4
Key Components of Demand Driven Supply Chain:

In this chapter, it will be briefly reviewed the supply chain processes based on the work developed by Lambert (2008), then it will be presented the 3 Demand Driven Supply Chain components proposed by the author, followed by a literature review for each one of the components. The reason to choose Lambert's processes review was due to its broad coverage of supply chain processes, including customers and suppliers.

4.1
Supply Chain Processes

Lambert (2008) states that empirical research has led to the conclusion that the structure of activities within and between companies is a critical cornerstone of creating unique and superior supply chain performance, and therefore, corporate success requires a change from managing individual functions to integrating activities into supply chain management processes.

He also emphasizes the importance of having standard business processes across the members of the supply chain, in order to have a "common language" that allows integrating processes from different companies.

Lambert (2008) describes that the Global Supply Chain Forum proposes the framework presented in the figure 12 to integrate and manage business processes across the supply chain:

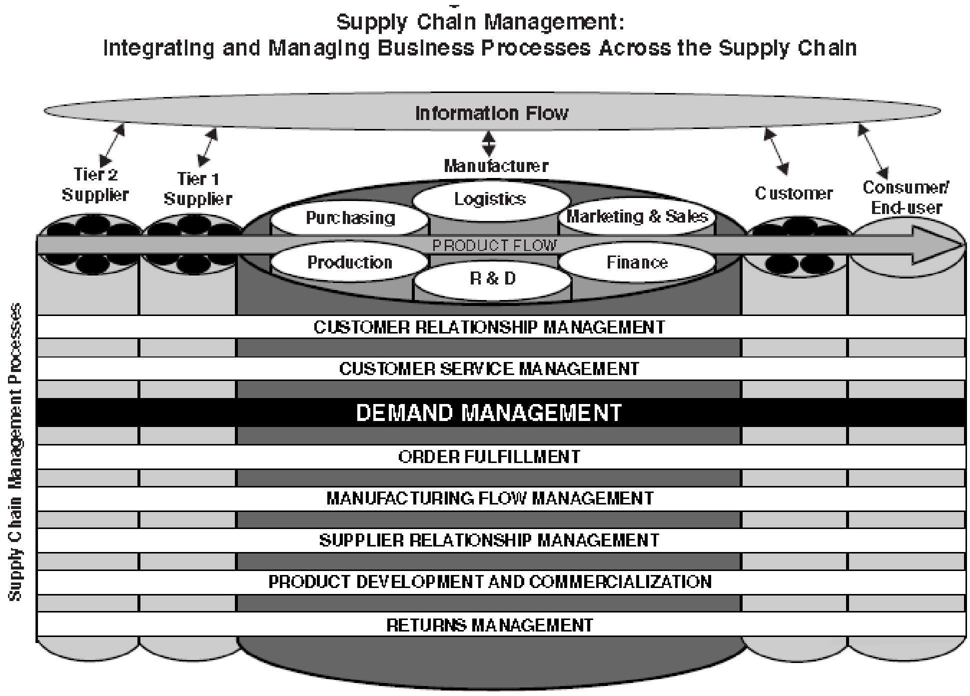

Figure 12 – Supply Chain Processes (Lambert, 2008)

This framework presents eight key processes that are common to all companies in a supply chain, as summarized below:

- **Customer relationship management** provides the structure for how the relationship with customers will be developed and maintained. The goal is to segment customers based on their value over time and increase customer loyalty of target customers by providing customized products and services. Cross-functional customer teams tailor Product and Service Agreements (PSA) to meet the needs of key accounts and other business segments, and also work together to improve processes and reduce demand variability and non-value added activities.
- **Customer service management** is the process that deals with the administration of the PSAs developed by customer teams as part of the customer relationship management process. Customer service managers monitor the PSAs and proactively intervene on the customer's behalf if there is going to be a problem to deliver the promise that has been made. The goal is to solve problems before they affect the customers.
- **Demand management** is the process that balances the customers' requirements with the capabilities of the supply chain. With the right process in place, management can match supply with demand proactively

and execute the plan with minimal disruptions. A good demand management process uses point-of-sale and key customer data to reduce uncertainty and provide efficient flows throughout the supply chain.

- **Order fulfillment** includes all activities necessary to design a network and enable the firm to meet customer demand while minimizing the total delivery cost. In this case, much of the actual work will be performed by the logistics function, but it also requires coordination with key suppliers and customers.
- **Manufacturing flow management** is the process that includes all activities necessary to obtain, implement and manage manufacturing flexibility in the supply chain to move products into, through and out of the plants. Manufacturing flexibility reflects the ability to make a wide variety of products in a timely manner at the lowest possible cost.
- **Supplier relationship management** provides the structure for how relationships with suppliers will be developed and maintained. Close relationships are developed with a small subset of suppliers based on the value that they provide to the organization, and more traditional relationships are maintained with others. Supplier teams negotiate PSAs with each key supplier, and for less critical suppliers, a standard PSA is provided and it is not negotiable.
- **Product development and commercialization** is the process that provides the structure for developing and bringing to market products jointly with customers and suppliers. Effective implementation of the process not only enables management to coordinate the efficient flow of new products across the supply chain, but also assists other members of the supply chain with the ramp-up of manufacturing, logistics, marketing, and other activities necessary to support the commercialization of the product.
- **Returns management** is the process by which activities associated with returns, reverse logistics, gate keeping, and avoidance are managed within the firm and across key members of the supply chain. The correct implementation of this process enables management not only manage the reverse product flow efficiently, but also identify opportunities to reduce unwanted returns and control reusable assets, such as containers, empty bottles, etc.

4.2
Components of Demand Driven Supply |Chain

Table 7 below compares the characteristics of a Demand Driven Supply Chain described in the literature review presented in chapter 2 with the Supply Chain Processes described by Lambert (2008) in section 4.1, and it can be seen that the supply chain processes represent a possible way to categorize the DDSC components.

Table 7 – Author's Comparison of DDSC Characteristics and SC Processes

Demand Driven SC Characteristics	Supply Chain Process
Capacity to sense and respond to real time demand across the Supply Chain	Demand Management
The higher the demand uncertainty, the more the firm should prefer to manage based on actual demand	Demand Management
Customer activates the replenishment flow in the Supply Chain	Order Fulfillment and Demand Management
Being market driven, understanding customers and markets	Customer Relationship Management and Customer Service Management
Have a demand driven replenishment process (Pull based system)	Order Fulfillment
Lean Manufacturing	Manufacturing Flow Management
Develop products that drives demand, getting excellence in innovation	Customer Relationship Management and Product Lifecycle Management
DDSC is the foundation of lean Supply Chain, allowing to operate in a low cost production environment	Manufacturing Flow Management
Being agile, capable of respond rapidly to changes in demand, both in terms of volume and variety	Demand Management and Product Lifecycle Management
Reduce complexity - product and brand proliferation, organization structure and management process	Product Lifecycle Management
Build agile networks to align materials suppliers, contract manufacturers, and logistics providers to a demand signal	Supplier Management
Agile networks start with the design and flexibility based on joint agreements (contract relationship and demand visibility are essential)	Customer Relationship Management and Supplier Relationship Management

For the sake of simplicity and due to the interrelations of some processes, like customer relationship and customer service management, the author proposes to categorize the 8 processes from Lambert (2008) in 3 key components, as explained below:

- **Demand Management**, which encompasses all aspects related to reading, sensing, shaping and synchronizing customer demand.

- **Supply and Operations Management**, which covers all aspects of providing right product with right quantity, based on actual demand signal and with low cost. This component should encompass:
    - **Procurement (Supplier Relationship Management).**
    - **Manufacturing Flow Management.**
    - Order Fulfillment and Return Management, which will be considered as **Logistics Management.**
    - Customer Service Management and Customer Relationship Management, which will be considered as **Sales Management.**
- **Product Lifecycle Management**, which comprehends new product introduction and product sunset, in order to reduce supply chain complexity and allow becoming agile.

It is important to mention that each one of the 3 components above will be detailed and characterized in the sections below, and based on these characteristics and the author experience, a Demand Driven Maturity Model will be developed and used to assess the current state of organizations in light of Demand Driven concepts.

4.3
Demand Management

In this section, it will be performed a literature review for each one of the 4 categories of the Demand management – Statistical Forecast, Sales and Operations Planning (S&OP), Collaborative Planning and Forecasting Replenishment (CPFR) and Vendor managed Inventory (VMI). This review allowed identify the DDSC characteristics for each category which was used to develop the 5 level maturity model.

Based on Croxton et al (2002), the demand management process is concerned with balancing the customers' requirements with the supply chain capabilities. This includes forecasting demand and synchronizing it with production, procurement, and distribution capabilities. A good demand management process can enable a company to be more proactive to anticipated demand.

An important component of demand management is finding ways to <u>reduce demand variability</u> and <u>improve operational flexibility</u>. They argue that reducing demand variability aids in consistent planning and reduce costs, and that increasing flexibility helps the firm respond quickly to internal and external events.

Most customer-driven variability is unavoidable, but one of the goals of demand management is to eliminate management practices that create noise and increase variability, and to introduce policies that foster smooth demand patterns. Another key part of demand management is developing and executing contingency plans when there are interruptions to the operational plans. The goal of demand management is to meet customer demand in the most effective and efficient way.

The demand management process can have a significant impact on the profitability of a firm, its customers and suppliers. Some examples are:

- Having the right product on the shelves will increase sales and customer loyalty
- Improved forecasting can reduce raw materials and finished goods inventories
- Smoother operational execution will reduce logistics costs and improve asset utilization.

For Croxton et al (2002), demand management is about forecasting and synchronizing, and has both strategic and operational sub-processes, as shown in figure 13:

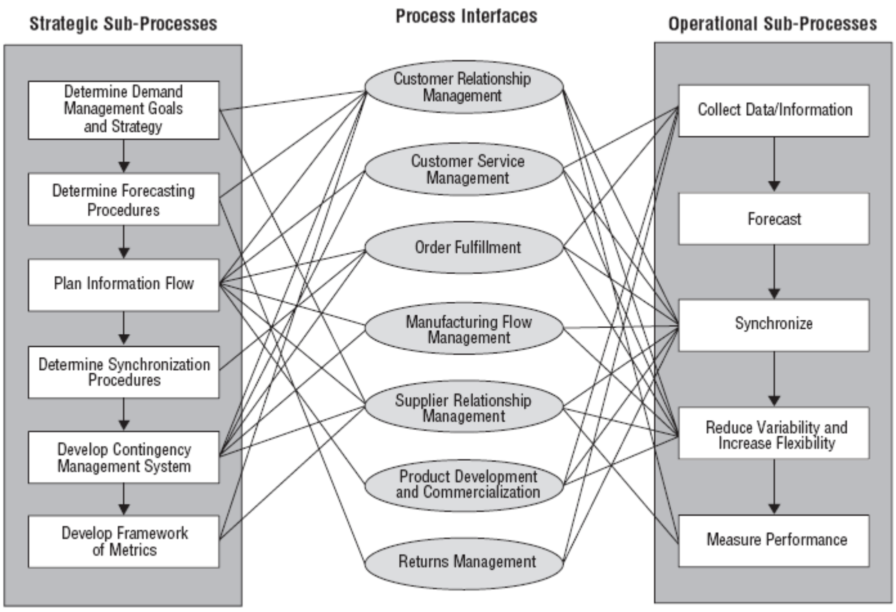

Figure 13 – Demand Management Framework based on Croxton et al (2002)

When Croxton et al. (2002) detailed the sub-process of “determine forecasting procedures”, they explain that the first step is to understand what type of forecast is needed, then what data is available, and finally, select a forecasting method +which will depend on the environment that the forecasting is taking place. They presented a two-by-two matrix to show which forecast approach is appropriate based on demand variability and demand volume, as shown in figure 14 below:

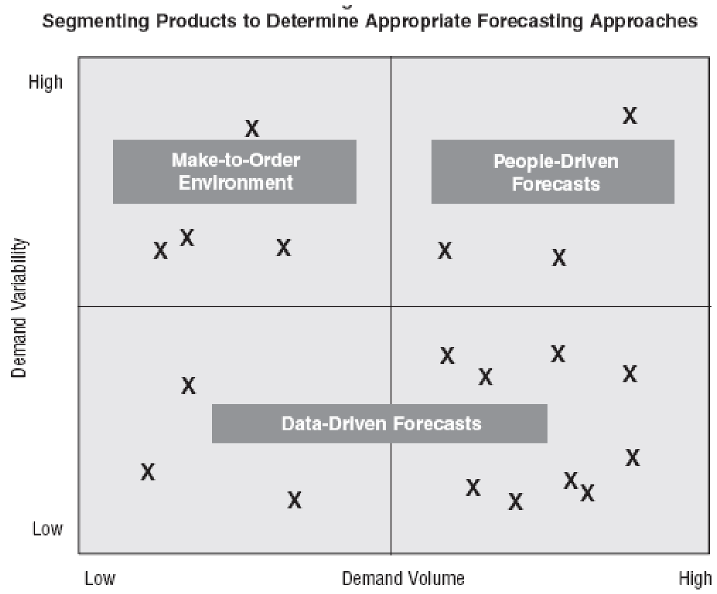

Figure 14 – Two by Two Matrix (Croxton et al, 2002)

This matrix shows that products with high variability and high volume require more human input from sales or customers, as the statistical quantitative methods alone will not be able to provide good forecast accuracy.

