design.

Figure 4.3.2.4: Cap and container prototype

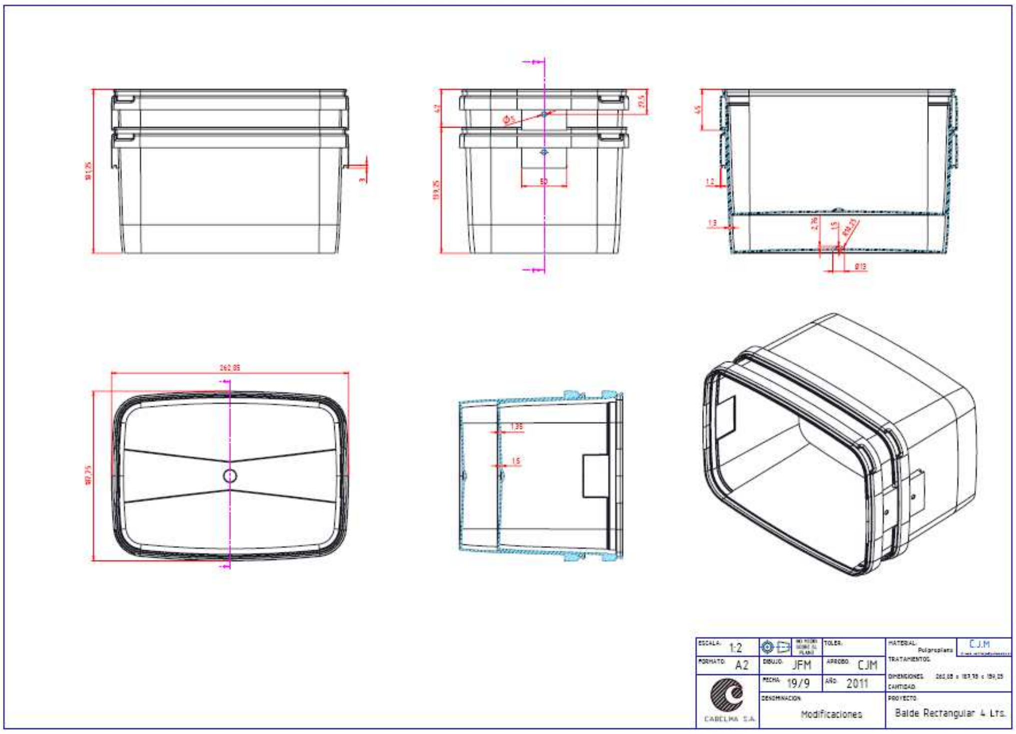


Figure 4.3.2.5: Final model to production startup. (November 19, 2011)

The idea was not to perform and display a design work. That is not the purpose of the process SC coordinated model of improvement. Previous figures have been shown the different stages of development project to illustrate the factors that may exist in the field practice level. In this case give, receive and share the advantages skills to and from local packaging supplier within the Colorin supply chain.

Figures 4.3.2.6 A and B: Differences between old (foreigner) and new model (local collaborative development)

Since the implementation of this new packaging, used between December 2011 and August 2012, we reach the amount of 160,350 units of this new rectangular packaging. Also, there are 32,202 packs at San Luis packaging warehouse, equivalent to a month and a half of average production requirement. This means that plant have been received 192,552 packs. This is equivalent to 481 full pallet positions (400 packs per pallet). And this quantity is equal 17,19 times in a standardized truck of 28 pallet positions.

Then, if we take into account the cost of transport between sites of every truck using kilometer pricing table. (7.56 AR$/Km). Also can deduce that the cost of each transport by Colorin facilities (Plant–DC) by distance traveled is expressed in AR$ 8064.

Excluding operating benefits foundations set out in the development of this new package (performance filling machines, more packs of finished product per pallet, reduction of scrap due to cargo handling and movement), at this moment we have a monetary profit of 138.637 AR$. (22.324 Euro).

If we take into also account the benefits of design optimization for the same capacity between the old (grey cap) and the new packaging (Figures 4.3.2.6), we noticed an improvement in productive times of plant operating processes (filling and thermo contractible furnace) as well as an improvement in the amount of packaging units per pallet.

Figures 4.3.2.7 A and B: Differences between former and new packaging stowage and stacking

Figures 4.2.3.7 A and B show the differences between the new and the old packaging stowage and stacking. In the previous system the pallet capacity was based on the six levels of 20 units each one, while stacking the new scheme achieves a number of 22 units for the same number of floors (levels).

This represents an improvement optimization about 10%, its incidence is directly proportional to the logistics cost reduction.

4.4 Program management for packaging waste reduction in Plant operational areas

In the 1950s, the entire Japanese automobile industry produced 30,000 vehicles, less than a half day's production for U.S. automakers. With such low levels of demand, the principles of mass production that worked so well for U.S. manufacturers could not be applied in Japan. Furthermore, the Japanese were short on capital and storage space. So it seems natural that efforts to improve performance (and stay solvent) would center on reducing the asset that soaks up both funds and space inventory. What is significant is that a system originally designed to reduce inventory levels eventually became a system for continually improving all aspects of operations. The stage was set for this evolution by the president of Toyota, Eiji Toyoda, who gave a mandate to his people to "eliminate waste. "Waste, or muda, was defined as "anything other than the minimum amount of equipment, materials, parts, space, and time which are absolutely essential to add value to the product." Here is the origin of the Lean manufacturing system, which will provide us with the basis for the realization of this improvement process.

Lean is a systematic method for reducing the complexity of a process and making it more efficient by identifying and eliminating sources of waste in a process (such as materials, labor, and time) that hinder flow. Lean basically seeks to optimize process flows through the organization in order to create more value for the customer with less work.

In early 2010 the plant was so far removed from the principles outlined above. Figures 4.4.1 and 4.4.2 show what the situation at that was, then:

Figure 4.4.1: San Luis Chemical plant scrap at the end of solvent borne paint batch filling

Figure 4.4.2: San Luis Chemical plant scrap at the end of working day

In these pictures it is possible see much more than a lot of spotted and stained cans. Missed useful packaging (material waste), costs of sorting and final disposal of waste (logistic waste), paint loss in packs should be packed into salable products (labor and material waste), costs unproductive internal movement (labor waste), housekeeping expenses (time waste).

All these ones are operations and processes that do not add value and generate a series of direct and indirect unproductive associated costs to the detriment of the company.

Under this critical situation is developing a management plan to waste reduction in the plant. With the purpose of maximizing packaging and components planned for each filling operation. In this way, it is possible reduce storage volume in the warehouse. In that manner decrease the level of necessary purchases. Subsequently we have less logistic cost of transportation. And mainly involve significant saving at associate cost of classification and special final waste disposition of these flammable and toxic products.

A manufacturing plant of waterborne and solvent borne paints and coatings can be determined from the processing, waste, and transport that take place. Recycling, renewable resources, clean energy, efficient operations, and proper waste disposal can help mitigate the environmental impact of manufacturing.

The first stage of this fourth collaborative process of improvement involved the collection of data by sector for counting all packaging unfit for use and the reason or cause for their scrap, both for steel manufactured as those made of plastic. This process mapping has the purpose to analyze streamlined operations and eliminated waste at the big three plant's areas: Production area (manufacturing and Filling sectors), packaging main warehouses and laboratory of quality control.

For more than five months, taking representative working days on high and low production season was measured and analyzed the values obtained. Trying to identify the most common causes for each type of packaging, their lost money and finally propose a reduction scheme and improvement.

Following data collected and all integrative comparison graphics are shown. First shows the values obtained for the steel waste divided into three major sectors. Before it is the turn of the plastic packs using the same scheme.

Then the data are grouped by the values gotten for each of the capacity (volume of filling) of the packagings. Also was differentiated plastics and steel.

Ending this part with the integrated graphics of the entire plant as waste packaging units as their impact on the monetary cost.

TYPE	VOLUME cm3	Unit SCRAP FILLING LINE	$ SCRAP LINE	Unit SCRAP WAREHOUSE	$ SCRAP WAREHOUSE	Unit SCRAP LAB.	$ SCRAP LAB.
Steel	250	560	$ 896	531	$ 850	96	$ 155
	500	1.443	$ 3.172	1.025	$ 2.233	244	$ 522
	1000	3.600	$ 9.985	2.948	$ 7.787	1.155	$ 3.184
	4000	2.303	$ 16.792	1.985	$ 14.546	890	$ 6.520
	10000	8	$ 138	2	$ 34	5	$ 86
	20000	125	$ 2.622	122	$ 2.318	36	$ 722
Total Steel		8.039	$ 33.605	6.613	$ 27.769	2.426	$ 11.190

weight pack + cap(gr)	total weight prod(kg)	total weight warehouse (kg)	total weight lab (kg)	Big total
55	31	29	5	65
85	123	87	21	231
128	461	377	148	986
319	735	633	284	1.652
815	7	2	4	12
1.516	190	185	55	429
	1.545	1.313	516	3.374

Figure 4.4.3: Plant steel scrap by sector (Warehouse, Manufacturing and Labs) during data collection period (5 months)

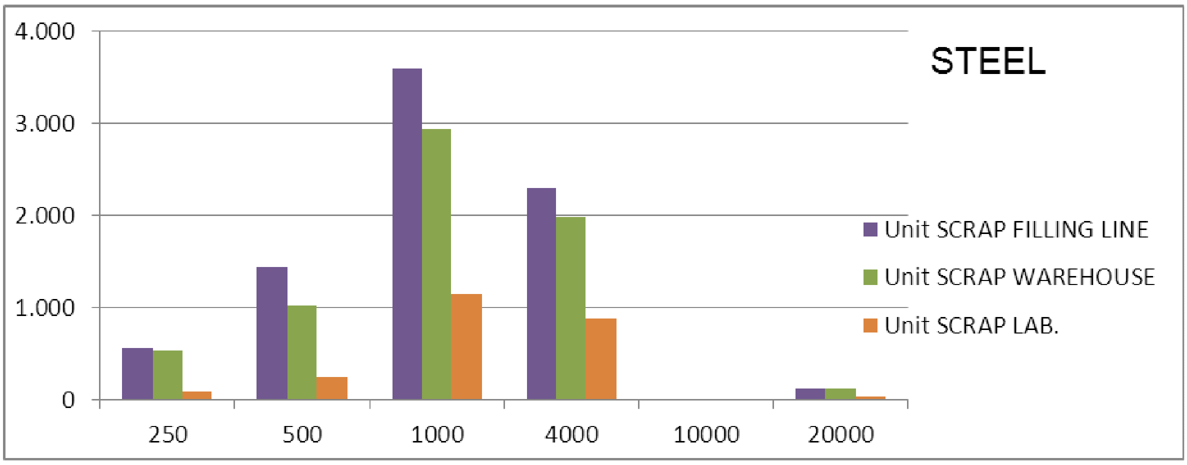


Figure 4.4.4: Comparison graphic of Figure 4.4.3

Now, we will see the values acquired for plastic packagings:

TYPE	VOLUME cm3	Unit SCRAP FILLING LINE	$ SCRAP LINE	Unit SCRAP WAREHOUSE	$ SCRAP WAREHOUSE	Unit SCRAP LAB.	$ SCRAP LAB.
Plastic	500	1.266	$ 1.443	1.472	$ 1.678	551	$ 628
	1000	1.969	$ 3.048	1.620	$ 2.570	790	$ 1.306
	4000	2.058	$ 10.567	1.612	$ 8.840	1.156	$ 6.061
	10000	394	$ 4.338	566	$ 6.077	580	$ 6.182
	20000	1.692	$ 26.990	852	$ 15.204	996	$ 17.727
Total Plastic		7.379	$ 46.386	6.122	$ 34.369	4.073	$ 31.904

weight pack + cap(gr)	total weight prod(kg)	total weight warehouse (kg)	total weight lab (kg)	Big total
48	61	71	26	158
85	167	138	67	372
302	622	487	349	1.457
620	244	351	360	955
1.219	2.063	1.039	1.214	4.315
	3.156	2.085	2.016	7.258

Figure 4.4.5: Plant plastic waste by sector (Warehouse, Manufacturing and Labs) during data collection period (5 months)

Fast forward the comparing graph to show us Figure 4.4.6; it is observed that the distribution of scrap is less concentrated in the plastics on steel. On the other hand, even with having greater weight steel cans, the contribution by weight of plastic is more than two times that in the case of steel. This will impact the monetary costs of recycling and disposal of waste.