The second case is when a product has low volume and high variability, which in this case a make-to-order production strategy (or pull system) should be used, which avoids the need for an SKU level forecast.

The last case is when a product has low demand variability, and in this case, a data driven statistical forecast should be applied, as it will allow capture the benefits of a push system. The approach described above brings light to help define when a company should be “demand driven” or “forecast driven”. Based on Croxton et al (2002), it is proposed to expand the matrix to also include the tools and approaches that can be used in each one of the three situations, as detailed below and illustrated in figure 15:

- For “data driven forecast”, it is suggested to apply statistical forecast models, which will generate good forecast accuracy results, and will also automate the forecasting calculation, saving demand planners’ time to devote to more complicated and/or variable SKUs.
- For “make to order”, it is suggested to apply Vendor Managed Inventory (VMI) and demand visibility to sense the demand signals and quickly react to fulfill it.

- For “people driven forecast”, it is suggested to apply Sales and Operations Planning (S&OP) and Collaborative Planning and Forecast Replenishment (CPFR), as they represent structured and formal processes to align demand figures across different functional areas and different organizations.

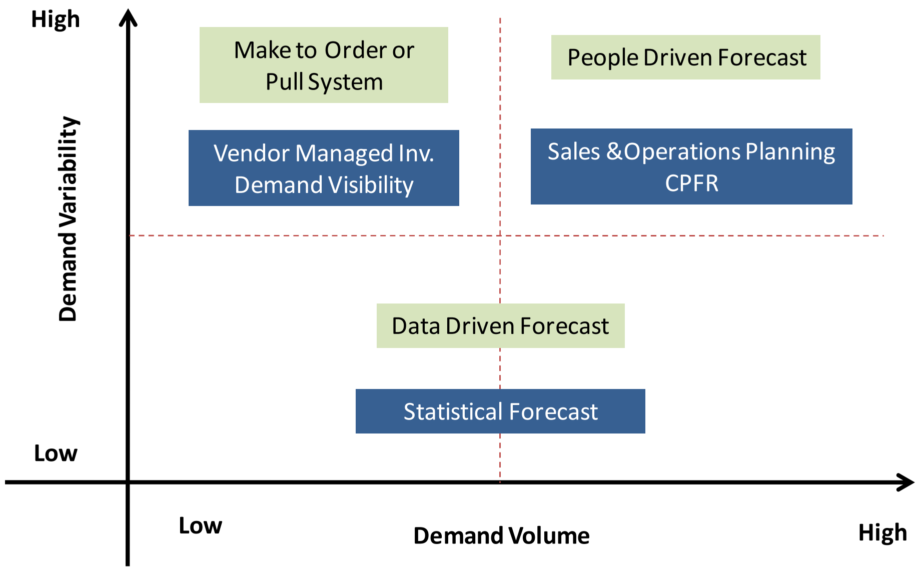

Figure 15 – Author’s Proposed Expanded 2x2 Matrix

Each one of the proposed tools & processes showed in figure 14 will be described in detail in the next sections.

4.3.1 Statistical Forecast

4.3.1.1 Introduction

In management and administrative situations, the need for planning is great because the lead time (time lag between awareness of an event and the occurrence of that event) for decision making ranges from several years (for the case of capital investments) to a few days or hours (for transportation or production scheduling) to a few seconds (for telecommunication routing), and forecasting is an important aid in effective and efficient planning.

The trend to be able to more accurately predict a wider variety of events, particularly those in the economic/business environment, will continue to provide a better base from which to plan, and formal forecasting methods are the means by which this improvement is possible.

Makridakis (1998) states that a wide variety of forecasting methods are available to management and range from the most naïve methods to highly complex approaches, such as neural nets and econometric systems of simultaneous equations.

Chatfield (2004) pointed out that it is also important to realize that no single method is universally applicable. Rather, the analyst must choose the procedure that is most appropriate for a given set of conditions. Forecasts are conditional statements about the future based on specific assumptions, and thus, forecasts are not sacred and the analyst should always be prepared to modify them as necessary in the light of any external information. For long-term forecasting, it can be helpful to produce a range of forecasts based on different sets of assumptions, so that, alternative "scenarios" can be explored.

Moon et al (1998) state that a sales forecasting is a management function that companies often fail to recognize as a key contributor to corporate success. From a top-line perspective, accurate sales forecasts allow a company to provide high levels of customer service, delivering volume in a timely and efficient manner, keeping both channel partners and final customers satisfied. Accurate forecasts help a company avoid lost sales or stock-out situations, and prevent customers from going to competitors. At the bottom line, the effect of accurate forecasts can be profound. Raw materials and component parts can be purchased much more cost-effectively, logistical services can be obtained at a lower cost and inventory levels can be reduced.

In order to get senior management support to develop the demand planning function inside the organization is critical to know how to measure the impact of forecast error on the company finance results. Mentzer (1999) states that senior levels are not concerned about the forecast accuracy results, but for the impact that improved forecasting accuracy can have on shareholder value. To that end, he proposed to use the "Du Pont Model" of financial performance. (The Du Pont Model is a framework for viewing the impact of changes in sales, capital, and operating expenses on return on net assets). The figure 16 below shows an example of the Du Pont Model:

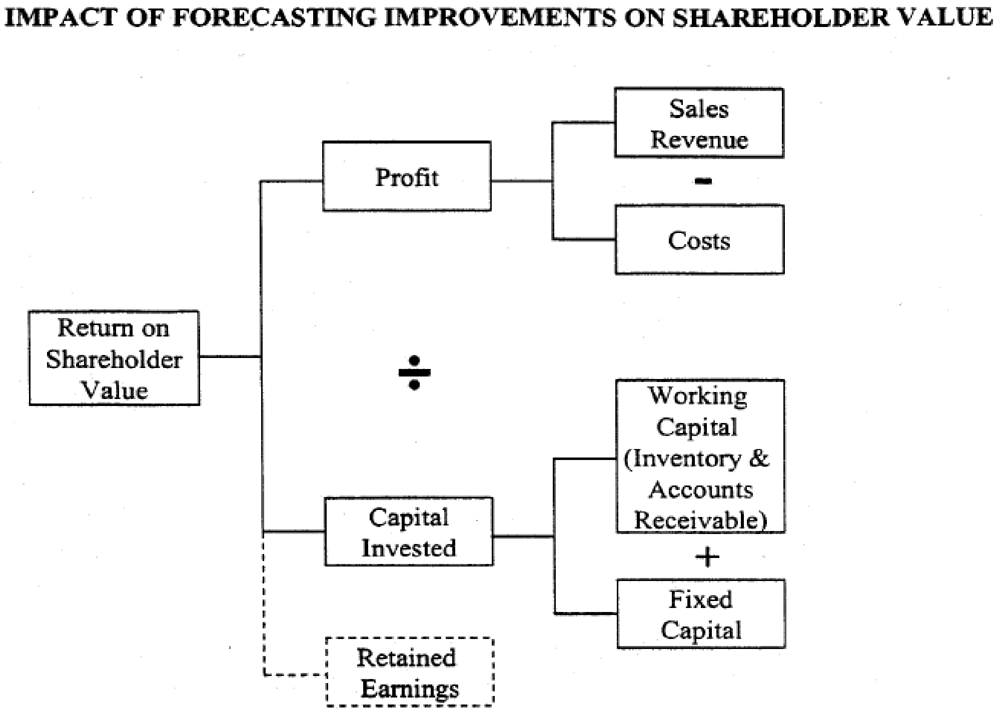

Figure 16 – Du Pont Model Proposed by Mentzer (1999)

Another key successful factor in forecasting is to have the right organizational structure, which means, the right number of people, with the right skills and performance metrics, and with the right report level.

Lapide (2003) argues that a combination of skills, organization and corporate culture form the cocktail that drives the success of any demand planning department. He describes the following critical skills:

- Quantitative skills because forecasting often involves the use of statistical forecasting methods and algorithms.
- Computer skills, since demand forecasts are often need to be done at the SKU (Stock Keeping Unit) level for multiple periods of time, which usually generate tens or hundreds of thousands of entities.
- Interpersonal skills to be able to communicate with other departments in order to gather the market intelligence needed to develop and adjust the baseline forecast.
- Understand the business in order to read market signals and identify demand variations.
- Process management skills to ensure to get a one number forecast. This entails getting a cross-functional team to come to a consensus on the forecasts.

Mentzer and Cox reported a study to analyze the corporate and forecast factors which affect forecast accuracy. The research revealed that the most important corporate factor was formal training of forecast personnel, which means more formal training received the greater achieved forecast accuracy.

Mentzer and Davis (2007) propose a theory-based sales forecasting management (SFM) framework, as illustrated in figure 17, consisting of four components (sales forecasting climate, capability, performance outcomes, and performance measurement), to facilitate the exploration of the effects of organizational factors in sales forecasting. They argue that a firm's sales forecasting climate influences its sales forecasting capability, which in turn determines performance outcomes.

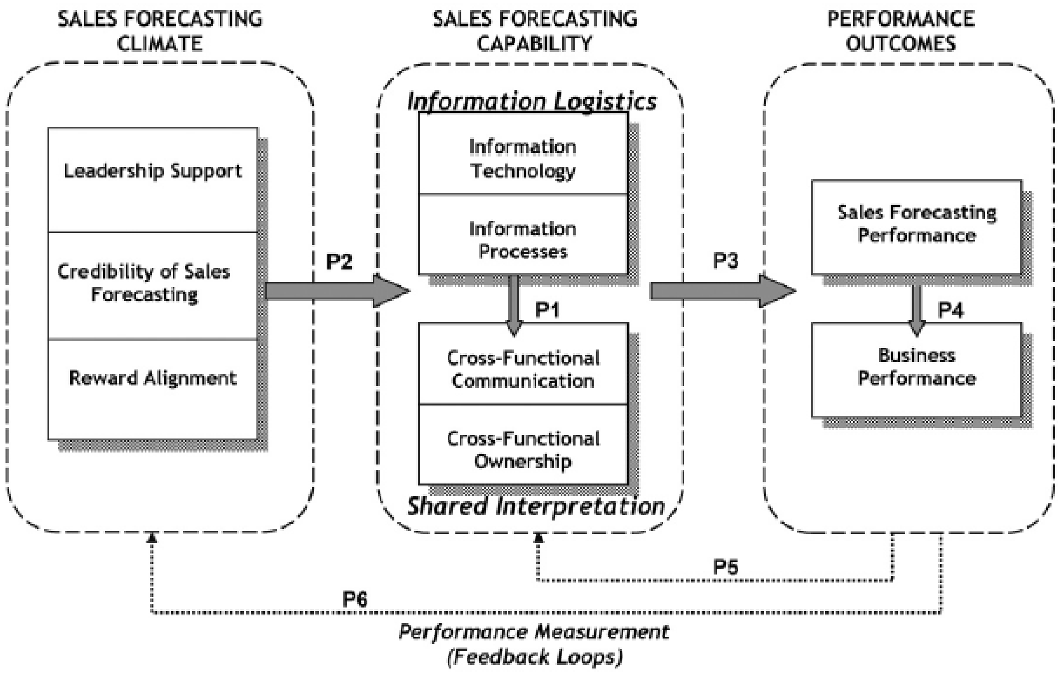

Figure 17 – Sales Forecasting Management proposed by Mentzer and Davis (2007)

Mentzer and Moon (2005) propose to have "multidimensional metrics", in other words, metrics that cover three dimensions to sales forecasting performance, in order to clear define for those responsible for sales forecasting what needs to be improved. Each of the three dimensions is described below:

1) Accuracy, which comprehends actual measures like the Mean Error (ME), Mean Absolute Error (MAE), Mean Squared Error (MSE), and Measures relative to a Perfect Forecast like the Percent Error (PE) and the Mean Absolute Percent Error (MAPE).

2) Costs, which comprehend operations costs, related to production and logistics, and marketing costs, related to trade promotions, ineffective advertising, and product development without adequate demand, wrong pricing that does not maximize profit contribution.

3) Customer Satisfaction which comprehends customer surveys to determine their satisfaction with all company activities. It should cover customers' perception of the timeliness, availability and condition of the distribution service they receive, and finally, the overall customer satisfaction process.

Taylor (2000) developed an approach to eliminate demand amplification. The approach developed had the objective to be sufficiently straightforward to be easily applied by staff that has day-by-day responsibility for managing demand along a supply chain. There are 7 steps to be followed:

- Identify and quantify demand amplification
- Analyze the specific causes of the effect in the supply chain under study
- Education and awareness raising with relevant personnel
- Creation of a demand management team from across the supply chain
- Development and application of detailed policies to address the effect in selected trial value streams
- Monitoring and evaluation of supply chain performance during the trial
- Roll out the policy to other value streams, modifying in light of the trial.

4.3.1.2
Forecast Models

Chatfield (2004) states that forecasting methods can be broadly classified into three group as follows:

1. **Subjective**:

   Forecasts can be made on a subjective basis using judgment, intuition, commercial knowledge or any other relevant information. Methods range widely, like the Delphi technique, in which a group of forecasters tries to obtain a consensus forecast with controlled feedback of other analysts' predictions and opinions, and other relevant information.

2. **Univariate**:

   Forecasts of a given variable demand are based on a model fitted only to present and past observations of a given time series. There are several different univariate models, like Extrapolation of Trend Curves, Simple

Exponential Smoothing, Holt Method, Holt-Winters Method, Box-Jenkins Procedure, and Stepwise Auto-regression, which can be regarded as a subset of the Box-Jenkins Procedure.

3. **Multivariate**:
   Forecasts of a given variable depend at least partly on values of one or more additional variables, called explanatory variables. Models of this type are usually called "causal models", and include Multiple Regression, and Econometric Models.

Makridakis (1998) classifies the forecasting techniques into two categories:

1. **Quantitative** to be considered when sufficient quantitative information is available. In this case, it can be sub-divided into:
   a. Time Series, which is a collection of observations made sequentially through time. In this class of models, prediction of the future is based on past values of a variable and / or past error, but not on explanatory variables.
   b. Explanatory, which assumes that the variable to be forecasted exhibits an explanatory relationship with one or more independent variables.
2. **Qualitative** to be considered when little or no quantitative information is available, but sufficient qualitative knowledge exists.

He also states that quantitative forecasting can be applied when three conditions exist:

- Information about the past is available
- This information can be quantified in the form of numerical data
- It can be assumed that some aspects of the past pattern will continue into the future.

Armstrong (2001) proposes a methodology tree to classify forecast models in different categories as detailed in figure 18:

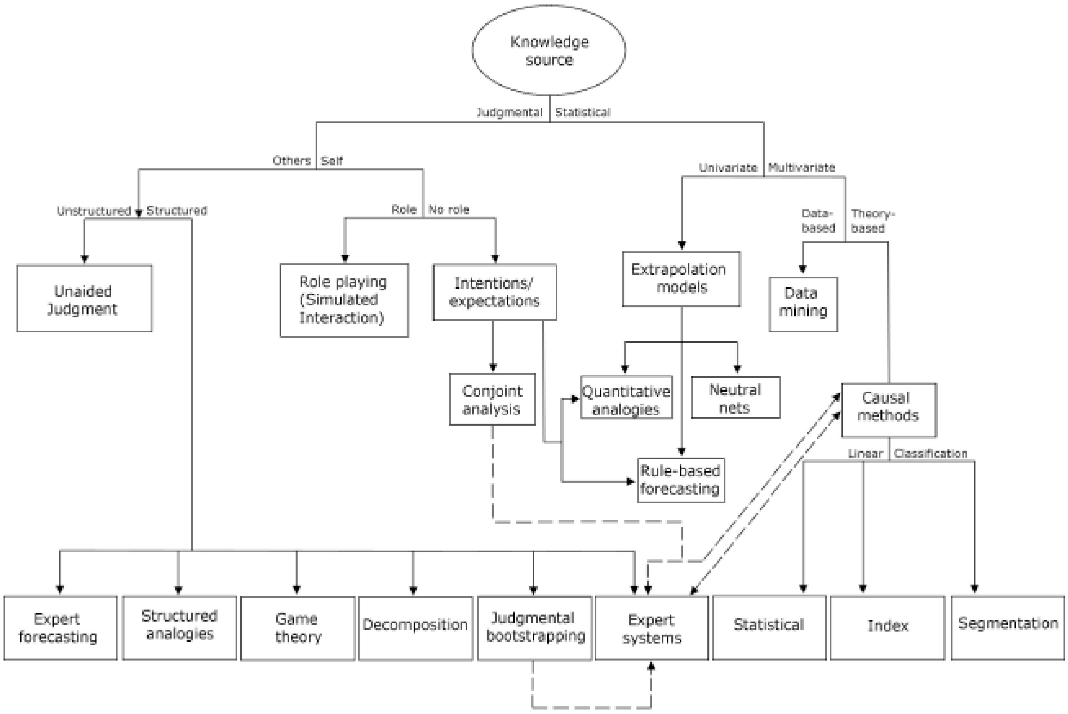

Figure 18 – Methodology Tree Proposed by Armstrong (2001)

It is not the objective of this thesis to review in detail each one of the forecast models currently available, but instead, list the key models that should be used in forecasting for business and operations. For a detailed explanation of each forecast model, please refer to the work developed by Mentzer and Moon (2005), Makridakis (1998) or Oliveira Junior (2004).

Regarding the steps required to perform a statistical forecast, Makridakis (1998) proposes 5 steps to forecast when quantitative data is available as detailed in figure 19:

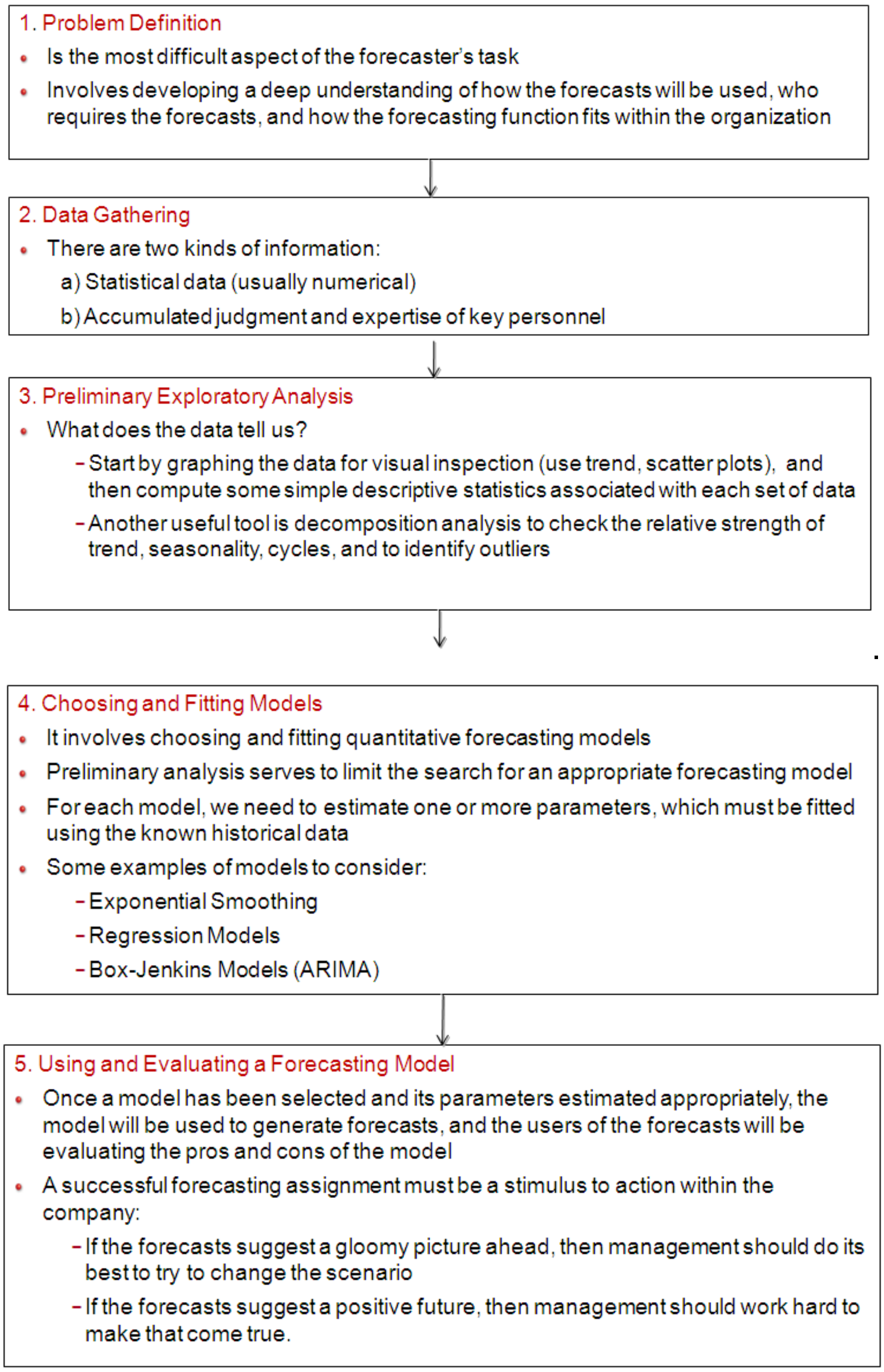

Figure 19 – Steps to forecast based on Quantitative Models (Makridakis, 1998)

4.3.1.3
How to Improve Forecast Accuracy

Moon et al (1998) proposed seven key points that companies should pay close attention to in order to improve its forecasting performance. The table 8 summarizes each principle:

Table 8 – Seven Principles to Better Forecast (Moon et al., 1998)

The Seven Keys to Better Forecasting

Keys	*Issues and Symptoms*	*Ac ions*	*Results*
Understand what forecasting is and is not.	• Computer system as focus, rather than management processes and controls • Blurring of the distinction between forecasts, plans, and goals	• Establish forecasting group • Implement management control systems before selecting forecasting software • Derive plans from forecasts • Distinguish between forecasts and goals	• An environment in which forecasting is acknowledged as a critical business function • Accuracy emphasized and game-playing minimized
Forecast demand, plan supply.	• Shipment history as the basis for forecasting demand • "Too accurate" forecasts	• Identify sources of information • Build systems to capture key demand data	• Improved capital planning and customer service
Communicate, cooperate, collaborate.	• Duplication of forecasting effort • Mistrust of the "official" forecast • Little understanding of the impact throughout the firm	• Establish cross-functional approach to forecasting • Establish independent forecast group that sponsors cross-functional collaboration	• All relevant information used to generate forecasts • Forecasts trusted by users • Islands of analysis eliminated • More accurate and relevant forecasts
Eliminate islands of analysis.	• Mistrust and inadequate information leading different users to create their own forecasts	• Build a single "forecasting infrastructure" • Provide training for both users and developers of forecasts	• More accurate, relevant, and credible forecasts • Optimized investments in information/communication systems.
Use tools wisely.	• Relying solely on qualitative or quantitative methods • Cost/benefit of additional information	• Integrate quantitative and qualitative methods • Identify sources of improved accuracy and increased error • Provide instruction	• Process improvement in efficiency and effectiveness
Make it important.	• No accountability for poor forecasts • Developers not understanding how forecasts are used	• Training developers to understand implications of poor forecasts • Include forecast performance in individual performance plans and reward systems	• Developers taking forecasts seriously • A striving for accuracy • More accuracy and credibility
Measure, measure, measure.	• Not knowing if the firm is getting better • Accuracy not measured at relevant levels of aggregation • Inability to isolate sources of forecast error	• Establish multidimensional metrics • Incorporate multilevel measures • Measure accuracy whenever and wherever forecasts are adjusted	• Forecast performance can be included in individual performance plans • Sources of errors can be isolated and targeted for improvement • Greater confidence in forecast process

Armstrong (2001) summarizes knowledge about forecasting in one hundred and thirty nine principles. The principles cover formulating a problem, obtaining information about it, selecting and applying methods, evaluating methods, and using forecasts. Each principle is described along with its purpose, the conditions under which it is relevant, and the strength and sources of evidence, and a checklist of principles is provided to assist in auditing the forecast process.

These principles will also be considered as a key input to develop the maturity model.

4.3.2
Sales and Operations Planning

4.3.2.1
Introduction

Based on Wallace (2004), Sales and Operations Planning (S&OP) is a business process that helps companies keep demand and supply in balance. It does that by focusing on aggregate volumes (e.g. product families or product groups), so that, mix issues (individual products and customer orders) can be handled more readily. It occurs on a monthly cycle and displays information in both units and dollars, thus it integrates operational and financial planning.

S&OP links the company's strategic plans and business plan to its detailed processes – order entry, master scheduling, plant scheduling, and purchasing. S&OP enables the company's managers to view the business holistically, and gives them a window into the future, to avoid lack of operational capacity to meet customer demand.

S&OP is cross-functional, involving general management, sales, demand planning, manufacturing, logistics, finance, and product development. It occurs at multiple levels within the company, up to and including the executive in charge of the business unit (e.g. division president, business unit general manager, etc.).