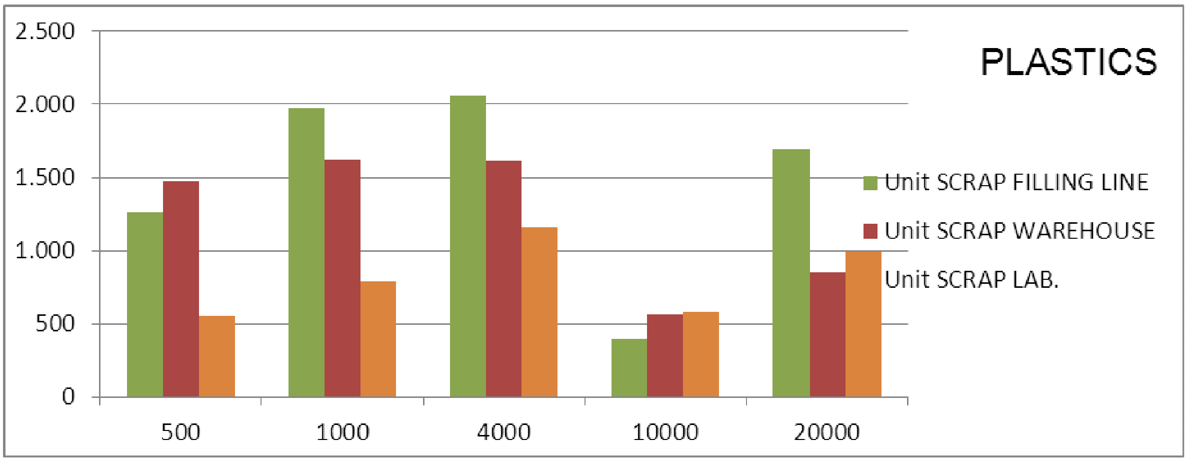


Figure 4.4.6: Comparison graphic of Figure 4.4.5

TYPE	VOLUME cm3	Unit SCRAP FILLING LINE	$ SCRAP LINE	Unit SCRAP WAREHOUSE	$ SCRAP WAREHOUSE	Unit SCRAP LAB.	$ SCRAP LAB.
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	1000	3.600	$ 9.985	2.948	$ 7.787	1.155	$ 3.184
	4000	2.303	$ 16.792	1.985	$ 14.546	890	$ 6.520
	10000	8	$ 138	2	$ 34	5	$ 86
	20000	125	$ 2.622	122	$ 2.318	36	$ 722
Total Steel		8.039	$ 33.605	6.613	$ 27.769	2.426	$ 11.190

Figure 4.4.7: Plant steel scrap grouped by capacity of packaging during data collection period (5 months)

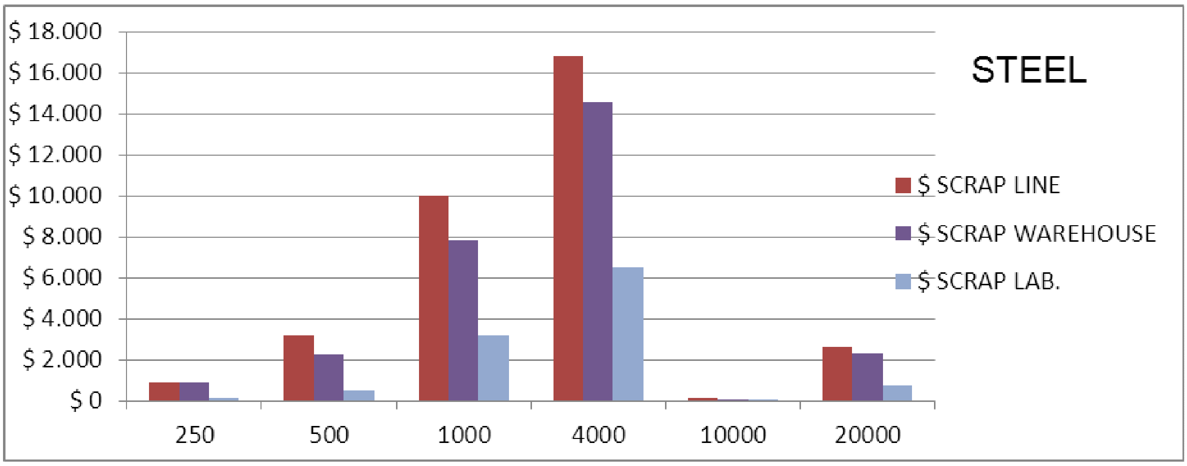

Figure 4.4.8: Comparison graphic of Figure 4.4.7

TYPE	VOLUME cm3	Unit SCRAP FILLING LINE	$ SCRAP LINE	Unit SCRAP WAREHOUSE	$ SCRAP WAREHOUSE	Unit SCRAP LAB.	$ SCRAP LAB.
Plastic	500	1.266	$ 1.443	1.472	$ 1.678	551	$ 628
	1000	1.969	$ 3.048	1.620	$ 2.570	790	$ 1.306
	4000	2.058	$ 10.567	1.612	$ 8.840	1.156	$ 6.061
	10000	394	$ 4.338	566	$ 6.077	580	$ 6.182
	20000	1.692	$ 26.990	852	$ 15.204	996	$ 17.727
Total Plastic		7.379	$ 46.386	6.122	$ 34.369	4.073	$ 31.904

Figure 4.4.9: Plant plastic waste grouped by capacity of packaging during data collection period (5 months)

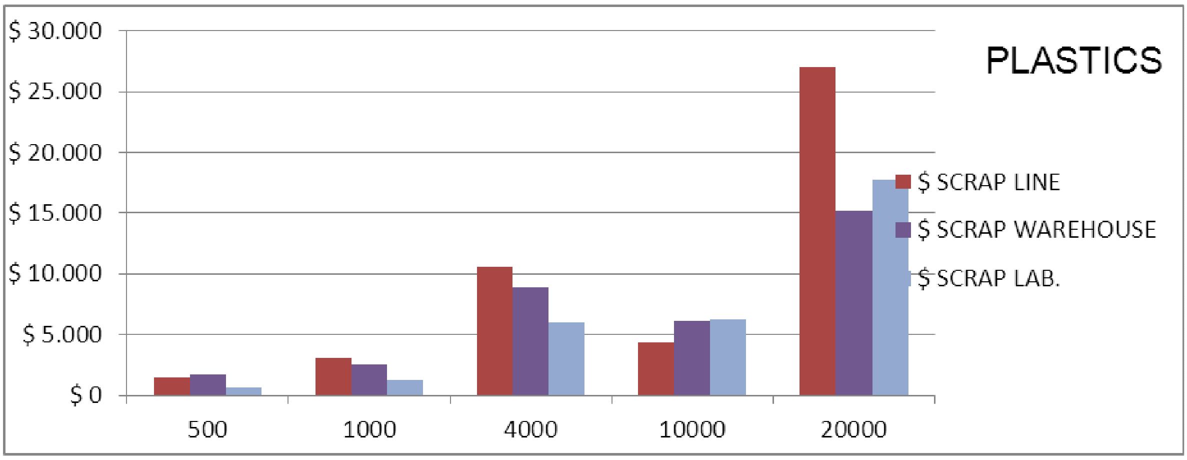

Figure 4.4.10: Comparison graphic of Figure 4.4.9

Comparison graphics helps to identified and well known the largest sources of waste in monetary terms and by unit quantities also. Plastics are strongly linked to the waste related to large packaging of twenty liters and four liters too. While for steel cans, the highest incidence is at four-liter packagings and then those of a liter of volume capacity.

TYPE	VOLUME cm3	Unit SCRAP FILLING LINE	$ SCRAP LINE	Unit SCRAP WAREHOUSE	$ SCRAP WAREHOUSE	Unit SCRAP LAB.	$ SCRAP LAB.
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	1000	1.969	$ 3.048	1.620	$ 2.570	790	$ 1.306
	4000	2.058	$ 10.567	1.612	$ 8.840	1.156	$ 6.061
	10000	394	$ 4.338	566	$ 6.077	580	$ 6.182
	20000	1.692	$ 26.990	852	$ 15.204	996	$ 17.727
Total Plastics		7.379	$ 46.385,57	6.122	$ 34.369,04	4.073	$ 31.904,10
Total Steel		8.039	$ 33.604,62	6.613	$ 27.768,76	2.426	$ 11.189,86
Grand Plant TOTAL		15.418	$ 79.990,19	12.735	$ 62.137,80	6.499	$ 43.093,96

Figure 4.4.11: Plant grand total, plastic waste + steel scrap, during data collection period (5 months)
(On previous page)

The figure 4.4.11 shows the integrated table for all areas of the plant, which are generating packaging waste. It is noted as the greatest contribution the sector makes production department in its container filling process, followed by the logistics sector in charge of the management of warehouses and their internal movements.

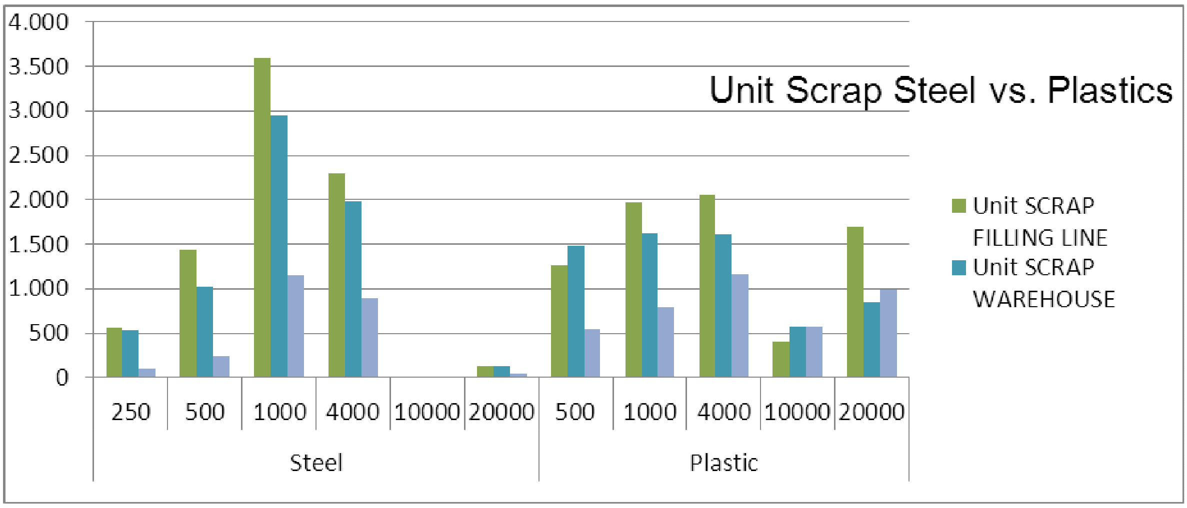


Figure 4.4.12: Plant steel vs. plastic comparison in number of wasted units

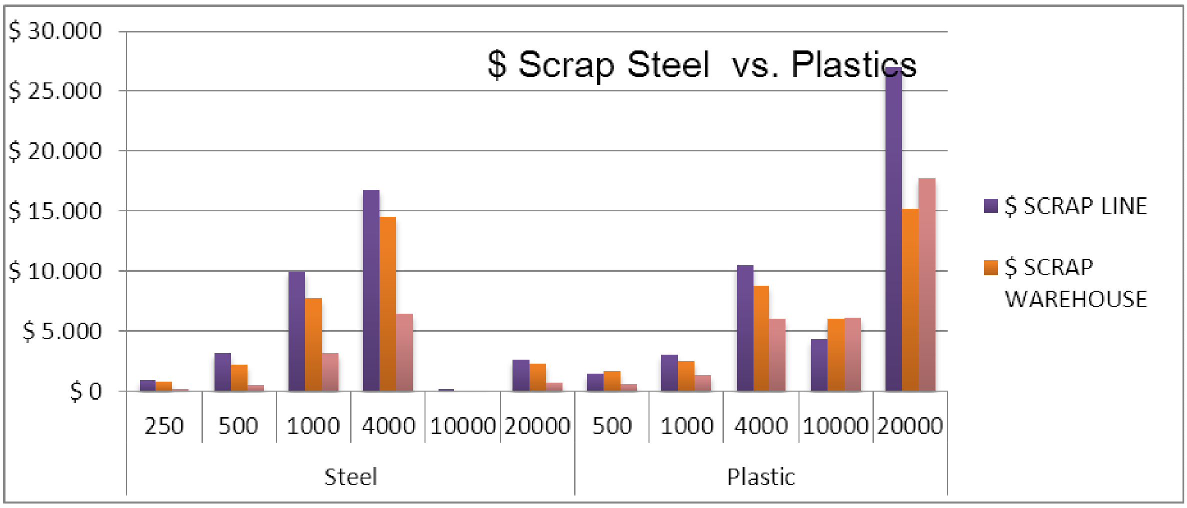


Figure 4.4.13: Plant steel vs. plastic comparison in number of monetary costs

The graphs of the figures 4.4.12 and 4.4.13 confirm the values before analyzed separately in the study of plastic and steel. It is remarkable as plastic packagings of one and half liter contribute proportionately little monetary cost in relation to its considerable amount of waste generated.