S&OP is an integral part of the Supply Chain Management. A given supply chain will not work well if its various members do not have good volume plans in the first place, and if they are slow to react to the inevitable changes in volume. In companies without S&OP process, there is frequently a disconnection between the strategic plans and the detailed plans and schedules. In other words, the plans developed and authorized by senior management are not connected to the plans and schedules that drive day-to-day activities on the plant floor.

The framework in figure 20 clearly shows the importance of the S&OP process, as it links the strategic and business plans together with the detailed planning process at the shop floor level.

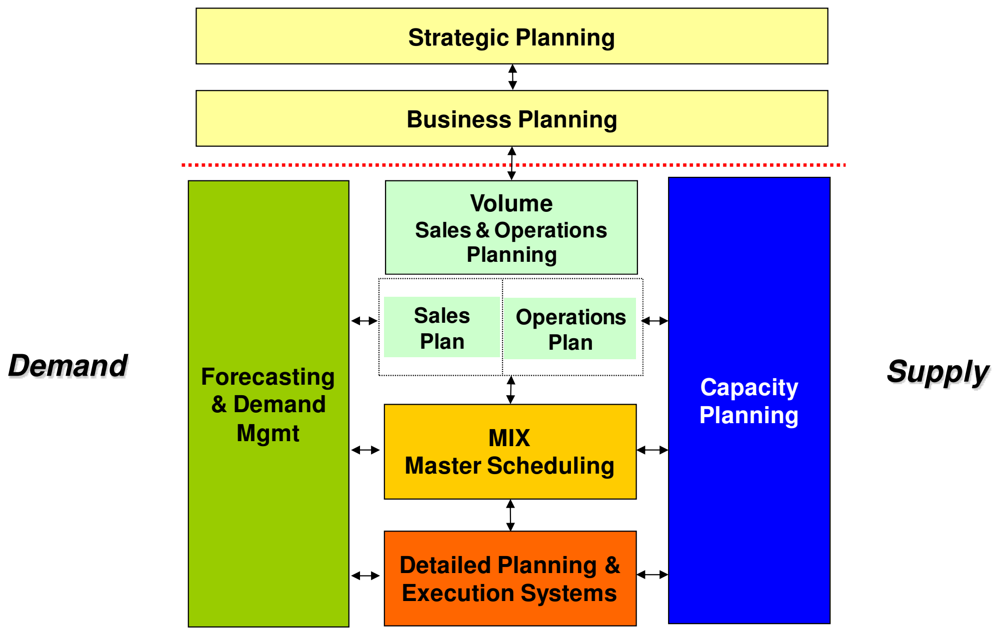

Figure 20 – Wallace (2004) Resource Planning Model

4.3.2.2
Detailed S&OP Process

Sales and Operations Planning is a monthly process that comprehends 6 steps, as illustrated and described in figure 21:

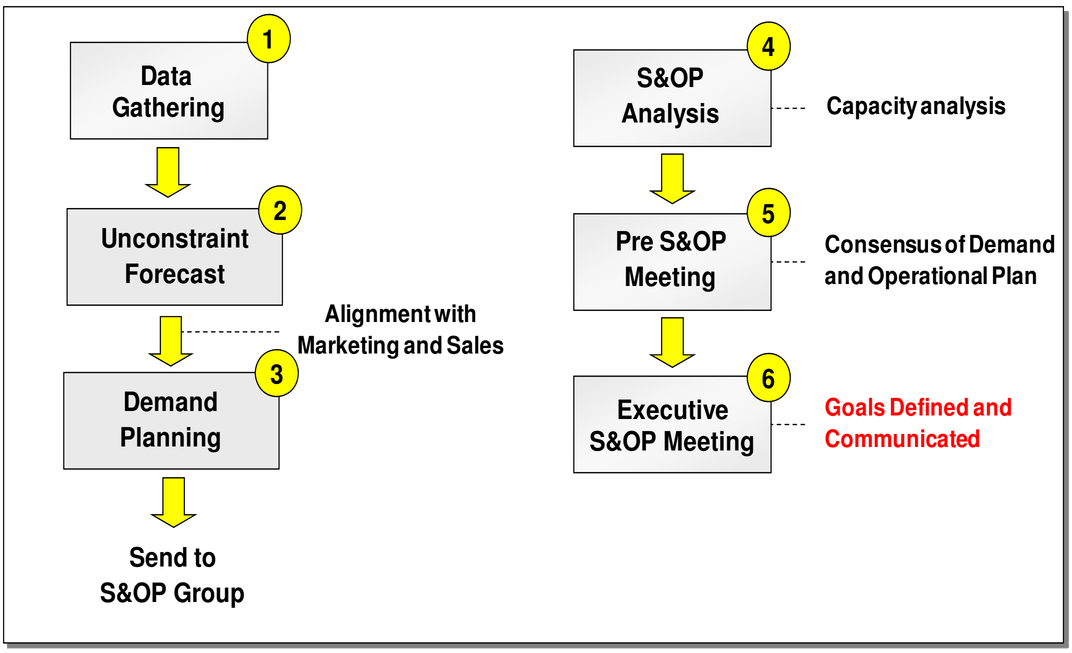

Figure 21 – Author's Monthly Sales & Operations Planning Process

Step 1: Data Gathering

Most of this activity occurs within the Information System and/or Demand Planning departments, and happens shortly after the end of the month. It consists of three elements:

- Update the files (e.g. sales, revenue, etc.) with data from the month just ended;
- Generate information for Sales and Marketing people to use in developing the new forecast: Sales analysis data, statistical forecast reports, etc.
- Disseminate the information to the appropriate people.

Step 2: Unconstraint Statistical Forecast

The second step is to generate the unconstraint forecast, and consists of two elements:

- Run statistical forecast models to predict future volumes, open by business unit, geographic regions, product family, SKU;
- Apply appropriate forecast techniques for New Products (e.g. Regression, Market Research, Sales Forecast, Conjoint Analysis)

Step 3: Demand Planning

The third step is one of the most important, and refers to the alignment of the demand figures that will be used by all departments for analyzing capacity availability and operational impacts, and consists of 3 elements:

- Sales people review the information received in step 2, analyze, discuss and generate the forecast figures for the next period (e.g. Special for key customers like Supermarkets, where promotions have a great impact).
- New Product department review and adjust timing and volumes for new product launches.
- Document key assumptions that underlie the forecasts.

Step 4: S&OP Analysis

The forth step refers to the supply (capacity) analysis and will be performed by each functional area (e.g. manufacturing, warehousing, inventory, distribution, transportation, etc.), and consists of 2 elements:

- Each functional area should analyze operational capacity to fulfill demand volumes:
    - Production capacity (master plan);
    - Warehousing and storage capacity;
    - Inventory availability (Fill Rate);
    - Supplier capacity for key raw materials;

  - Distribution capacity (delivery);
  - Transportation capacity (long haul)
- Estimate company’s financial results based on the forecast:
  - Net Operating Profit After Tax (NOPAT), Earnings Before Interest, Taxes, Depreciation and Amortization (EBITDA), and Earnings per Share (EPS), just to give some examples.

Outputs from the S&OP analysis are the standard graphics comparing required vs. available capacity for each process, and also a list of any supply problem that cannot be resolved by the functional area or that require senior manager decision. (In some cases, demand can highly exceed supply capacity and the constraints cannot be overcome within the allowable time, requiring, for instance, extra investment).

In some companies, they prefer to conduct a formal meeting for supply planning, while others find it more effective to simply work the process informally on a one by one basis.

Step 5: Pre S&OP Meeting

The fifth step refers to the S&OP meeting, where each area will present their findings and results, and have 4 objectives:

- Make decisions regarding the balancing of demand and supply;
- Identify areas where agreement cannot be reached, and determine how the situation will be presented in the Executive S&OP meeting;
- Develop, where appropriate, alternative scenarios with different courses of action to solve a given problem;
- Set the agenda for the Executive S&OP meeting

The key players in this meeting typically include several different positions like, demand manager, logistics manager, customer service, supply planning manager, production manager, and finance planning manager, sales manager and marketing manager.

Step 6: Executive S&OP Meeting

This is the culminating event in the monthly S&OP cycle and has the following objectives:

- Make decisions about demand and operational plans (accept the recommendation from the Pre-S&OP team or choose another course of action);
- Authorize changes in production, procurement, distribution, where significant costs are involved;

- Analyze the dollar version of the S&OP against Business Plan targets

The key players in this meeting include CEO, director of sales, marketing, supply chain, logistics, finance and human resources. Outputs from this meeting should include the meeting notes, which spell out the decisions made, and modifications to the business plan, if required.

4.3.2.3
S&OP Successful Factors

Lapide (2004) proposed a list of dozen factors that can help to implement an effective S&OP process that maintains exceptional supply chain operational performance over time. The factors are listed below and are detailed in the reference provided:

- Ongoing, routine S&OP meetings
- Structured meeting agendas
- Pre-work to support meeting inputs
- Cross-functional participation
- Participants empowered to make decisions
- An unbiased, responsible organization to run a disciplined process
- Internal collaborative process leading to consensus and accountability
- An unbiased baseline forecast to start the process
- Joint supply and demand planning to ensure balance
- Measurement of the process
- Supported by integrated supply-demand planning technology
- External inputs to the process.

4.3.2.4
S&OP Maturity Model

Lapide (2005) proposed a 4 step maturity model to help companies assess their current performance in terms of process and enabling technology, as described in figure 22:

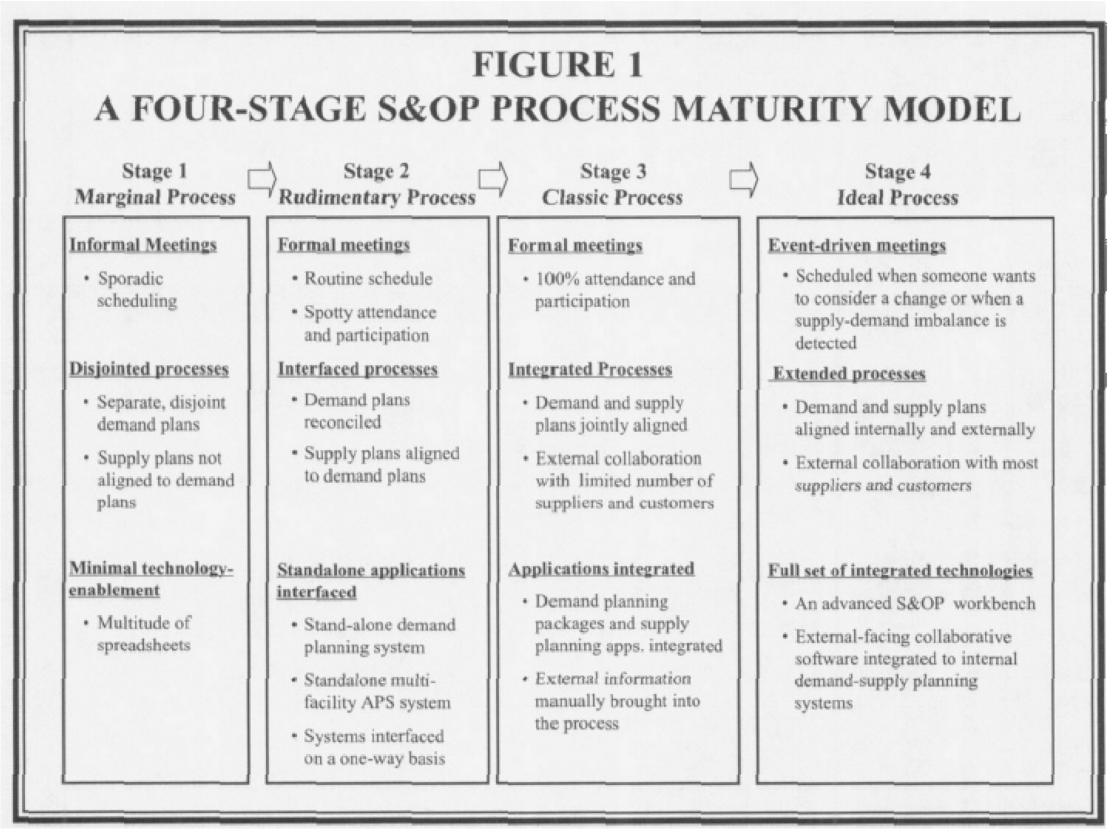

Figure 22 – 4 Step Maturity Model (Lapide, 2005)

4.3.2.5
Benefits from S&OP Implementation

Based on Wallace (2004), the implementation of S&OP process usually results in the following benefits:

- More stable production rates and less overtime, leading to higher productivity
- Better visibility into future capacity problems, covering both over and under capacity
- Enhanced teamwork among middle-management from different areas like sales, operations, finance, etc.
- Enhanced teamwork within the executive group
- Greater accountability regarding actual performance to plan
- Better demand & supply balance across the company's supply chain
- Ability to make changes quickly off of that common game plan
- For make to stock companies: Higher customer service, and often lower finished goods inventories, at the same time

- For make to order companies: Higher customer service, and often smaller customer order backlogs and hence shorter lead times, at the same time
- For finish-to-order companies: Higher customer service, quicker response, and often lower component inventories, at the same time.
- The establishment of “one set of numbers”, which will be the base to run the business.