Certainly by direct analysis using the Pareto rule, the first waste sources to face are the twenty liters plastic big containers, the steel made cans of four and a liter and then the four-liter plastic.

We know how many are the amounts of generated packaging waste, in which areas of the plant stem, can differentiate in plastic and steel made, in which filling volume capacity and how much is their total contribution. Both for monetary costs and quantities per unit.

Then we begin to deal with them to minimize the generation. But still we need to know what the reasons for these sources of scrap are. Now, we first must know what the causes of them are, then perform a reduction plan to this improvement program.

For this next step, it was decided to focus on the areas of production and logistics deposits. For this analysis approach, was arguing that the contribution to the scrap generation by the laboratory was based on destructive testing activities related to quality control.

For the study of causes in the manufacturing area the identified causes were:

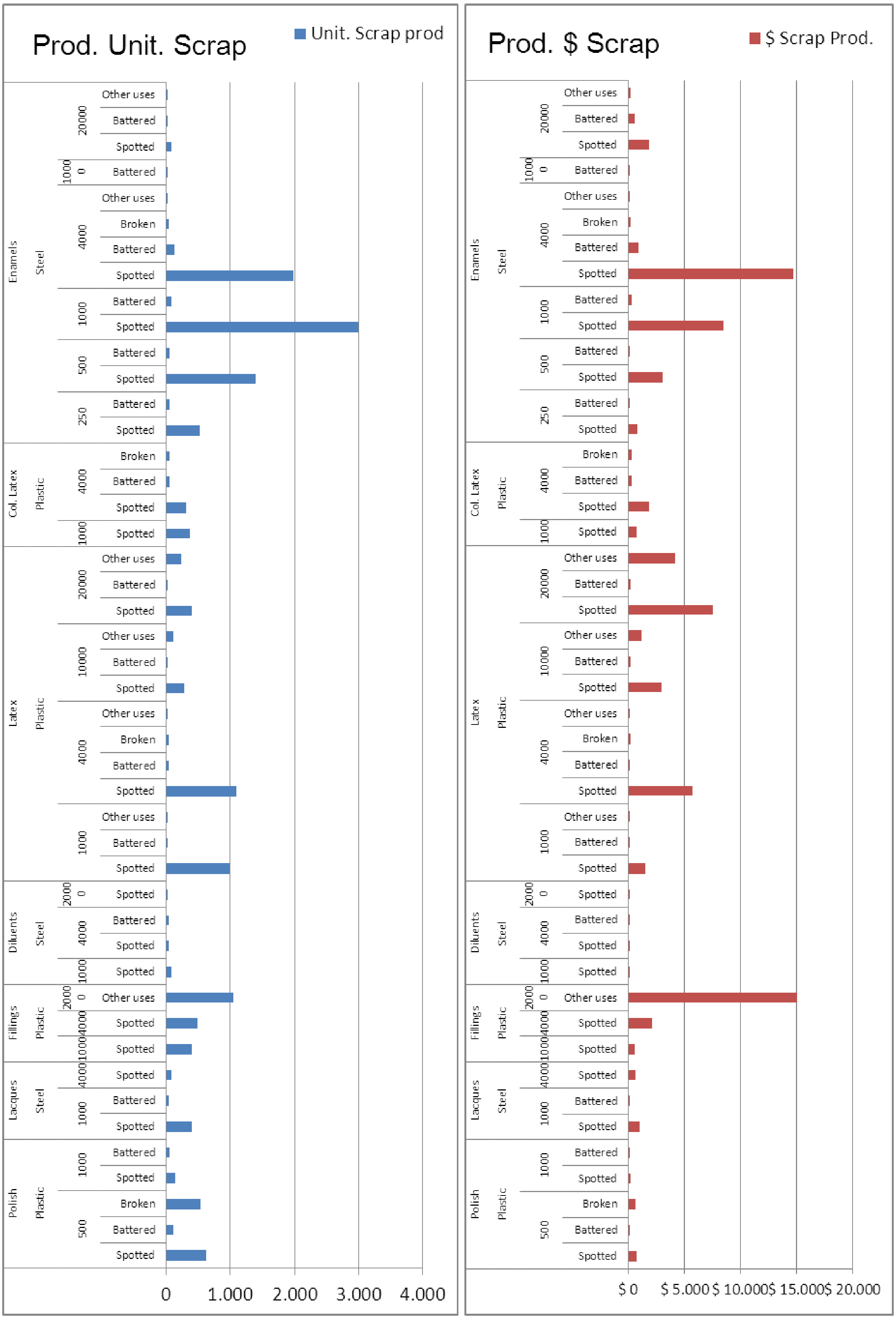
- Spotted / Stained (during filling process)
- Dented / Battered (manipulation)
- Breakages (transportation to plastic film contractible furnace)
- Other different causes

While the recognized sources causes of waste in the warehouses were:

- Battered (manipulation)
- Broken (transportation from warehouse to filling line)
- Dirty (low rotation units)
- Poor Quality (oxidation by weather conditions, UV rays discoloration)

Below are the figures show the data collected during the process of sources identification and causes of waste containers. Also, they are included in which group or family of paintings and coats belong: automotive polish applications, plastic fillings, varnish and lacquers, solvent borne diluents and thinners, white latex, colored latex and finally the whole family of enamels.

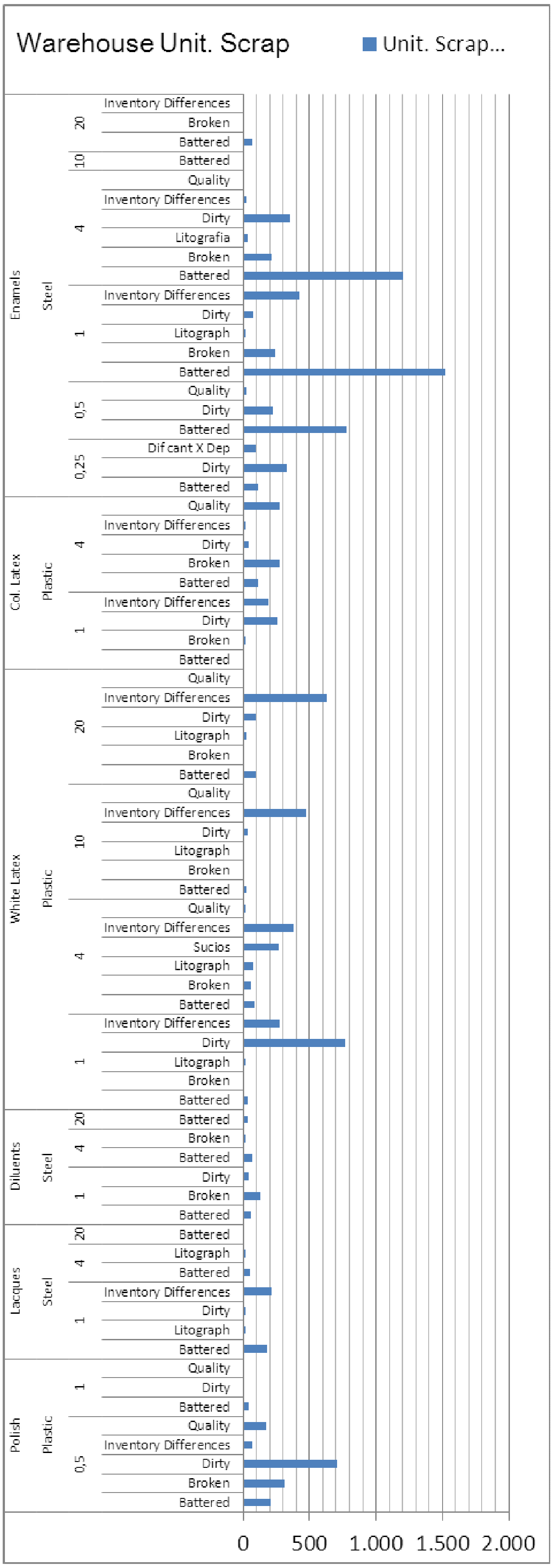
Category	Material	Capacity	Cause	Scrap	$ Scrap Prod.
Polish	Plastic	500	Spotted	630	$ 718
			Battered	104	$ 119
			Broken	532	$ 606
		1000	Spotted	140	$ 192
			Battered	57	$ 80
Lacques	Steel	1000	Spotted	404	$ 987
			Battered	42	$ 123
		4000	Spotted	87	$ 638
Fillings	Plastic	1000	Spotted	390	$ 573
		4000	Spotted	493	$ 2.085
		20000	Other uses	1.050	$ 15.057
Diluents	Steel	1000	Spotted	81	$ 124
		4000	Spotted	35	$ 141
			Battered	34	$ 137
		20000	Spotted	4	$ 61
Latex	Plastic	1000	Spotted	985	$ 1.451
			Battered	18	$ 26
			Other uses	6	$ 9
		4000	Spotted	1.089	$ 5.757
			Battered	28	$ 120
			Broken	32	$ 188
			Other uses	9	$ 43
		10000	Spotted	269	$ 2.965
			Battered	15	$ 201
			Other uses	110	$ 1.172
		20000	Spotted	402	$ 7.539
			Battered	12	$ 240
			Other uses	228	$ 4.155
Col. Latex	Plastic	1000	Spotted	373	$ 716
		4000	Spotted	310	$ 1.804
			Battered	49	$ 288
			Broken	48	$ 282
Enamels	Steel	250	Spotted	516	$ 826
			Battered	44	$ 70
		500	Spotted	1.399	$ 3.063
			Battered	44	$ 109
		1000	Spotted	2.986	$ 8.507
			Battered	87	$ 245
		4000	Spotted	1.986	$ 14.699
			Battered	126	$ 928
			Broken	28	$ 209
			Other uses	7	$ 40
		10000	Battered	8	$ 138
		20000	Spotted	86	$ 1.810
			Battered	27	$ 570
			Other uses	8	$ 182
Total				15418	$ 79.990

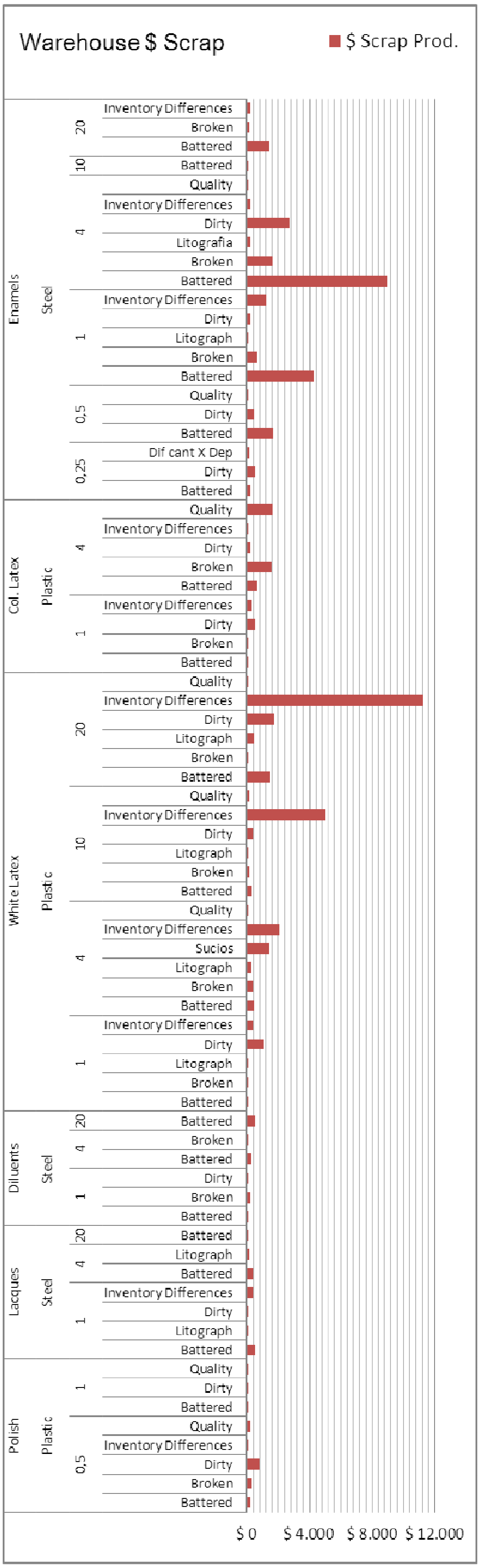


(On previous page) Figure 4.4.14: Manufacturing area waste generations identified by cause.