Several companies, from different industries and business segments in Brazil, had already started implementation of S&OP process and concepts, as described by ILOS institute (2009) in figure 23:

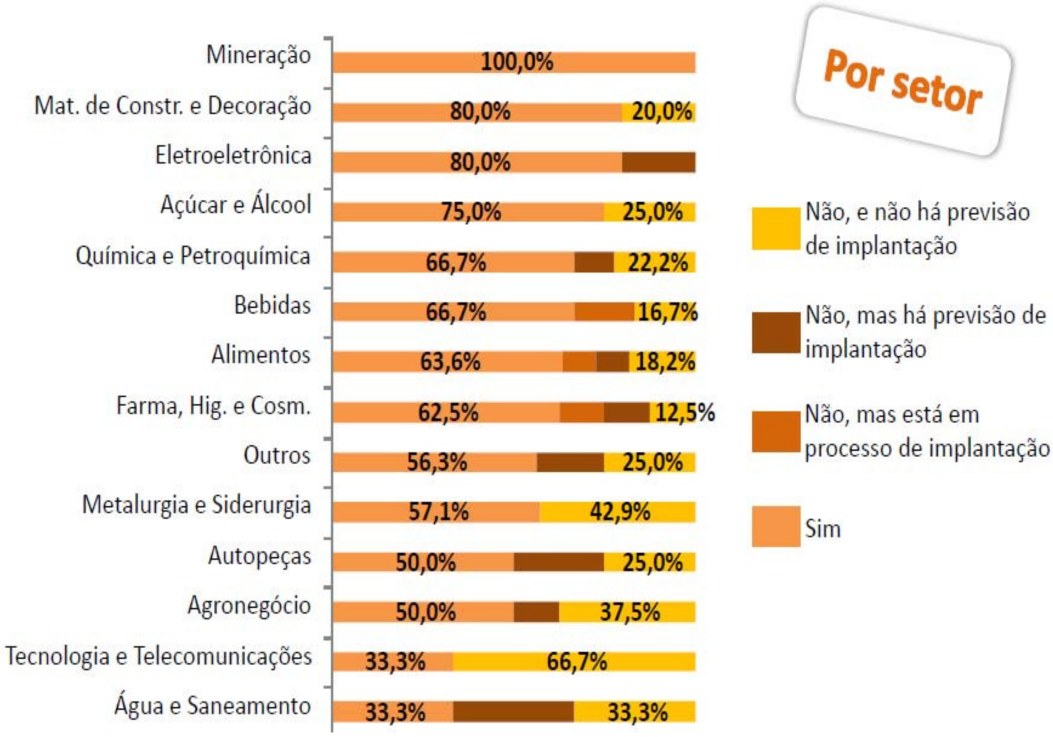

Figure 23 – Status of S&OP Implementation in Brazil (ILOS, 2009)

Companies that implemented S&OP process achieved significant business and operational results, as listed below:

- SPP-Nemo achieved 40% increase in forecast accuracy with a 40% eduction in inventories and 27% reduction in total time to plan operations.
- RECKITT BENCKISER achieved 35% reduction in forecast error based on Mean Average Percentage Error (MAPE) from 23% to 15%, and also increased visibility of customer demand, generating a unique demand plan for the whole organization.
- ARNO achieved 30% reduction in forecast error based on Mean Average Percentage Error (MAPE) from 54% to 38%, and also get greater commitment from the sales team to the planning process.

- DIMED achieved 35% reduction in forecast error based on Mean Average Percentage Error (MAPE) from 54% to 35%, and also 50% reduction in inventory of low turn products, which generated a cost avoidance of U$1MM/year
- MICHELIN reported an 18% reduction on average inventory levels, and also reduction of expedite imports using transportation.

ILOS (2009) also reported the benefits of S&OP implementation based on research of 94 companies in Brazil, as described in figure 24:

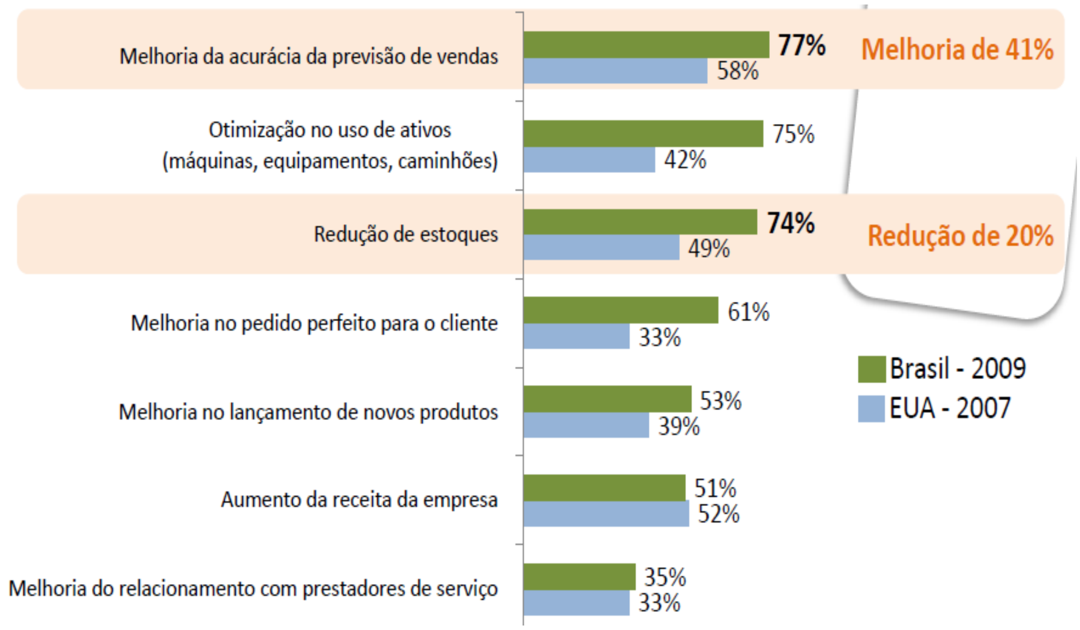

Figure 24 – Benefits of S&OP Implementation (ILOS, 2009)

4.3.3 Collaborative Planning, Forecasting and Replenishment (CPFR):

4.3.3.1 Introduction

Based on VICS (**V**oluntary **I**nterindustry **C**ommerce **S**tandards) definition, CPFR is a business practice that combines the intelligence of multiple trading partners in the planning and fulfillment of customer demand. CPFR links sales and marketing best practices, such as category management, to supply chain planning and execution processes to increase product availability while reducing inventory, transportation and logistics costs.

The CPFR model has a general framework, illustrated in figure 25, by which a buyer and seller can use collaborative planning, forecasting, and replenishing processes in order to meet customer demand. To increase performance, the buyer and seller are involved in four collaboration activities that are listed in logical order, but companies often engage in these activities simultaneously.

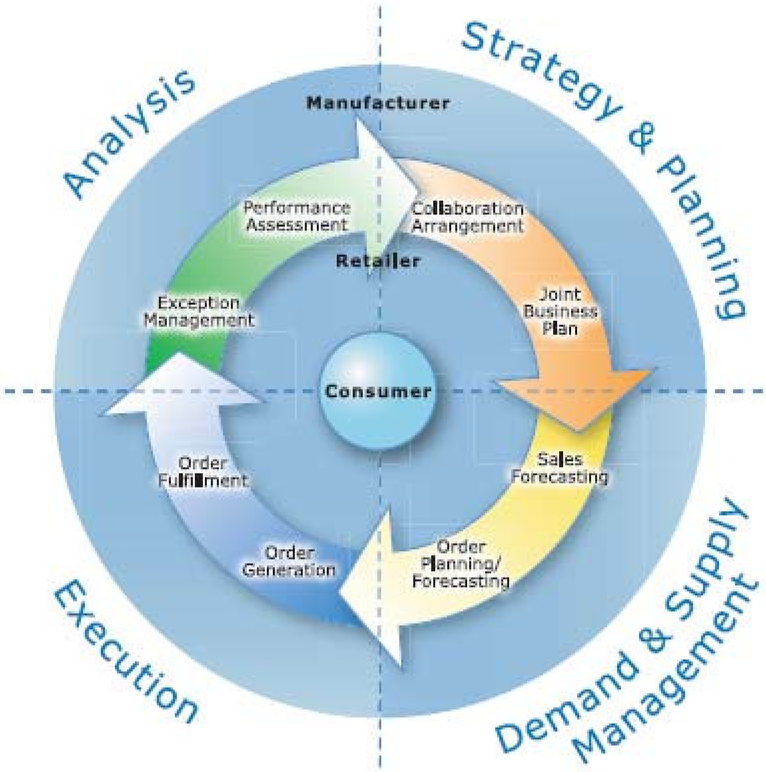

Figure 25 – VICS CPFR Model

Strategy and Planning

The first collaboration task under this activity is Collaboration Arrangement, which is a method for defining the relationship in terms of establishing business goals, defining the scope, and assigning checkpoints and escalation procedures, roles, and responsibilities. The retailer task related to this collaboration task is *Vendor Management*, and the manufacturer task is Account *Planning*.

The second collaboration task is Joint Business Plan. This task pinpoints the major actions that affect supply and demand in the planning period. Examples of these are introducing new products, store openings and closings, changing inventory policy, and promotions. The retailer task associated with this is *Category Management* and the manufacturer task is *Market Planning*.

Demand and Supply Management

Sales forecasting, which projects point-of-sale consumer demand, is one of the collaboration tasks associated with this activity. The retailer task here is Point of

Sale (*POS) Forecasting* and the manufacturer task is *Market Data Analysis*. The other collaboration task is Order Planning/Forecasting which uses factors, such as transit lead times, sales forecast, and inventory positions to determine future product ordering and requirements for delivery. The associated retailer task is *Replenishment Planning*, and *Demand Planning* is the associated manufacturer task.

Execution

The first collaboration task under the Execution activity is Order Generation. This task transitions forecasts to demand for the firm. The retailer task related to this collaboration task is *Buying/Replenishing*, and the manufacturer task is *Production and Supply*. The second collaboration task is Order Fulfillment, and this is the preparation of products for customer purchase through the process of producing, shipping, delivery, and stocking. In this case, both the retailer and manufacturer task is *Logistics/Distribution*.

Analysis

Exception Management, which oversees the planning and operations for conditions that are out-of-bounds, is one of the collaboration tasks associated with this activity. The retailer task is *Store Execution,* and the manufacturer task is *Execution Monitoring*.

The other collaboration task is Performance Assessment which calculates important metrics in order to discover trends, develop other strategies, and assess the attainment of business goals. The retailer task here is *Supplier Scorecard,* and the manufacturer task is *Customer Scorecard*. The model described above is a two-tiered model. However, this model can be extended to include more than two layers in the supply chain. VICS calls this “N-tier Collaboration”, which is a relationship that develops from retailers through manufacturers/distributors to suppliers.

4.3.3.2
Detailed CPFR Process

With CPFR, trading partners agree to develop a collaborative business relationship based on exchanging information to support the synchronization of activities and to deliver products in response to market demand.

The following nine steps illustrated in figure 26 for CPFR implementation are based on VICS CPFR Voluntary Guidelines. Broadly, the nine steps can be further classified under three different phases – 1) Planning, 2) Forecasting and 3) Execution. The planning stage involves preparation to evaluate a company's internal requirements and capabilities, trading partner segmentation, and implementation strategy. The forecasting phase involves steps, such as creation of sales and order forecast, and exception handling, which is an ongoing iterative process. In the third phase, order execution and delivery are handled. In all three phases, trading partners work together to achieve common goals defined in the initial phase

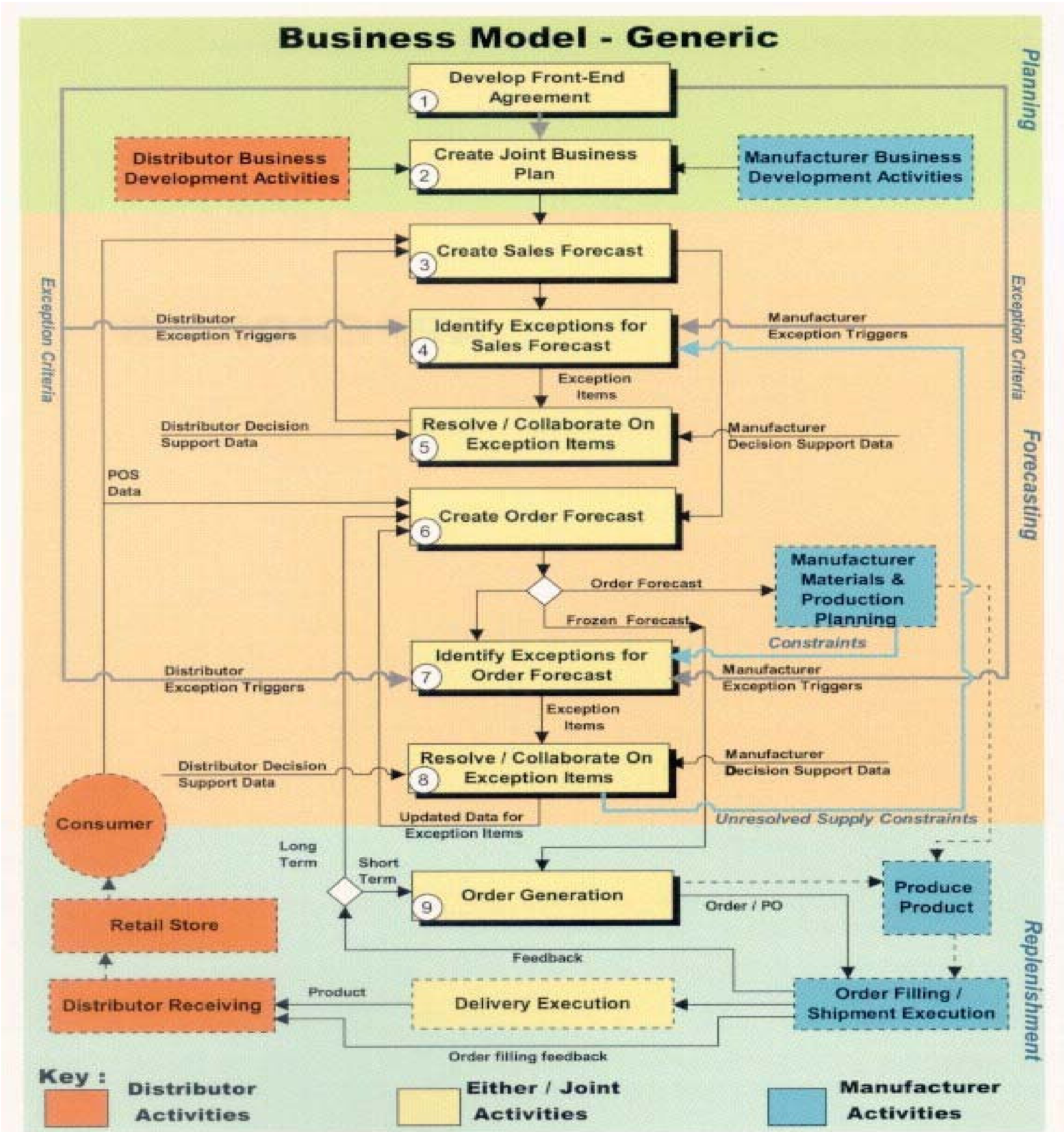

Figure 26 – VICS CPFR Business Model

Phase 1: Planning

Step 1 – Develop CPFR Front-end Agreement

The entities involved in a collaborative relationship (suppliers and buyers) establish guidelines and rules for the collaborative relationship. The front-end agreement addresses each party's expectations, and the actions and resources necessary for success. To accomplish this, the two parties co-develop a general business agreement that includes the overall understanding and objective of the collaboration, confidentiality agreements, and the empowerment of resources (both actions and commitment) to be employed throughout the CPFR process.

Step 2 – Create Joint Business Plan

In this step of the CPFR process, the entities (suppliers and buyers) exchange information about their corporate strategies and business plans in order to collaborate on developing a joint business plan. The partners first create a partnership strategy, and then, define category roles, objectives, and tactics. The item management profiles (e.g., order minimums and multiples, lead times, order intervals) for items to be collaborated on are established.

Phase 2: Forecasting

Step 3 – Create Sales Forecast

In this step, retailer point of sale (POS) data, causal information, and information on planned events are used to create a sales forecast that supports the joint business plan. Table 9 describes that in scenarios A, B, and C, this step is carried out by the retailer/distributor (or buyer), and in Scenario D, the manufacturer (or seller) is responsible for creating the sales forecast.

Table 9 – Key Scenarios Lead Role (VICS)

Scen ario	Sales Forecast	Order Forecast	Order Generation
A	Buyer	Buyer	Buyer
B	Buyer	Seller	Seller
C	Buyer	Buyer	Seller
D	Seller	Seller	Seller

The sales forecast is generated by either or both parties for a given period with forecasting tools that use all the relevant information and set guidelines.

Step 4 – Identify Exceptions for Sales Forecast

This step identifies the items that fall outside the sales forecast constraints set jointly by the manufacturer and distributor. (The exception criteria for each item are agreed to in the Front-end agreement).

Step 5 – Resolve/Collaborate on Exception Items

This step involves resolving sales forecast exceptions by querying shared data, email, telephone conversations, meetings, and so on, and submitting any resulting changes to the sales forecast. “Collaborative negotiations between buyer and sellers resolve item exceptions” (VICS, 2002).

Step 6 – Create Order Forecast

In this step, POS data, causal information, and inventory strategies are combined to generate a specific order forecast that supports the shared sales forecast and the joint business plan. Actual volume numbers are time-phased and reflect inventory objectives by product and receiving location. The short-term portion of the forecast is used for order generation, while the longer-term portion is used for planning.

Step 7 – Identify Exceptions for Order Forecast

This step determines what items fall outside the order forecast constraints set jointly by the manufacturer and distributor.

Step 8 – Resolve/Collaborate on Exception Items

This step involves the process of investigating order forecast exceptions through querying of shared data, email, telephone conversations, meetings, and so on, and submitting any resulting changes to the order forecast.

Phase 3: Execution

Step 9 – Order Generation

This last step marks the transformation of the order forecast into a committed order. Order generation can be handled by either the manufacturer or distributor depending on competencies, systems, and resources. Regardless of who completes this task, the created order is expected to consume the forecast.

4.3.3.3
CPFR Technology

The CPFR process does not fundamentally depend upon technology. However, specialized technology can make the process more scalable. Many CPFR solutions have been developed to facilitate the process, including:

- Sharing forecasts and historical data
- Automating the collaboration arrangement and joint business plan
- Evaluating exception conditions
- Enabling revisions and commentary

A CPFR solution must be integrated with the enterprise systems of record that produce and consume demand and supply chain data, as illustrated in the figure 27:

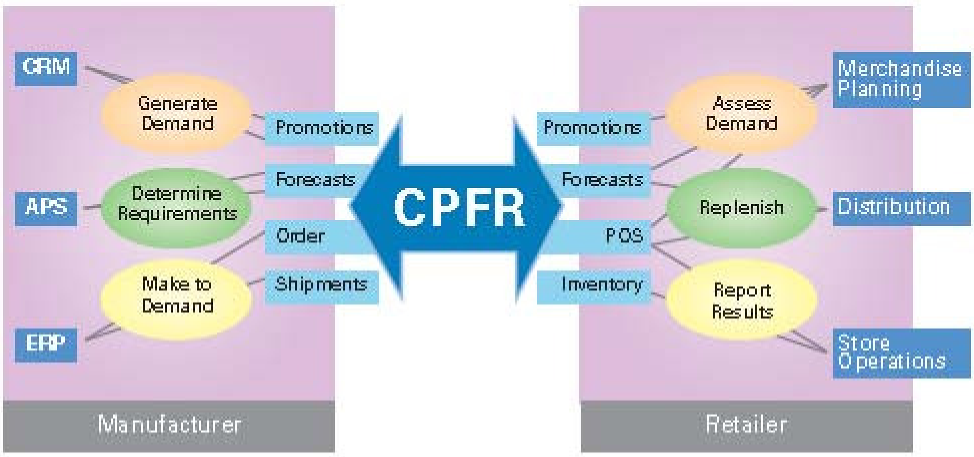

Figure 27 – The Role of CPFR Technology in Integrating Retailer and Manufacturer Processes

CPFR technology can be deployed as a shared solution, or as a peer-to-peer network of interoperating CPFR applications. The shared solution can be operated as part of a retailer's or manufacturer's extranet, or hosted by an exchange or other third party. Peer-to-peer communications may flow directly between manufacturers and suppliers, or via proxies (trading-partner-to-exchange or exchange-to-exchange).

4.3.3.4
Benefits

Based on Oliver Wight (2005) research, the implementation of CPFR process usually results in the following benefits:

- Forecast accuracy improvements of 20% to 30%
- Sales revenue growth of 8% to 10%
- Cost of goods sold reduced 3% to 4%
- Operating costs reduced 1% to 2%
- Lead times and cycle times reduced 25% to 30%

4.3.3.5
CPFR Assessent

The VICS (Voluntary Interindustry Commerce Standards) developed a CPFR capability assessment to provide a framework for understanding the gap between a company's existing practices and CPFR best practices, and also to serve as the starting point for change and enable realistic expectations for a CPFR program.

The table 10 below shows the 4 key areas covered in the VICS assessment and illustrates the increasing difficulty and benefits of progressing vertically through the processes of **Collaboration** to **Integrated Planning and Forecasting** to **Replenishment** and finally to **Supply Chain Management**.

Table 10 – VICS Capability Assessment

CPFR Stages of Progression

Process Area	Basic	Developing	Advanced
D Supply Chain Management	No Supply Chain Focus/Plan	Internal Enterprise Optimization	Supply Chain Optimization
C Replenishment Processes	Pre-DC Limited/No Retail Visibility	DC Replenishment Focus	Computer Assisted Retail Ordering Flow-Through
B Integrated Planning & Forecasting Processes	Manual Non-Standard Forecasting Planning	Standardized Demand Data Creation & Input	Integrated Planning, Forecasting & Collaboration
A Collaborative Processes	Limited One-Way Communication	Standardized & Integrated Collaboration	

It will not be presented the detailed VICS assessment in the body of this thesis. However, it will be considered as a key input when developing the Demand Driven Supply Chain Maturity Model in chapter 5.

4.3.4 Vendor Managed Inventory & Demand Visibility

4.3.4.1 Introduction

VMI is essentially a distribution channel operating system whereby the inventory at the distributor / retailer is monitored and managed by the manufacturer/vendor. It includes several tactical activities including, determining appropriate order quantities, managing proper product mixes, and configuring appropriate safety stock levels. The rationale is that by pushing the decision making responsibility further up the supply chain, the manufacturer/vendor will be in a better position to support the objectives of the entire integrated supply chain, resulting in a sustainable competitive advantage. Centralizing the replenishment decision also helps reduce the distortions in ordering introduced when there are several intermediaries that place orders in a supply chain.

VMI was popularized in the late 1980s by Wal-Mart and Procter & Gamble (Waller et al., 1999), and then, it was subsequently implemented by many other leading companies from different industries, such as GlaxoSmithKline (Danese, 2004), Electrolux Italia (De Toni and Zamolo, 2005), Nestle and Tesco (Watson, 2005), etc.

The enabling technology behind successful VMI is Electronic Data Interchange (EDI) which provides manufacturer/vendor with essentially the same point of sales (POS) and inventory information retained by the distributor / retailer. As a result, improved forecasting is possible because the manufacturer/vendor can observe demand for its product over a wider range of customers and can incorporate the effects of promotions, competing products, and seasonal variations in demand. Therefore, successfully integrating systems technology in the transactions between value chain participants is integral to realize benefits of VMI.

4.3.4.2
Detailed VMI & Demand visibility Process

Based on Hall, C. (2000), there are two EDI (Electronic Data Interchange) transactions at the heart of the process as illustrated in figure 28:

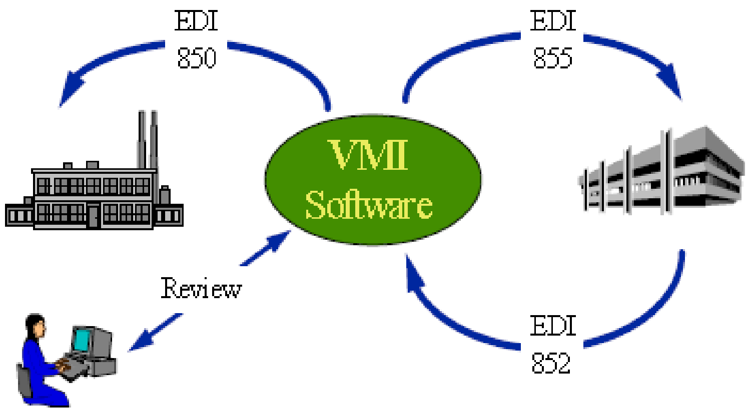

Figure 28 – EDI documents for VMI Implementation

The first is the "Product Activity Record", frequently referred to as an 852. The data contained in this document are sales and inventory information. The inventory data is typically segmented into various groups, such as on hand, on order, committed, back ordered, and so forth. This transaction is the backbone of VMI, and is sent by the customer on a prearranged schedule, typically, daily. The decision to order is based on this data.

The business process fed by this data is relatively simple. The supplier reviews the information that has been sent in by the customer on the 852 to determine if an order is needed. This review of the data varies by supplier and the software being used, but, many things are consistent:

• The first step is to verify if the data is accurate and meaningful. Depending on the software, much of this verification is automated.