Figure 4.4.15 A and B: Comparison graphics of unit and monetary costs related to Figure 4.4.14

Category	Material	Capacity	Cause	Scrap	$ Scrap Prod.
Polish	Plastic	0,5	Battered	207	$ 236
			Broken	314	$ 358
			Dirty	711	$ 811
			Inventory Differences	70	$ 80
			Quality	170	$ 194
		1	Battered	43	$ 58
			Dirty	7	$ 10
			Quality	4	$ 6
Lacques	Steel	1	Battered	185	$ 554
			Litograph	17	$ 29
			Dirty	13	$ 22
			Inventory Differences	218	$ 377
		4	Battered	54	$ 397
			Litograph	17	$ 123
		20	Battered	4	$ 61
Diluents	Steel	1	Battered	60	$ 92
			Broken	130	$ 199
			Dirty	41	$ 63
		4	Battered	68	$ 275
			Broken	14	$ 57
		20	Battered	33	$ 501
White Latex	Plastic	1	Battered	37	$ 54
			Broken	2	$ 3
			Litograph	14	$ 21
			Dirty	766	$ 1.125
			Inventory Differences	274	$ 403
		4	Battered	84	$ 440
			Broken	64	$ 374
			Litograph	73	$ 291
			Sucios	270	$ 1.410
			Inventory Differences	383	$ 2.064
			Quality	15	$ 69
		10	Battered	26	$ 313
			Broken	12	$ 138
			Litograph	11	$ 86
			Dirty	33	$ 398
			Inventory Differences	474	$ 5.026
			Quality	10	$ 116
		20	Battered	97	$ 1.520
			Broken	6	$ 87
			Litograph	25	$ 484
			Dirty	92	$ 1.744
			Inventory Differences	627	$ 11.265
			Quality	5	$ 105
Col. Latex	Plastic	1	Battered	9	$ 15
			Broken	18	$ 31
			Dirty	260	$ 498
			Inventory Differences	186	$ 348
		4	Battered	116	$ 681
			Broken	274	$ 1.564
			Dirty	39	$ 229
			Inventory Differences	18	$ 106
			Quality	276	$ 1.613
Enamels	Steel	0,25	Battered	115	$ 184
			Dirty	325	$ 520
			Dif cant X Dep	91	$ 146
		0,5	Battered	779	$ 1.696
			Dirty	222	$ 485
			Quality	24	$ 53
		1	Battered	1.526	$ 4.283
			Broken	245	$ 683
			Litograph	13	$ 38
			Dirty	75	$ 219
			Inventory Differences	425	$ 1.228
		4	Battered	1.201	$ 8.951
			Broken	213	$ 1.600
			Litografia	32	$ 225
			Dirty	358	$ 2.723
			Inventory Differences	25	$ 176
			Quality	3	$ 21
		10	Battered	2	$ 34
		20	Battered	68	$ 1.415
			Broken	6	$ 120
			Inventory Differences	11	$ 221
Total				12735	$ 62.138





(On previous page) Figure 4.4.16: Warehouse area waste generations identified by cause.

Figure 4.4.17 A and B: Comparison graphics of unit and monetary costs related to Figure 4.4.16

At operational manufacturing area we can see that the cause that generates the largest source of waste is the stained/spotted packs and cans (as evidenced in Figure 4.4.1 and 4.4.2). But to make a more detailed analysis we see that the main reason for the waste generated in the twenty liters plastic packaging (the one of highest incidence in monetary costs as observed at the first part of this study) is to be used in other applications.

The warehouse's identified causes shows that in the item of twenty liter plastic packaging used in white latex family the causative difference is due to undercount inventory, no procedure compliance of entry and exit of components and mainly (once again) other applications.

While the contribution given by steel made cans in one and four liter of volume capacity due to denting and damage upon their removal and manipulation into the warehouse.

Having identified the most important sources that contribute to the appearance of scrapping waste began the corrective action plan to reduce or minimize their existence.

Initially during 2011, the new process was focusing on improvement actions to reduce scrap generation on 20 liter plastic packs in the filling line. Avoid their use in other applications (garbage container, absorbent cotton rag bag, used like seat in rest hours, quality samples reservoir, used PPE clothes, gloves and glasses mobile storage system).

In the other hand, was performed an analysis to increase the internal logistical performance at warehouses. Packaging handling procedures, unloading instructive and components and inputs plant internal transporting was development in order to reach wasting reduction between logistic warehouse and the operational areas. Focalizing to reduce scrap tin cans of one and four liters.

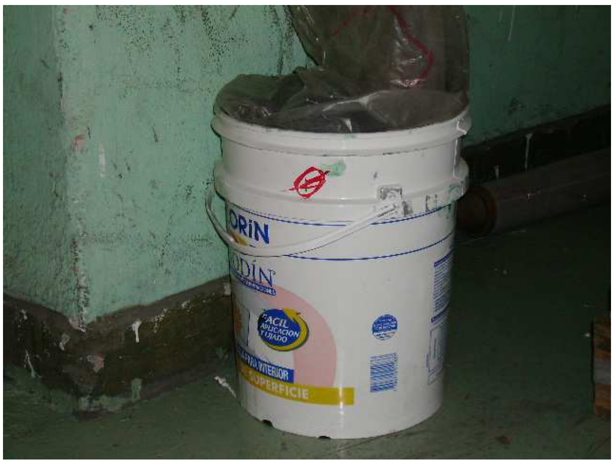


Figure 4.4.18: New plastic packs used for filling machine setting (Left side)

Figure 4.4.19: Twenty liters plastic packaging used like garbage reservoir (Right side)

Figure 4.4.20: Plastic packaging spotted due to filling machine bad cleanness condition (Left side)

Figure 4.4.21: Four liters steel made cans battered and stained due to deficient internal transportation (Right side)

Figure 4.4.22: One liter can with bottom dented due to incorrectly stacked and stowed (Left side)

Figure 4.4.23: Twenty Four liters steel made cans spotted due to overfilling (Right side)

Improvement processes continue being implemented in this 2012:

- Changing the positioning of steel packaging in the location of the warehouse racks, optimizing layouts in order to avoid breaks, battered and dents cans.

- Inclusion in the checklist of the tasks of filling the exact amount of packaging to use plus a percentage of determined scrap. In this way operators can only use the exact amount and if they need more units must complete a data requirement with its process deviations.

- Regulation and setting of the filling machine should be done with packaging identified for this purpose and should not use the new packs units ready to fill.

- Quality control laboratory destructive testing must be done in packaging that has problems of ink printing or cosmetic marketing defect. This does not make them suitable for filling but serve for dimensional and structural testing.

As seen difficulties related to packaging waste generation problematic not obey a single area. We have seen that both the warehouse logistics area as the production filling area are the biggest cause of scrap and not the only ones inside the plant.

If the problem is not one plant area or sector, then their solution too. Achieving a team work of collaboration and coordination between the logistic and the production area was the key to start to minimize scrap sources.

The researcher began this fourth sub process of coordination and integration between these two members of the supply chain within chemical plant thinking would be of low complexity and it would become almost immediate. It was facing two contiguous located areas in the same site (San Luis plant) and with a high knowledge of one another.

I must admit that the process of information sharing to generate the necessary changes to the ultimate goal of reducing scrap demanded almost the same time that the process of forecasting improvement and sharing information with the marketing department (described in the first sub process).

Figure 4.4.24 shows the percentage results obtained during 2011 with the implementation of the first series of improvements and changes.

The obtained values were very satisfactory. Packaging waste reduction objectives are reached both from plastic containers to those steel made.

The greater tendency of reduction occurs in the plastic containers where concentrated joint efforts in logistics and production to optimize the use of twenty liters containers and prevent other applications have begun to yield positive results.

Improvements in the layout of the warehouse, which finished and implemented at July, have been a major factor. The result for the reduction of scrap steel in packaging begins to be evident in the third quarter as a positive effect of the developments executed. This one reaches its best performance on the fourth and last quarter of 2011 with a notorious minimization of steel scrap.

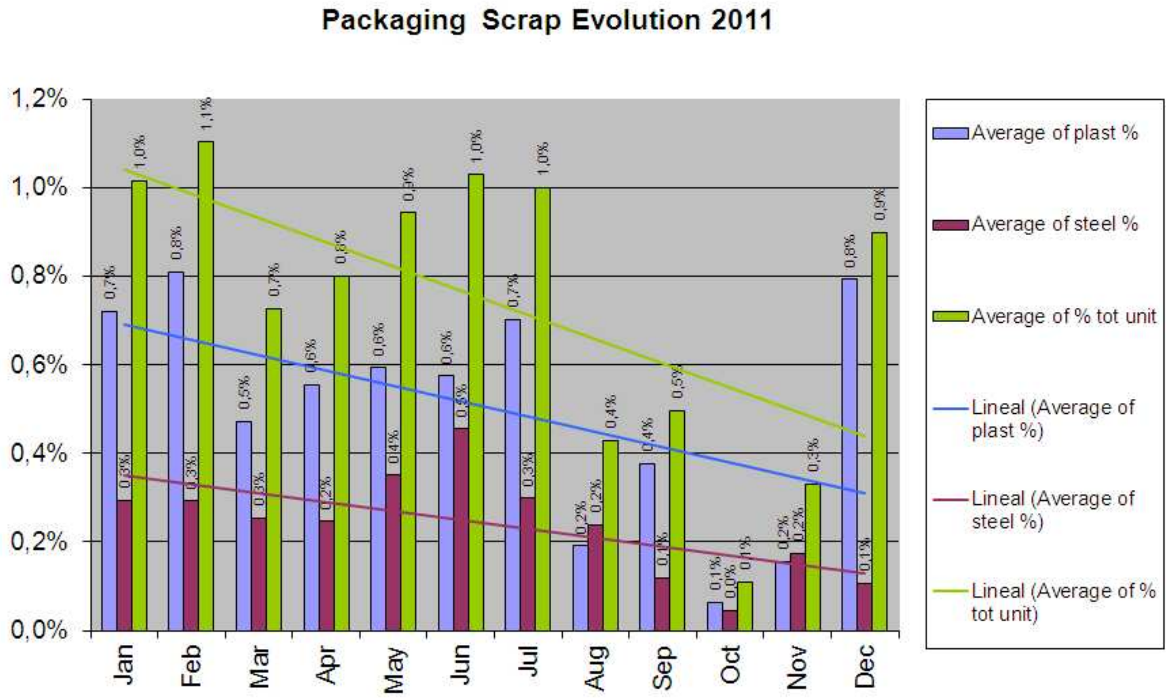


Figure 4.4.24: Steel and plastic scrap reduction and its 2011 trends

4.5 Manufacturing batch complexity and outsourcing program to semi-finished processes

The last of this five chosen improvement process within the coordinated model argued throughout the theoretical study of the types of supply chain architectures: agility, lean, complexity reduction and flexibility analyzed in the chapter two.

The first part of this fifth improvement process was based on the concepts above low. Modeling of supply chain and we really want to reach that goal. Does this desired model is aligned with business strategies of the corporation?

The chemical industry has long been accustomed to maintaining large stocks and plenty of inventories in the pipeline. Colorin was not the exception. One of the reasons have place because hundred percent of Colorin finished line products, 785 unique stock keeping units (SKUs), are make to stock.

For this type of scheme was employed Lean production model with the intention to optimize resources and minimize as possible fixed costs (labor man-hours, energy, time of quality control, process sequence, minimum amount of adjustment and formula settings) associated to each liter manufactured inside the Plant.

The real problem occurred when demand exceeded expectations out of safety stock inventory located in the distribution center. We have seen in the first thread of this fourth chapter the very low levels of accuracy of sales forecasts. Then, the plant lacked the agility to address this over demanding sales requisition, new out of program manufacturing order delays many days, and stockout lingered for long times, with all its disadvantages linked.

The reaction of customers when faced with a stock-out was highlighted by the same study. As Figure 4.5.1 illustrates, over a quarter of shoppers bought a different brand and 37 per cent said they would shop elsewhere for that product. This represents bad news for both the manufacturer and the retailer. Even worse, other studies have suggested that over two-thirds of shopping choices are made at the point of purchase, i.e. the purchase is generated by seeing the product on the shelf. If the product is not on the shelf then the purchase will not have place. Continuous stock-outs can also drive customers away from the Company brands and/or the store permanently. The potential loss of business for both manufacturers and retailers caused by out-of-stock situations is clearly significant.

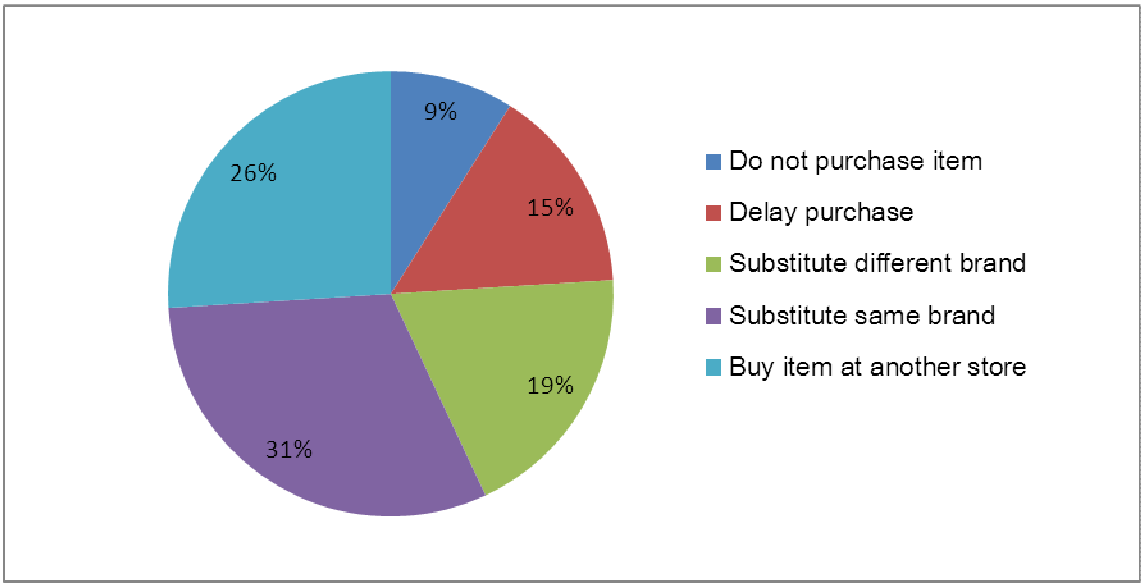


Figure 4.5.1: Customer behavior against stockout (Source: Corsten, D. and Gruen, T., 2004).

Significant damages has been the focus of CFO's on cost reduction that has driven many chemical companies' operational strategy, particularly in Argentina with continuous highs inflation rates and economic periods of recession. Cost reduction is a worthy goal as long as it is not achieved at the expense of value creation. Low cost strategies may lead to efficient operations but not to effective operations. More often than not today the order winning criteria are those elements of the offer that have a clearly identifiable positive impact upon the customers' own value creating processes.

As the demand by all partners in the supply chain for a quick response increases, the more will be the pressure placed upon manufacturing to meet the customer's needs for variety in shorter and shorter time frames. The plant is often faced with unexpected short-term demands for products, which leads to frequent changes to their production sequences and manufacturing schedules and thus additional cost and performance loss.

At this point was decided to perform a complete analysis of the manufacturing plans. From there families identify products and their production frequencies. As well as those associated with multiple SKU. That is, the same product is marketed under more than one brand.

They were able to identify cases of products for polishing and cleaning vehicles. Also the plastic fillings used in the first stage of the preparation of surfaces to be painted. These two product families had in common that possessed a quasi-stabilized seasonal independent sales demand. In addition, on the ground the amount of batches produced per day were more than five with peaks up to eight manufacturing orders for the plastic fillings and two manufacturing lots of production for automotive aesthetics family.

Here the operative model did not have any question. Being a continuous and repetitive with a large number of production batches with a low incidence of the demand variations correspond to apply Lean system trying to optimize manufacturing times. Production scheme is working with twins tanks, while the first approved tank is canning another batch production is made on the second tank. Minimizing dead times. Production operator works crossed with the line packers. Line packers can optimize filling tasks in small containers with the use of with semi-automatic filling/canning machines.

Figure 4.5.2: plastic fillings production upper level of the plant (Left side)

Figure 4.5.3: Line packer of plastic filling at the bottom level (Right side)

In the Figure 4.5.2 it is possible to appreciate at production level the operator clean the empty tank with the raw materials ready for incorporation process (big bags of calcium carbonate). While in the second tank being packaged other approved batch (Figure 4.5.3) in the second tank (the farthest from the operator, both tanks with engine carcass in blue).

The following families that were identified were the white latex. These were produced in large batches with a common raw material base and then the raw materials or sub elaborated that gave their characteristics.

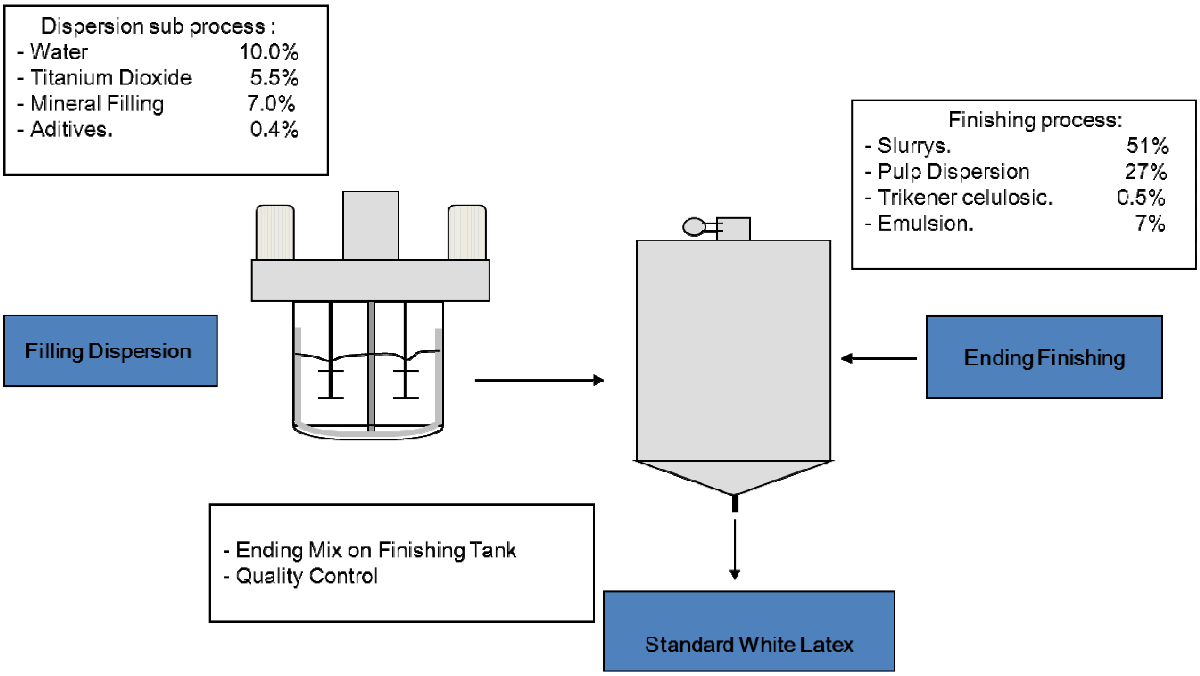


Figure 4.5.4: Waterborne white latex paint manufacturing process

The manufacturing process of the latex white consists of two stages. In the first place the filler dispersion within the aqueous vehicle (carrier) and with the addition of additives to prevent foaming. In the second stage the filler dispersion (paste or pulp) is combined into the finishing tank to the final stage with slurries of calcium carbonate, is added acrylic or vinyl emulsions according to the type of paint and finally the last additives specific to each.

Every filler dispersion process is given according to the characteristics of each product and its desired quality. The proportions of the components and the dispersion and agitation times are different for each type of paint of this family.

This means that from the beginning of the production process each kind of latex paint has a different formula and manufacturing process. That which distinguishes them from each other is the recipe proportions of each component and the degree of grinding and filtering quality.

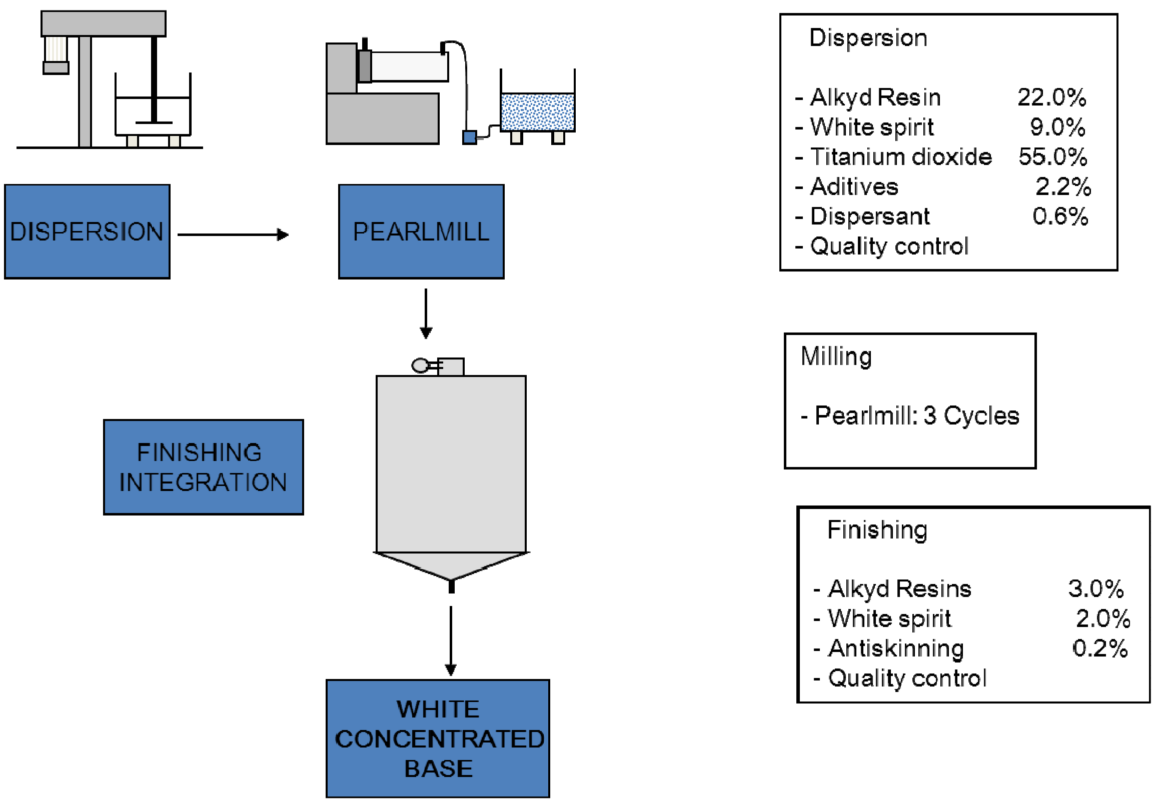
For this family of products the reduction of complexity is limited and would come through the optimization of quality control elapsed times in order to make the productive sequence shorter. Besides, the standardization of raw materials in cases where is possible.

The emulsions are corresponding to different base substrate: vinyl or acrylic. While slurries of precipitated calcium carbonate differ in their rate of solution in water. This difficult logistic operations and increases the number of storage tanks since they cannot be mixed.

Under this state of art for white latex paints system is that it adopted a different system to the previous case. With the objective to search for plant operations in this manufacturing sector one approach more related to agile model. High profitable products with high variety as function of fashion and weather season. With market demand more volatile, where consumers for product availability is essential and the penalty for stockouts are immediate and very expensive as detailed above.

The core of the difference between leanness and agility in terms of the total valued providing to the end customer is that service is the critical aspect calling agility at the same time as cost, and therefore the sales price is clearly linked to leanness.

I this volatile low predictable marketplace of fashionable waterborne white paint both stockout and undesirability costs are punitive. Consequently the purchasing policy moves from placing order upstream for products moving in a regular flow (like plastic fillings and car polish components) to that of assigning capacity to finalize products in rapid response mode (high variety of white waterborne latex paint).



(On previous page) Figure 4.5.5: Solvent borne white concentrate pigment manufacturing process

The manufacturing process of solvent-based enamels and glazes has the similar process like white waterborne latex but with the addition of extra steps.

Again we start with a process of dispersion of fillers (calcium carbonate, mineral talc and titanium dioxide) and alkyd resin, which generate the paste or pulp but this time in a vehicle (carrier) of solvent composition (Figure 4.5.5).

The dispersed fillers with the alkyd resin in a solvent carrier are then transferred to horizontal pearl mills where after three cycles of grinding is obtained the required particle size.

From horizontal mills then transferred to integration tank which are added the latest components and specific additives to achieve the technical specifications.