• On a scheduled basis, the software calculates a reorder point for each item based on the movement data and any overrides contributed by the customer or supplier. These overrides might include information such as promotions, projects, seasonality, new items, etc.

• The VMI software compares the quantity available at the customer with the reorder point for each item at each location (SKU by location). This determines if an order is needed.

• The order quantities are then calculated, and typically calculation of order quantities takes into account such issues as case quantities and transaction costs. This completes the order build process.

The second VMI transaction informs the customer what product will be delivered by the supplier. There are two transactions being used for this function. The most frequently used is the “purchase order acknowledgment”, referred to as the 855. This document contains the product numbers and quantities ordered by the supplier on the customer’s behalf. A few customers skip the 855 and rely on the advance ship notice (ASN), or 856, to alert them to the order and shipment. This document differs from the 855 in both timing and content. The 856 is sent after the shipment has been made instead of at the time of the order. The 856 contains only the part numbers shipped as well as additional information, such as carrier and waybill information. For the purposes of VMI, either of these documents works well if properly implemented.

4.3.4.3
Benefits

Based on the working paper from Kellogg Graduate School of Management (2000), VMI can have a number of benefits, including lowered investment in the supply chain, due to better forecasting, JIT delivery and less overstocking and greater inventory turnover. Its primary benefit, however, is improved customer service due to fewer stock outs and more optimal product mixes. Manufacturer / vendor also stand to benefit from VMI, as it allows them to schedule production and transportation more efficiently (including ordering raw materials), to observe end-user consumption and general market trends more closely, and to develop closer ties with their customers. In summary, the benefits of VMI Program are detailed in table 11:

Table 11 – Benefits from VMI Implementation (Kellogg University, 2000)

Typical Benefits to Mfg/Vend	Typical Benefits to Dist/Ret
• Lower inventory investment (raw and • finished) • Better scheduling and planning • Better market information • Closer customer ties and preferred status	• Fewer stock-outs with higher turnover • Better market information • More optimal product mixes • Less inventory in channel (transfer costs) • Lower administrative replenishment costs

The working paper from Kellogg also reports the following benefits out of the VMI implementation:

- Fred Meyer, the 131-unit chain of supercenters in the Pacific Northwest, reduced inventories 30% to 40%, while sales rose and service levels increased to 98%. This was due to a VMI program implemented with two key food vendors.
- Grand Union, a New Jersey-based grocery retailer with more than 100 stores and three DCs, improved inventory turns by close to 80% and achieved 99% service levels. This significantly improved sales by eliminating out-of-stock conditions and dramatically reduced warehousing costs.
- Oshawa Foods, a $6 billion Canadian food distributor and retailer, had tremendous success with Pillsbury, Quaker and H.J. Heinz with inventory turns improving from 3 to 9 times, while achieving customer service levels of 99%.

The author had also implemented a VMI project in the beverage industry with one key customer from the airline industry to increase customer service level (fill rate) at the same time that optimizes the inventory levels. Figure 29 illustrates the relationship between the two companies:

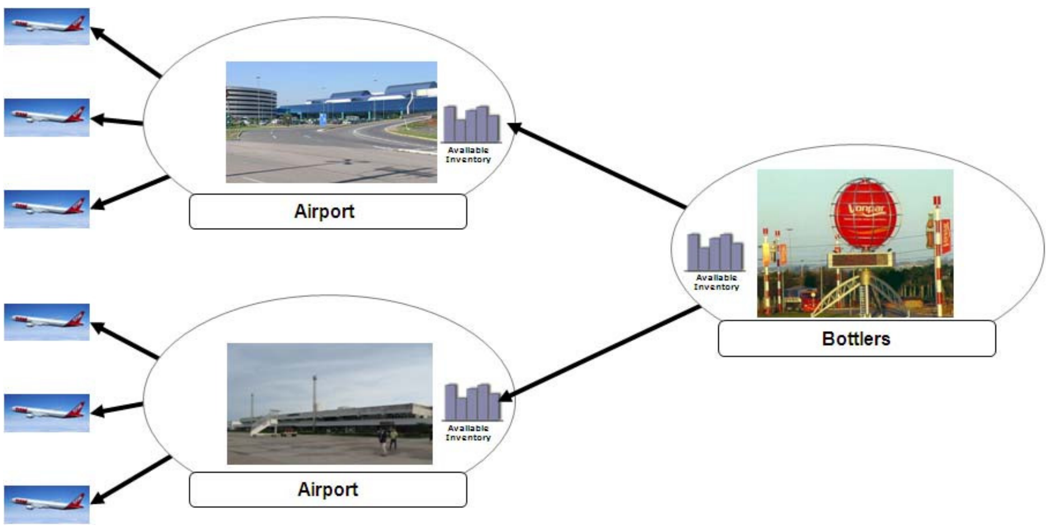

Figure 29 – VMI Project Implemented in the Beverage Industry

The project started in Feb/2008 and 4 months later (June/2008), the project team was able to measure 55% reduction in inventory level with 100% fill rate in this period, as illustrated in the figure 30:

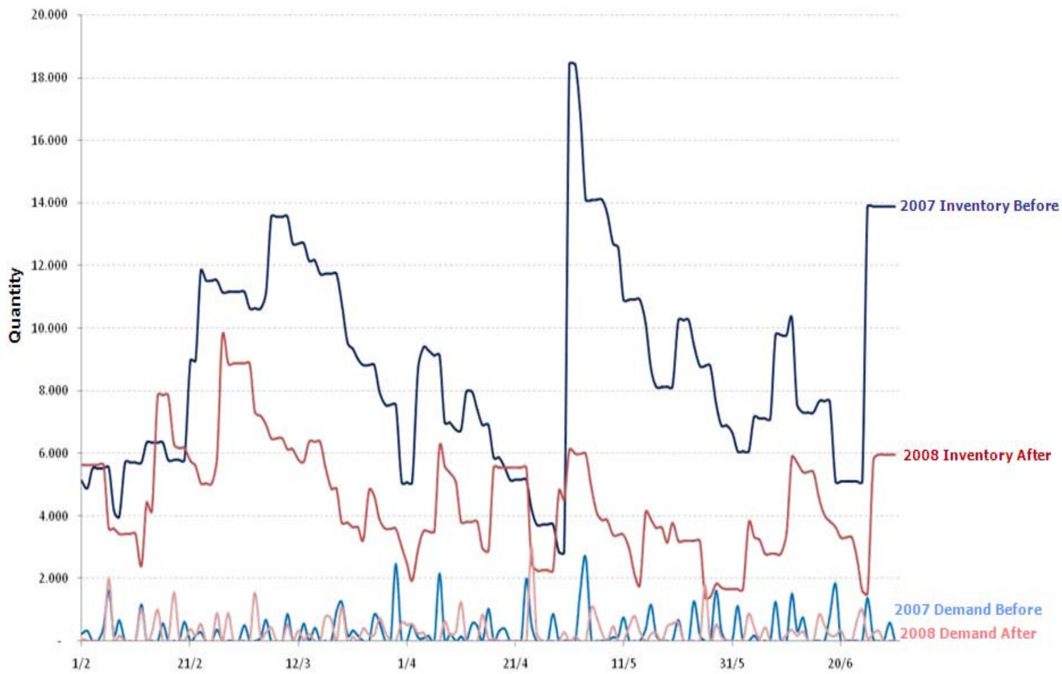

Figure 30 – Daily Demand & Inventory Levels Before and After VMI Project

4.4
Supply and Operations Management

In this section, it will be performed a literature review for each one of the 5 categories of the Supply & Operations management – Procurement, Manufacturing, Logistics, Customer Service and Senior Management Support. This review allowed identify the DDSC characteristics for each category which was used to develop the 5 level maturity model.

4.4.1
Introduction

Supply and Operations Management refers to the capabilities of the firm to source, produce, store, sell and delivery its products in the market place. It is a critical capability both in terms of cost, due to all fixed and variable costs required to perform the operational activities, and also in terms of customer service, due to the high pressure of customers towards better and customized services.

Stewart (1997), states that managing supply-chain operations is critical to any company's ability to compete effectively, and that success for many companies now depends on their ability to balance a stream of product and process changes with meeting customer demands for delivery and flexibility. Optimally managing supply-chain operations, has therefore, become critical to companies' ability to compete effectively in the global marketplace.

Still based on Stewart (1997), to assist companies in increasing the effectiveness of their supply chain, and to support the move to process-based management, two consulting firms – PRTM and Advanced Manufacturing Research (AMR) – set out to consolidate within a process reference model their experience along with a group of senior operations, manufacturing and supply chain managers from many of the leading companies. This group of companies, together with other leading US and multinational firms, joined together in 1996 to form the Supply-Chain Council (SCC). The SCC took the reference model and helped develop, test and finally release it, calling it the Supply Chain Operations Reference Model (SCOR). SCOR is the first cross-industry framework for evaluating and improving enterprise-wide supply-chain performance and management

SCOR is designed to enable companies to communicate, compare and develop new or improved supply-chain practices from companies both within and outside of their industry segment. Its key components are:

- Standard descriptions of the process elements that make up complex management processes.
- Benchmark metrics used to compare process performance to objective, external points of reference.
- Description of best-in-class management practices.
- Mapping of software products that enable best practices.

SCOR model spans:

- All customer interactions, from order entry through paid invoice.
- All physical material transactions, from the supplier's supplier to the customer's customer, including field service logistics.
- All market interactions, from the understanding of aggregate demand to the fulfillment of each order.

SCOR model focuses on five basic supply chain processes, as described below:

- **Plan – Demand / Supply Planning and Management**
  - Balance resources with requirements and establish / communicate plans for the whole supply chain, including return, and the execution processes of Source, Make and Deliver.
  - Management of business rules, supply chain performance, data collection, inventory, capital assets, transportation, planning configuration, regulatory requirements and compliance, and supply chain risk.
  - Align the supply chain unit plan with the financial plan.
- **Source – Sourcing Stocked, Make to Order, and Engineer-to-Order**
  - Schedule deliveries, receive, verify and transfer products, and authorize supplier payments.
  - Identify and select supply sources when not predetermined, as for engineer-to-order product.
  - Manage business rules, assess suppliers' performance, and maintain data.
  - Manage inventory, capital assets, incoming product, supplier network, import / export requirements, supplier agreements, and supply chain source risk.
- **Make – Make to Stock, Make to Order, and Engineer to Order Production Execution**
  - Schedule production activities, issue product, produce and test, package, stage product, and release product to deliver.
  - Finalize engineering for engineer-to-order product.
  - Manage rules, performance, data, work-in-process products (WIP), equipment and facilities, transportation, production network, regulatory compliance for production, and supply chain make risk.
- **Deliver – Order, Warehouse, Transportation / Distribution**
  - All order management steps from processing customer inquiries and quotes to routing shipments and selecting carriers.
  - Warehouse management from receiving and picking product to load and ship product.
  - Receive and verify product at customer site, and install, if necessary.
  - Invoicing customer.

- Manage deliver business rules, performance, information, finished product inventories, capital assets, transportation, product lifecycle, import/export requirements, and supply chain deliver risk.

- **Return – Return of Raw Materials and Receipt of Returns of Finished Goods**
  - All return defective product steps from source – identify product condition, disposition product, request product return authorization, schedule product shipment, and return defective product – and deliver - authorized product return, schedule return receipt, receive product, and transfer defective product.
  - All return excess product steps from source – identify product condition, disposition product, request product return authorization, schedule product shipment, and return excess product – and deliver – authorize product return, schedule return receipt, receive product, and transfer excess product.
  - Manage return business rules, performance, data collection, return inventory, capital assets, transportation, network configuration, regulatory requirements and compliance, and supply chain return risk.

For the sake of supply and operations management in this thesis, the supply chain processes proposed by SCOR will be covered, but using a different terminology, as detailed below, in order to be closer to the organization structure names found in most industries.

4.4.2
Procurement

Lockamy and McCormack (2004) performed an exploratory study to investigate the link of SCOR planning processes to supply chain performance. In this study, they showed that supplier transactional collaboration activities have a significant impact on supply chain performance within the SOURCE decision area. These activities include the sharing of planning and scheduling information with suppliers. The source planning process, which includes the documentation of procurement processes, the establishment of information technology that supports these processes, and the management of supplier inter-relationships, also has a significant impact on supply chain performance in this decision area.

Supplier inter-relationships included in the source planning process include the management of product and delivery variability, along with metrics for monitoring such variability. Additionally, the designation of a source planning process owner is required to ensure its effectiveness. The establishment of a procurement process planning team was found to have an impact on supply chain performance within the SOURCE decision area. This team should meet on a regular basis, and work closely with other functional areas, such as manufacturing and sales. Supplier operational collaboration also has a significant impact on supply chain performance. This involves the development of a joint operational plan that is supportive of strategic sourcing activities, and outlines how routine transactional activities are to be conducted by the participants.