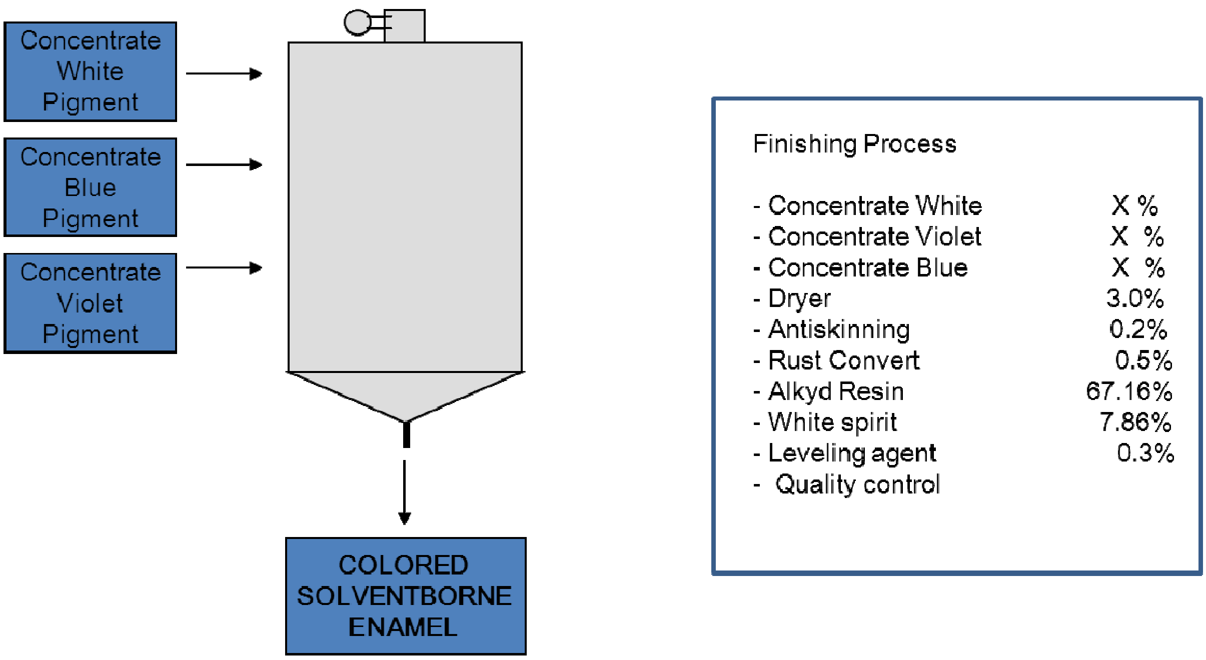


Figure 4.5.6: Solvent borne enamel manufacturing process

The base of white concentrate pigment is combined with blue and purple/violet concentrate pigments to be able to achieve the desired color. These combinations are made in the finishing tank where the alkyd resin in large proportion in conjunction with the combined colored pigments, mineral solvents (white spirits) and additives formed the specific enamel paint (Figure 4.5.6).

At this point is where we find the first differences that allow the opportunity to implement an improvement process with the collaboration of the research and development department. Viewing more in detail the process can be appreciated that the finishing stage has made inside plant semi-finished products which add complexity to this production process.

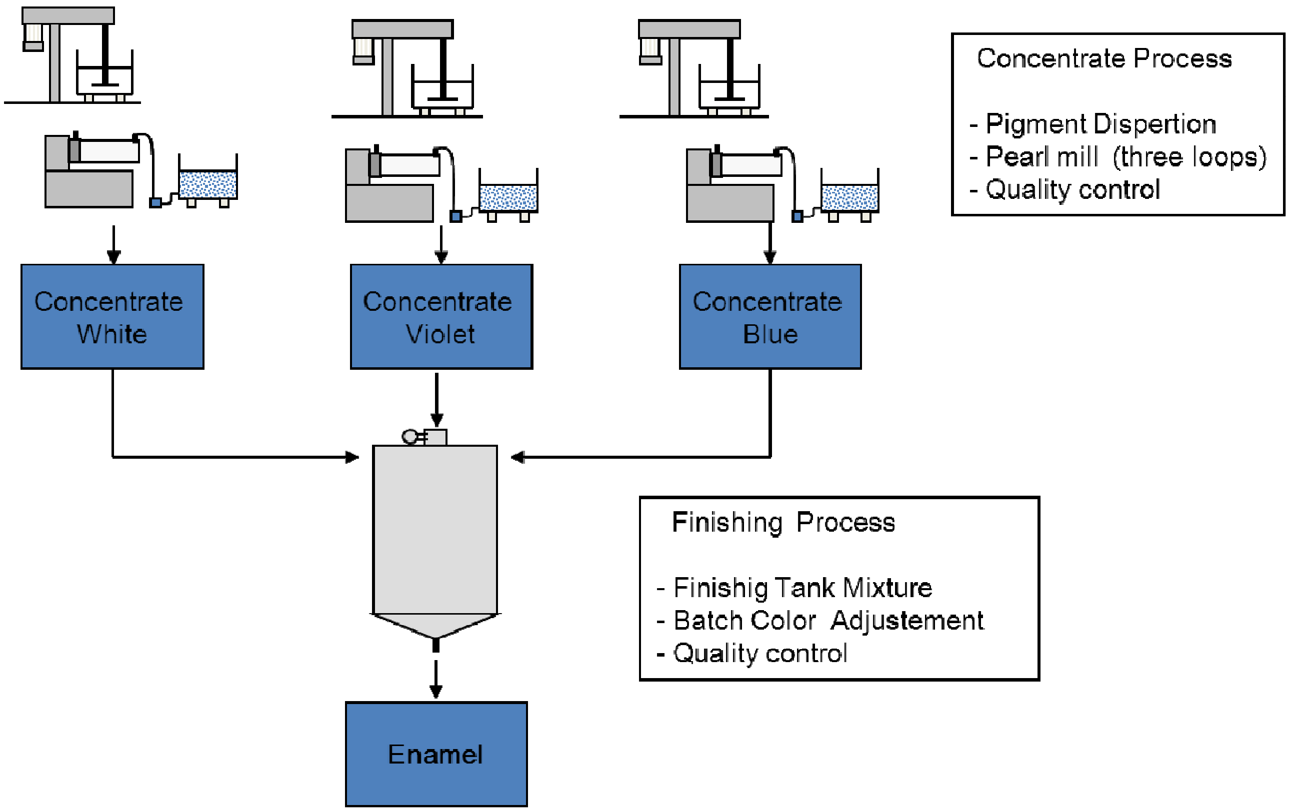


Figure 4.5.7: Solvent borne colored enamel integrated process

For many years the area of research and development together with industrialization processes department of the plant took the manufacturing process of enamels and glazes as a single integrated sequence. Filler dispersion operations, grinding and finishing of color concentrates were usually part of the plant production processes.

The formulas, working procedures and specifications for the manufacture of these products were adapted to color pigments themselves made within the plant.

Over the years, many multinational and domestic companies dedicated exclusively to the manufacture of pigments. But Colorin firm politics still considered the own production of these chemical components.

In 2010, the company belonging to the industrial group Materis could begin work on a sustainable reduction of complexity by replacing the color pigment plant made by those commercially available.

The objective was clear: reach complexity reduction by means of factory manufacturing processes improvement being focused in produce paints and not in grinding pigments pastes.

The first step for the improvement process of replacement commercial solvent based pigments concentrates for in plant tinting in decorative and industrial paint families was to perform a cost analysis.

Shade	Code	Raw material Cost $/lt New Formula	Raw material Cost $/LT STD	RM Cost Difference $/lt	RM Cost Difference %	Anual Volume Jul 10/ Jun 11	Replacement cost $
Vitrospray Naranja Fíat	275-3005/02	8,79	10,14	-1,35	-15,358	3900	5265
Vitrospray Bermellon	275-3006/08	7,98	7,97	0,01	0,125	23600	-236
Vitrospray Amarillo Cromo	275-5007/02	8,23	10,35	-2,12	-25,759	16800	35616
Vitrospray Azul Bandera	275-7013	7,09	7,99	-0,9	-12,694	12500	11250
Martilux Azul Oscuro	277-7025	5,67	6,18	-0,51	-8,995	22000	11220
Martilux Verde esmeralda	277-6017	5,86	6,4	-0,54	-9,215	7000	3780
							66895

Figure 4.5.8: Comparative analyses of industrial coats formula costs

The cost analysis of ccommercials solvent based pigments concentrates those ones will replace in plant made tinting pigments at the family of industrial paints shows, as expected, expensive results. The alternatives to replace concentrates (code 025 correspond tome made in Plant), using third parties supplier CX Universal Pigments from Inquire S.A. outsourcer.

Except in the case of fast drying paint for industrial applications in vermilion colour, in all other five cases, paint formulations for industrial applications using commercial colour concentrates gave a cost growth in their recipe formulations.

Inside the jointly collaborative work, formulations were done at R&D laboratory and then tested in industrial size batches at San Luis factory. With the purpose to homologate these changes at manufacturing real scale and measuring the costs related to operational tasking: energy, labour man hour, tanks cleanness operations, logistic transportation and equipment damages.

In the next figure show the same cost studies applied to the family of colored glazes and enamels for decorative and household use (DIY). For this family of solvent borne products the results were grateful expected since family of decorative paintings has sales volume eight times higher than for industrial coatings.

Shade	Formula	New Solutint Formula	Cost STD Model $/lt	Cost Solutint Model $/lt	Difference of costs $/lt	Difference of costs %	Annual sales volume 2010	Changing costs by Clariant using
Vitrolux Magic Gris Perla	271-2003/06	271-2003/08	5,28	5,27	-0,01	0,189	35328	-353
Vitrolux Magic Gris hielo	271-2005/06	271-2005/07	5,73	5,75	0,02	-0,349	46026	921
Vitrolux Magic Gris	271-2006/06	271-2006/08	5,14	5,26	0,12	-2,335	66470	7976
Vitrolux Magic Marron	271-4049/06	271-4049/07	5,01	5,62	0,61	-12,176	21562	13153
Vitrolux Magic Tostado	271-4053/06	271-4053/07	5,51	6,14	0,63	-11,434	19253	12129
Vitrolux Magic Tabaco	271-4066/06	271-4066/07	5,18	6,2	1,02	-19,691	43208	44072
Vitrolux Marfil	271-5041/06	271-5041/07	6,04	6,19	0,15	-2,483	31650	4748
Vitrolux Magic Verde Ingles	271-6019/08	271-6019/10	5,86	6,28	0,42	-7,167	78629	33024
Vitrolux Verde Esmeralda	271-6031/07	271-6031/09	5,64	6,5	0,86	-15,248	14879	12796
Vitrolux Verde Noche	271-6032/08	271-6032/10	5,72	6,99	1,27	-22,203	34030	43218
Vitrolux Azul Adriatico	271-7023/06	271-7023/07	6,68	6,17	-0,51	7,635	27367	-13957
Vitrolux Azul Bandera	271-7050/06	271-7050/07	5,97	6,01	0,04	-0,670	25691	1028
Vitrolux Traful	271-7059/06	271-7059/07	5,57	5,72	0,15	-2,693	22389	3358
								162113

Figure 4.5.9: Comparative analyses of decorative paints formula costs

And finally we have left to detail the impact of costs that would become passing to commercial pigment color concentrates in the family of low-gloss enamel. For this last family of colored enamel was used the same process of collaboration between the department of research and development and manufacturing area of the plant. Both for the production of new formulas at industrial scales and for the quantification of times and resources related to these test batches.

Shade	Formula	New Solutint formula	Cost of STD model $/lt	Cost of Solutint Model $/lt	Difference of cost %	Annual sales volume Jan 10/Dec 10	Change cost by use Solutint
Titanio Gris	272- 2009/04	272-2009/06	4,55	4,56	-0,220	5551	56
Titanio Gris hielo	272-2010/02	272-2010/04	4,78	5,22	-9,205	2890	1272
Titanio Gris Vison	272- 2021/02	272-2021/04	4,74	4,74	0,000	2709	0
Titanio Pro café tabaco	272-4062/02	272-4062/04	5,04	4,77	5,357	8718	-2354
Titanio Pro Marfil	272-5045/06	272-5045/08	5,51	5,5	0,181	7336	-73
Titanio Pro Verde Noche	272-6038/02	272-6038/05	5,46	5,06	7,326	3528	-1411
Titanio Pro Azul Marino	272-7060/02	272-7060/04	8,08	6,72	16,832	5253	-7144
Titanio Pro Azulejo	272-7032/04	272-7032/06	5,22	5,01	4,023	4569	-959
Titanio Pro Traful	272-7041/03	272-7041/05	4,96	4,83	2,621	4482	-583
							-11198

(On previous page) Figure 4.5.10: Comparative analyses of low gloss enamels formula costs

Surprisingly and unlike the other two products sets studied, family of low gloss enamels gives a positive margin with the new formulation including commercial pigment. This means it is cheaper to buy directly to outsourcer, more than produce it inside the plant with our equipment and technology (Figure 4.5.10).

The cost study is completed with annual manufacturing comparison between formula costs versus operational savings.

Total replacement ($) raw material cost		217810
(Period 2011 and 2012)		
Saving in production man hours	200 Hs	-25094
Saving in maintenance man hours	527 Hs	-23741
Saving machinery hours (energy cost)	1520 Hs	-52220
Savings in grinding materials uses		-64308
Saving in cleaning manufacturing equipments		-17605
Saving in waste (3 %)	2910 Kgs	-20370
Annual cost of replacement in $		**14472**

Figure 4.5.11: Economic balance of commercial solvent borne replacement (u$s)

The annualized economic balance in monetary terms is 14472 dollars for this change. This means that to get to use these new models of production would have to spend $ 14472 per year. This quantity is not conclusive and cost study gave feasibility implementation of this semi-finished outsourcing process. These do not include indirect costs associated to improve supply chain efficiency and cost reduction allowing multiplying several times that amount.

- ✓ Manufacturing tank cycle reduction
- ✓ Milling operator can be located on another production sector
- ✓ Inventory reduction of former RM
- ✓ Reactive and preventive maintenance task eliminated
- ✓ Energy savings at whole manufacturing process
- ✓ Work in progress drastic reduction

Once confirmed the feasibility of the process followed another collaborative work in SC as was its implementation and the changes that each chemical plant area had to do to be aligned with the main objective. Learn and share new methods information and working procedures, without losing the coordinated synchronization. No one plant operations department, logistic area or quality control laboratory be delayed in the new changes.

- ✓ R&D had to adapt manufacturing processes to new replaced product specifications. Making new test batches in the plant and adapting the moisture conditions mixing speeds according to the new needs.

- ✓ Quality control laboratory had to renew the paint test patterns and adapt the controls of the raw material. Besides, has to coordinate with logistics the RM receiving schedule and entry warehouse admission after approval sampling test.

- ✓ Logistic had to adapt their warehouse to the location of the new products for third flammable category and highly toxic level. Also, create a new logistics layout for stacking and subsequent final disposal of used empty drums.

- ✓ Manufacturing renewed its manufacturing methods. Previously could make more grinding cycles with laboratory approval until a particle size that guarantees optimum tinting power in the alkyd base to be colored. Now, the particle size is specified that the supplier and cannot be changed. Therefore, alkyd base to be produced with the proper balance that allows the exact dilution of the color pigments.

- ✓ Maintenance and plant engineering department should work jointed with logistic and manufacturing to adopt systems and equipment for better handling of 200 liters drums. That ones are the container chosen for commercial pigment transportation. With the old system, the pigments produced inside the plant passing by pipes directly from the mills to finishing tanks.

Some of these changes and upgrading made during 2011 and 2012 in the framework of this fifth collaborative improvement process are shown in the following photos.

Figure 4.5.12: Raw material warehouse dedicated place for third degree of flammable pigments (Left side)

Figure 4.5.13: Manufacturing out of service grinding mills (Right side)

Figure 4.5.14: New production area solvent borne pigment tinting stocking (Left side)

Figure 4.5.15: Two hundred liters pigment drum with Laboratory approval labeling (Right side)

The last family of products that we have to analyze the manufacturing process is the waterborne color paintings. The process has certain similarities with white latex but like the previous case presents a new opportunity for improvement for the reduction of its complexity. The opportunity did not pass through water based color concentrates that these have already been used in a while.

This time the opportunity for complexity reducing is located in the first stage of manufacturing process. This means for the dispersion of fillers and paste generation.

The paste that is obtained as product of the filler dispersion in the aqueous carrier medium goes to the finishing tank. There are added the acrylic emulsion and the slurry of precipitated calcium carbonate to form quasi white transparent paint which is then colored to achieve the tone and brightness specified (Figure 4.5.16).

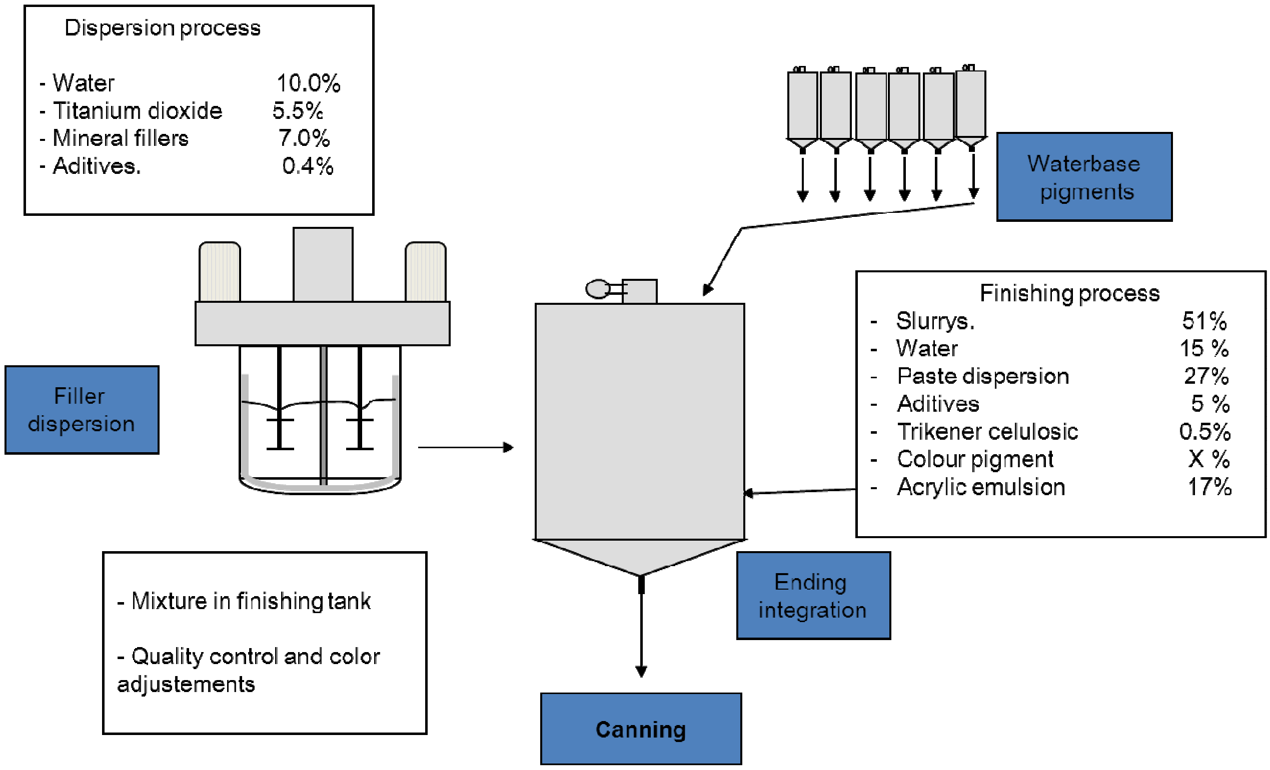


Figure 4.5.16: Waterborne colored latex paint manufacturing process

Unlike the process of the white latex, the variety of products of this family is uniquely assigned color. While the family of white latex each product had its distinctive features and different process too. From dispersion process up to finishing stage any product were different from each other. Every product had its formula and its proportion and combination of different raw materials and additives.

Dispersion process for this family is the same, the completed and additives mixture is the same and in the last stage of adding color concentrates is the difference.

These allow standardization of the first two parts of the process and at that point the researcher proposes make a postponement strategy. Then, depending on the sales demand and plant requirements may be coloring the quantities of each batch of product needed.

This proposal is based that the concept of postponement means that paint products or plant production process is redesigned to delay the point of customer specification as much as possible. Work-in-process is not committed into a particular finished product until a later point in the supply chain. This approach also allows postponing decisions until a later point in time. The decision is made on the production volume for a family of similar colored latex paints and only later the committed production volume is allocated among the products within the family.

One benefit is inventory reduction, because holding inventory of a non-specific product requires less safety stocks compared to holding inventory of several specific products.

This proposed process restructuring involve changing the order in which activities are executed and for that is necessary involve additional costs

Standardization and postponement involve both savings and additional costs, and a careful evaluation is warranted. This evaluation requires simulating the financial impact of changes in advance and then measuring the actual costs and benefits.

Practical and financial limitations found in the feasibility study of this model proposed postponement. For the case presented the alignment of incentives was not desired and unlike all previous four improvement processes which evidenced a pattern of collaboration between all supply chain acting members, in this particular one did not reach the wanted conditions projected initially by the researcher.

- Plant Engineering presented a project where they would go the new tanks located intermediate stocking tanks that would waterborne semitransparent bases before dosing and subsequent coloration of each batches at finishing tanks. They idea was not to redesign processes and the layout of the pipes, the project was to add new equipment and working levels within the plant which had a high cost for construction. There no was a joint effort with the manufacturing area to rethink existing processes and look for ways to upgrade existing facilities and set tanks.

- Firm financial department have seen the high costs of the project directly reject his execution. Never try to found alternative sources: leasing, capital credits, credits from the Argentinean state for special projects. Monetary quantification of direct operational improvement was not sufficient to approve the investment. No intangible costs were estimated as increase in the efficiency level of customer service. The potential ability to add more colors to the family of products. Times reduction in the SC pipeline which generated a quick response from customer demand, production orders and delivery of the colored paint in the right amount.

- R&D was not very encouraged to make all necessary changes made to the implementation of the manufacturing system. The formula of semitransparent bases remained the same but had to make an additional set of tests with additives that maintain product homogeneity and prevent its sedimentation in the stock tank.

- Many manufacturing operators with years of seniority in the plant resisted this project. They saw with no satisfaction the proposal to change the way of produce the colored paint family. For years they had done in the same manner and did not have a willingness to change. No feedback was given at detailed study of the costs, benefits and risks of this new way carried out during the plant tests. Neither shared information with staff of R & D and Plant Engineering staff.

Briefing, the project for a postponement scheme in the manufacturing process of latex color not advanced to the implementation phase. The difference among researcher initially proposed model based on a study on theoretical and benchmark cases from other companies versus their practical implementation in the field were notorious. Even, the initial stage of feasibility study and economic impact developed by the researcher remains stand by the end of this year 2012.

Stand by status which is waiting better financial conditions and maturity development in firm members' collaboration to carry out again this process of reducing complexity and improving the performance of the chemical plant.

Even considering this last complexity reduction process for colored waterborne paints, the overall result conducted on this fifth process gave a very positive improvement.

They were able to identify the types of operations models according to their manufacturing process and physical characteristics and be also aligned with corporate policies and strategies of the company.

Implemented two different schemes of production management (lean and agile) and mainly achieving a significant reduction in complexity by outsourcing the entire production sequence of semi processed solvent borne color concentrate.

The manufacturing process of these products fell by 34.7% measured in the tank cycle times for whites and blacks. These ones represent 64.8% of the production volume. Achieve a 27.82% of time reduction for the remaining colors it a significant objective reached. This values correspond for both families of industrial applications such as paints for decorative and that of low brightness level.

In addition, limitations and constraint found in the process of reducing the complexity of colored latex should not be taken negatively. Now we has the tools to know how to re-propose the model and that focal points should work with each area involved to ensure their cooperation and to align the objectives of each. This case has also been a process of learning and improvement.

5. RESULT ANALYSES and CONCLUDING REMARKS

This section discusses the result obtained in the field cases which make up the coordinated collaborative process model for the improving of supply chain and its chemical plant. These achieved results and principally the ways and manners to reach them become substantial to answers to the first and second research question.

Then, discussions related concluding remarks are presented with notes and views of the researcher. Further research analysis in order to continue and open new study proposals while is ending this thesis work inside the doctoral program.

5.1 Results analyses

The first process is about collaboration between the departments of marketing, planning and plant operations resulting encouragement.

The measure used to quantify the performance and the evolution of the proposed process to the demand forecast of sales was monitoring the mean absolute deviation (MAD). This key performance indicator represents the total error in the estimation of sales demand because use the average of all quantified forecasts errors.

It is clear the improvement obtained with the adoption of this new collaborative process reaching a 50% increase for the family of water-based white paint and high profits margin. This set of paints, as mentioned in the fifth improvement process, is characterized by a wide variety of products with a highly volatile demand by the marketplace and stockout penalties.

The less improvement and even significant in percentage corresponded to the family of wood varnishes and industrial application lacquers. Anyway, a 30% of MAD upgrading for a market where demand is quasi stable is truly remarkable.

The other product families are placed around 40% of MAD optimization becoming this proposed process from the quantitative point of view in an important achievement.

The second process introduced a lot of new procedures and functions. Include within the structure of the company and an outsourcer partner open IT systems and share information generated a significant big cultural change.

Logistic indicators used for measuring and monitoring of this new phase and logistic work methodology have been positive. The loading and unloading times at the plant have been improved by about 10.01% and 8.14% respectively. At distribution center were obtained time progress close to those plant's percentages.

The incidents and paints leakages at plant as well in DC have declined drastically. Have yet been eliminated as evidence in the photos included in the chapter, but lost associated these problems have been greatly reduced.

Purchasing and inventory of spare parts for the truck fleet was reduced by 28.77% and plant's maintenance staff workload related to repair and conditioning tasks on trucks was decreased in 17.33% (measured in man-hours of work).

Shared work efforts and technological exchanges with partners located in areas near the plant were also beneficial. Successful collaboration with small resin production company (Crilen S.A.) ensured a steady supply of a critical raw material for the manufacture of the double-layer coatings. The influence of the Colorin dominant position to get the imported raw materials in order to not interrupt the outsourcer production process was an action in which both partners were winners (clear example of a win-win agreement).

The plant receiving a raw material with the technical specifications tailored to the needs of Colorin with the same quality controls that were made formerly in the plant. Was eliminated duplicated control and quantities of chemical tests and being able to work with certified quality scheme. Double and single layer lacquers tank cycles decreased by 26% of total time from the outsourcing of critical inputs EZ 310.

The largest economic impact in this third collaboration process was the development of the new plastic packaging for paint color family. The monthly reduction of logistics costs for the supply of this packaging to plant stood at 23,000 AR$. In the periods of high sales season this value is greater than 35K, only calculated the savings of provision of this container manufactured by a local outsourcer.

Also, if you consider deliveries from the plant to the distribution center have a direct improvement of 10%. This is because that optimizes achievement of finished products stowed in the certified pallets, passing from 120 units to 132 units per yellow pallet. This improvement quantified in monetary saving represent 4854 AR$ by month.

The results of the fourth process improvement, reducing waste of plastic and metal cans is also encouraging. The laborious and sometimes even tedious for almost six months initial work of data acquisition to identify sources of waste and its causes was the platform for the implementation of corrective actions focused on the reduction and minimization of scrap. The map of waste which was possible distinguishing by type of material, capacity and product family each waste packaging and steel made can was essential. This one permit us know the causes of waste, most relevant sources and to diagram a coordinated plan between all areas of the plant to address the problem.

The values achieved after the first stage of improvement made by all operational areas of the plant in aligned and synchronized way were really positive. Plastic packagings' waste scrap generation in January 2011 pass from 0.7% to 0.036% at the end of that year, taking the total plant entries. Under this same indicator, steel made cans passed from one scrap generation of 0,038% to 0,017% at the equal period.

The fifth and final improvement process to improve performance of the chemical plant produced the most dissimilar results. Paint families were classified from its characteristics not only operational if not with an integrated point of view from the policies and strategies of the company according to the market share, the demand variation, end consumer behavior and the risks associated with the stockouts. Thus be able to propose and implement in plant site different operating models (lean and agile) in order to obtain the best performance of supplying, manufacturing and logistics for each set of products involved. These proposed changes during 2012 permit to move from a relationship of 157.3 to 184.6 liters/hh (17.3% of improvement) for primer coat plastic filling. And pass from 103.5 up to 117.4 lt/hh of productivity for the automotive polishes products family (13.42% of increasing efficiency).

The second stage in the reduction of complexity process has been the greatest demand of time and resources has generated. Breaking a lot of cultural barriers to implementing new work procedures and carry out these tasks in a coordinated manner and with the same motivations among members of the plant and supply chain was remarkable.

The process of solvent borne color concentrates pigments outsourcing was a task full of collaboration with the supplier (and new partner: Clariant) to analyze jointly Colorin requirements and compliance levels in Clariant facilities that this new partnership could ensure. Improvements in direct manufacturing costs signify no savings for the company as it was noted in the tables in chapter 4.5. But that difference becomes savings by taking into account the reduction of operating costs associated with this new production process of colored enamels.

Finally, the experience of not being able to move forward with a proposed postponement model serves to illustrate the differences that may exist between reach a theoretical case and the practical reality in the field of supply chain and its factory.

Alignment of objectives oriented to the mail goal, the motivation to achieve efficiency gains mutually and share information and provide feedback to other members will be the focus for when re-propose a working model of these characteristics.

5.2 Conclusions

The conclusions concerning the first research question are presented next. The research question was:

How to identify an operational plan to improve Supply Chain performance with the descripted structure and environments restrictions?

This thesis presents a model for improvement composed by five processes which are closely connected to each other. During the reading stage of the renowned subject authors and benchmark case studies that can be found in the literature, the researcher thought find examples or applications already analyzed for cases of supply chain with its production site away from the other members that compound supply chain.

There is no rule or guide for the selection of a model to address this specific case. The authors refer and also mention generic success models and value-added approaches for certain types of industries but never show what the right models to implement an improvement plan are.

That the study and operative research provide to researcher on this case, but on Operations and Supply Chain managers in the practice the mechanisms and the theoretical basis for implementation.

They are solely responsible for the choice of the model they consider most appropriate for the target settled. This choice will be more or less successful the greater the knowledge by the staff of SC managers of their strengths and limitations. The improved ability to identify and estimate are the risks to which it is subjected supply chain and also to the knowledge of the internal dynamics and degrees of relationship that exists within the company.

The grade of performance will be focus on this managerial condition and ability by those supply chain responsible to reach a balance between theoretical and practical knowledge. Researching new ideas and industrial green sustainable trends, support co-workers innovation and expose strategic benefits and feedback must be an equilibrate activity with day by day problems solution tasks inside manufacturing plant and their related general and specific difficulties to be solved.

"In the future, competition will not be company to company, but rather supply chain to supply chain."

Michael E. Porter, Harvard University

The second research question was focused on the selection of the chosen processes and their impact within the plant operations:

How to select processes for greater impact on the plant performance?

Here the answer is given by a combination among which is intended to propose and implement and what they actually do. In these three and a half years of research into the chemical plant were proposed and analyzed several cases of improvement besides the five presented.

The five chosen had common characteristics of collaboration between several areas of the supply chain department with the need to coordinate with stakeholders from other company areas such as marketing, finance, commercial and research and development.

With the knowledge that many of these processes when reach the plant transformation stage was difficult and impractical to achieve a significant performance improvement.

The idea was to start working upstream so to get to the process plant stage was aligned with the ending main purpose. So the changes to be made at the plant and its added value implemented processes were in the same sense.

Also elected five processes were chosen to include the four drivers of supply chain. The first process is related to information driver to address issues related to sales forecasts, planning of production schedules and optimization of the MRP system calculation.

The second focuses on the management and optimization of transport and the truck fleet outsourcing for a major part of the company's logistics network.

The third study case is through outsourcing to local suppliers mainly lower logistics costs and reduces inventories security of plastic packaging. Decreasing lead times and managing partner warehouse through a kan ban system that enables optimize plant inventory. Besides, this third process allowed us to reduce plant complexity and avoid the storage of raw material with high flammability and risky manipulation.

The fourth process is linked to the factory driver and its production management and its components and materials. Eliminating packaging waste caused by poor practices, carrying a significant cash savings but also a reduction of kilograms of materials destined for final disposal. This concept is very important for the green sustainable management that requires all chemical plant’s processes.

The last process integrates the four SC drivers. With a production process management different for each family is possible reduce the complexity of the plant. Lower inventories in finished products are managed by outsourcing plant pigments that were previously manufactured at the plant. It reaches optimize logistics transports of these components with an open information system where the outsourcer supplier has access to and can view stock levels for these products and coordinate new shipments in the light of evolutions in the manufacturing scheduling.

5.3 Discussions

This thesis provides the theoretical background for the practical implications, vantages and disadvantages for any SC subject addressed included in the research proposed collaboration model. The results of this thesis are presented from the viewpoint of supply chain coordination and collaborative performance system, logistics networking integration, outsourcing and partnership and supply chain architecture models. The fourth section of the thesis is devoted to the five field process of the application and implementation of sound supply chain concepts or principles in the specific chemical company settings. It is here we see supply chain practice in real life cases. Generally, this set of field improvement processes provides a limited snapshot of the situation in the wide, changing and dynamic scenery of supply chain practice.

This research study supports the principle that supply chain integration can be implemented in different wideness and the objective of the relationship is not close collaboration with all partners. Collaboration is an investment that requires an aligned joint effort of the actors involved. When theory analyses are carried out sometimes is not accounted the lack of trust and loyalty of some members. In the practice, not all suppliers and customers justified such an initial investment.

The study considers the use and need of resources for company cultural collaborative way of working. At Colorin, and generally in several companies, resources for development are limited, so area managers must choose which development actions to take each year, and with whom. The presented field successful processes cases of improvement may offer a validated reference tool with quantified cost saving upgrading examples when considering development actions and help targeting monetary and other resources efficiently.

The objective of this thesis is to identify new methodologies and tools for improve the performance of the chemical plant which is characterized by a complex Supply Chain network. During these three years of theoretical and practical research have been found the actions that have led to this goal and allow plant will make their processes more efficient. This performance increment permit to achieve the corporate aim of be economically and operational better in terms of profit margin and with superior security and environmental green sustainability conditions.

The focus of the research study is on supply chain practice and supply chain theoretical framework too. Because the researcher considers that supply chain practice has been heavily influenced by supply chain research and vice versa. In this period I had lived and experimented very exciting times like supply chain practitioner as well as researcher.

Trying to find the right balance and integration of both tasks for a feedback to the other and thus achieve the best results in my research.

5.4 Research limitations

The first limitation that this doctorate researcher was the work environment and supports the responsibilities of my position inside plant. Possessing the highest level of responsibility within the plant, site manager, was an aid in the speed of time to propose, analyze and implement the studied cases. But at the same time also generate the inconsistency in my functions as researcher.

Often everyday problems and search for its solutions made me get fully involved in tasks related to the position and not to turn away to take the role of student and try to look at the plant processes from another point of view.

In the first year of the doctoral program the focus of the research was placed more on practical activities due from the day to day operations of the plant, and those questions was not framed within a general analysis of the supply chain.

The distance factor and develop this research work in my home country could have contributed to this situation. But I always had available consultation and feedback from my tutor. Then in the second year, while beginning to develop the chosen improved processes and data acquisition, I had the time to update me with recommended literature and necessary to have a complete picture of the chosen theme.

I think that maturity and balance between practical and theoretical knowledge was reached in the second half of 2011 and all this 2012. From that time was found a feedback model to meet the case studies supported by theoretical research and benchmarking cases, which allowed me to review and optimize the collaboration processes in a more efficient manner.

The second found limitation was the access and publication permission of all necessary data. Being Colorin a member of Materis group, a company in the chemical product retail market with several locations in the world, the level of open information outside the group has been restricted in some cases. Anyway, this has also not been a limitation to carry out the studies described in this thesis, if it has been for the data publication for illustrate research developments.

The third limitation ascended in the detail and depth of analysis should take each case study. As they progressed with their development were emerging new fields of study to the chosen process more complex and more and more motivating to face.

The obstacle transformed into the time available. Any process that needed higher time resources would be taking the time to another of the five processes chosen. To what level of detail that progress had to be consistent with the purposes of the investigation?

The answer was in the management of time and meets the maximum premise of this research. Which one consists on seeking mechanisms, methodology and tools to achieve improved plant performance. In some cases it is possible could go to a high degree of detail and get to the root problems of the supply chain subject studied.

In others could meet the targets set at the beginning of the research and let the foundations and future platform for further study researches.

5.5 Further research

Each of the five study cases within this model of collaboration may have been considered as subjects for a degree thesis and even in some of them to post grade studies.

Continue optimized algorithms of linear regression and calculating the mean absolute deviation and extend it to the rest of the family of products not included in this phase of the work is a research case high added value. Even seeing the results achieved at this stage for the main families of company products.

Conduct study site locations to determine the feasibility of localizing a second distribution center is a next task at hand. Based on the node Buenos Aires need to discharge of a portion of the total deliveries made daily and whose picking capacity is almost collapsed. Research supported by computer simulation for distances and travel frequencies to the main customers along the entire country. With the need to take into account the costs associated per kilometer, operating costs of picking preparation and the design and calculation of capacity of this new warehouse and site is a comprehensive task with logistical high impact within chain supply chain.

Extend and complete the studies of waste generation to the rest of physical flows that are transported and handled in the plant is a further development.

Based on what has been done with the packaging and its methodology and implementation is another tool to plant performance improvement.

All these proposed subjects carried out within a framework of aligned goals in a collaborative environment and a high level of shared information at each member involved which allows us to have better and more efficient management tools to achieve the proposed supply chain improvements.

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