Supplier strategic collaboration activities also impact supply chain performance in the Source decision area. These activities include electronic ordering and supplier-managed inventory. In addition, the presence of on-site employees of key suppliers facilitates strategic supplier collaboration activities that enhance overall supply chain performance.

Ayers (2006) provides a 7 steps methodology to allow companies embark on the journey from purchasing to strategic procurement. The steps are:

- **Step 1: Determine your spending**. In this step, companies should quantify how much was spent, who spent the money, where and how was it spent and what specifically was it spent for.
- **Step 2: Prioritize the spend categories**. Prioritizing means looking at the size of the savings opportunities compared to the degree of difficulty in actually achieving the savings. The degree of difficulty is determined by such issues as organizational turf, complexity of the product or service, and the complexity of the actual sourcing process (e.g. vendor selection, vendor certification, Request for Proposal - RFP, negotiations, etc.). He suggested to always starting with the "low-hanging fruit", which are the opportunities with high savings and that can be achieved with little difficulty.
- **Step 3: Form category teams**. These teams are small groups with the charter to examine the sourcing options for the category and to make recommendations to senior management. Ideally, especially in a decentralized organization, teams should have representatives from each of the key business units to obtain diversified inputs and to build consensus.

- **Step 4: Develop a sourcing strategy for your categories**. Each category team needs to develop a basic strategy to source its category. These can range from joint ventures with suppliers when the product or service being sourced is highly technical, critical to your business, and only a few suppliers are capable of meeting the specifications to very competitive bidding situations, when the product is simple and widely available.
- **Step 5: Perform the Request for Proposal (RFP) process and make the final selection**. Identify a list of potential suppliers, starting with your current suppliers. The category team should reach consensus on the basic ground rules for awarding the business (e.g. national contract for all corporation's office supply) and the criteria (e.g. prices, rebates, breadth of offering, delivery frequencies, etc.) to use to select the wining proposal. It is extremely important to reach consensus on these issues before sending out the RFP (Request for Proposal).
- **Step 6: Manage the supplier relationship aggressively**. Supplier management is the area of strategic sourcing with the greatest opportunity for both success and failure. Too many companies just sign the contract and forget about the relationship until contract renewal time. To make the relationship a real success, ensure that the benefits you and the category team fought so hard to achieve are sustained. Both parties should be actively involved in monitoring results, reviewing pre-established performance metrics, partnering on creative ways to mutually lower costs, and ironing out any contract or performance disputes.
- **Step 7: Provide feedback to both suppliers and senior management**. Category team should provide regular feedback to suppliers on both successes and failures. It is important to make them feel a part of company's overall strategic sourcing process and also keep senior management informed about what the team has accomplished. Present an annual plan to senior management that recaps savings achieved during the year and planned activities for the upcoming year.

Harrison (2003) states that there are two extremely different approaches for managing the relationship with suppliers: On line procurement (also called "eProcurement") and Strategic Alliances. He claims that the decision on which approach to take should be based on the characteristics of the purchased component and of the marketplace. A summary of the risks and benefits of each of these two approaches is provided in tables 12 and 13:

- **Risks and Benefits of Strategic Alliances:**

Table 12 – Risks and Benefits of Strategic Alliances (Harrison, 2003)

Benefits to Buyer	Risks to Buyer	Benefits to Supplier	Risks to Supplier
Decrease total cost of ownership	Increased transactions cost per supplier	Locks in the business	Limited opportunities for new business, particularly with alliance partner's competitors
Increased quality	Supplier becomes monopolistic, less responsive	Ability to increase skill	Capacity locked up by partner
Faster response		Ability to make long-term investments	
Enhanced new product development with supplier involvement		Higher margins	
Highly skilled supplier base			
Fewer suppliers to manage			

- **Risks and Benefits of On line Procurement (eProcurement):**

Table 13 – Risks and Benefits of On Line Procurement (Harrison, 2003)

Benefits to Buyer	Risks to Buyer	Benefits to Supplier	Risks to Supplier
Decreased unit cost	Decreased quality	Access to new business	Lower margins
Decreased transactions and processing cost	Loose specifications	Use of excess capacity	Decreased ability to invest in improvements
Faster response	Fewer suppliers over the long term	Knowledge of winning bid	Startup costs for new software
	Alienate suppliers		Buyer uses information to generate off-line bids

4.4.3
Manufacturing

Ayers (2006) provides a roadmap to implement demand driven supply chain concepts in the manufacturing area, which is illustrated in figure 31:

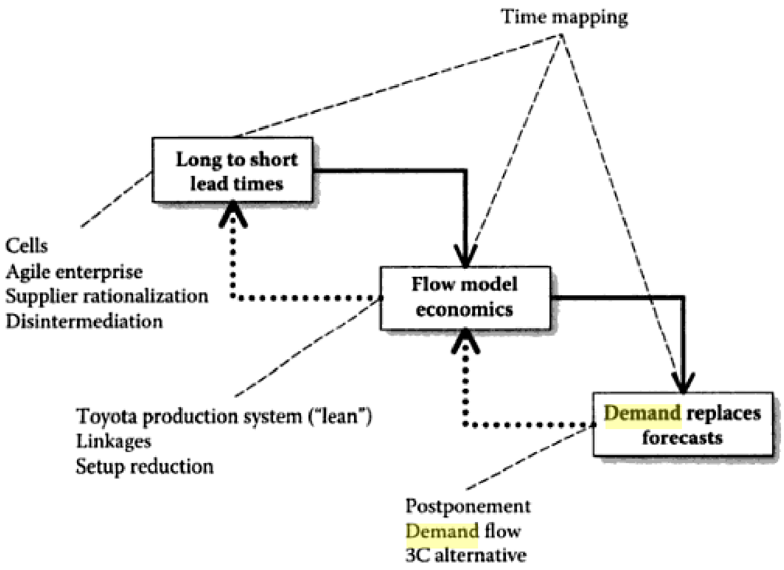

Figure 31 – 3 Phase Roadmap for Implementing DDSC in Manufacturing (Ayers, 2006)

Evolution to a demand-driven supply chain will likely proceed in the order these items are listed. Shortening the lead-time is fundamental to changing batch model economics. Basing decisions on demand comes after adopting the economics of the flow model. Along the path there is feedback to earlier steps.

4.4.3.1
Cells

Cells are a proven way to save time and reduce cost in both manufacturing and service companies. The design of any production process will fall into one of two generic categories:

- Functional design - It is the traditional approach and it has its foundation in traditional accounting mentality and the associated batch approach to production. In a functional setup, the work must progress sequentially through each unit. Because the batch model stresses worker and machine utilization while ignoring lead-time, the functional design is a natural response despite not so obvious penalties in terms of lead-time.
- Cell design – Cell design is a component of the Toyota Production System, or lean manufacturing. In the cellular shop floor, machines of different types are located together and the focus shifts to the product, not the means of production. In a cellular paperwork process, small groups do all operations.

Cells reduce lead-times and enable products to be produced in small-lot or single-lot quantities. There are three outcomes from implementing cells in manufacturing environment: Improvement in flow, density and velocity, as described below:

- Flow should include simplicity of layout and minimal movement distance of components around the factory.
- Density is the measure of workspace to total space, that is, how much of the factory floor is occupied by value-adding activities as a proportion of total space. Density should be as high as possible.
- Velocity refers to the percent of time spent in value-added operations. Low velocities are characteristic of high waits for processing – usually in a batch process.

Cellular manufacturing has other benefits like:

- Improved quality – In a functional batch manufacturing setup, a whole batch of bad product may be produced before the error is detected. In the high-velocity cellular environment, the next operation will receive the product much more quickly, and defects will be caught before more bad products are produced. Feedback to the operator producing the bad parts is also fast, facilitating a learning environment.
- Focused factory – Cells also facilitate implementation of the “focused factory”, a concept developed by Wickham Skinner, and which characterizes a factory that does not attempt to do much different things. The analogy is the athlete. To excel in a sport, one must concentrate on that sport. The multisport professional athlete is relatively rare. Within the focused factory, each cell can be tailored to customer needs, rather than operating in a “one-size-fits-all” environment.

4.4.3.2
Agile Enterprise

The agile enterprise line of thinking relates to the need to respond quickly in dynamic markets. In these markets, opportunities come and go rapidly, and to respond, managers must design production systems capable of rapid deployment to meet these opportunities.

The agile enterprise will be able to do two things well:

- Rapidly reposition internal operations for new opportunities, which mean structuring internal operations using cells and focused factories.
- Be good at partnerships, which mean be ready to form or participate in multi-company supply chains.

Agility requires rapid responses. Cell capabilities could be deployed more rapidly than entire factories, and so, the focus in cell design may be more on building in the ability to shift market positions rather than defend any particular market position. Flexibility, rather than cost, should be the primary goal.

The agile enterprise extends the philosophy of cellular manufacturing up into the organization. It would encompass infrastructure, including control systems, union contracts, rewards and incentives, information systems, and technology competencies. This means, in all probability, that the focused factory or cell can even be dissociated from the enterprise. The agile enterprise will be fast, not only in putting out product once it is up and running, but also in setting up supply chains in response to market opportunities.

4.4.3.3
Toyota Production System (Lean Manufacturing)

The Toyota Production system (TPS) is a philosophy of manufacturing that Toyota credits with its success in producing high quality automobiles. The concepts behind TPS underpin the “lean manufacturing model”.

We can define Lean as “*A systematic approach to identifying and eliminating waste through continuous improvement, flowing the product at the pull of the customer in pursuit of perfection*”.

The wastes noted above are commonly referred to as “non-valued-added” activities, and are known to Lean practitioners as the “Eight Wastes”. Taiichi Ohno (co-developer of the Toyota Production System) suggests that these account for up to 95% of all costs in non-Lean manufacturing environments. These wastes are:

- Overproduction – Producing more than the customer demands. The corresponding Lean principle is to manufacture based upon a pull system, or producing products just as customers order them. Anything produced beyond this (buffer or safety stocks, work-in-process inventories, etc.) ties up valuable labor and material resources that might otherwise be used to respond to customer demand.

- Waiting – This includes waiting for material, information, equipment, tools, etc. Lean demands that all resources are provided on a just-in-time (JIT) basis – not too soon, not too late.
- Excess of Transportation – Material should be delivered to its point of use. Instead of raw materials being shipped from the vendor to a receiving location, processed, moved into a warehouse, and then transported to the assembly line, Lean demands that the material should be shipped directly from the vendor to the location in the assembly line where it will be used. The Lean term for this technique is called “point-of-use-storage” (POUS).
- Non-Value-Added-Processing – Some of the more common examples of this are reworking (the product or service should have been done correctly the first time), deburring (parts should have been produced without burrs, with properly designed and maintained tooling), and inspecting (parts should have been produced using statistical process control techniques to eliminate or minimize the amount of inspection required). A technique called Value Stream Mapping is frequently used to help identify non-valued-added steps in the process (for both manufacturers and service organizations).
- Excess of Inventory – Related to Overproduction, inventory beyond that needed to meet customer demands negatively impacts cash flow and uses valuable floor space. One of the most important benefits for implementing Lean Principles in manufacturing organizations is the elimination or postponement of plans for expansion of warehouse space.
- Defects – Production defects and service errors waste resources in four ways. First, materials are consumed. Second, the labor used to produce the part (or provide the service) the first time cannot be recovered. Third, labor is required to rework the product (or redo the service). Fourth, labor is required to address any forthcoming customer complaints.
- Excess of Motion – Unnecessary motion is caused by poor workflow, poor layout, housekeeping, and inconsistent or undocumented work methods. Value Stream mapping (see above) is also used to identify this type of waste.
- Underutilized People – This includes underutilization of mental, creative, and physical skills and abilities, where non-Lean environments only recognize underutilization of physical attributes. Some of the more common causes for this waste include – poor workflow, organizational

culture, inadequate hiring practices, poor or non-existent training, and high employee turnover

In order to reduce or eliminate the above wastes, Lean practitioners utilize many tools or Lean Building Blocks. Successful practitioners recognize that, although most of these may be implemented as stand-alone programs, few have significant impact when used alone. Additionally, the sequence of implementation affects the overall impact, and implementing some out of order may actually produce negative results (for example, you should address quick changeover and quality before reducing batch sizes). The more common building blocks are listed below:

- **Pull System** – The technique for producing parts at customer demand. Service organizations operate this way by their very nature. Manufacturers, on the other hand, have historically operated by a Push System, building products to stock (per sales forecast), without firm customer orders.
- **Kanban** – A method for maintaining an orderly flow of material. Kanban cards are used to indicate material order points, how much material is needed, from where the material is ordered, and to where it should be delivered.
- **Work Cells** – The technique of arranging operations and/or people in a cell (U-shaped, etc.) rather than in a traditional straight assembly line. Among other things, the cellular concept allows for better utilization of people and improves communication.
- **Total Productive Maintenance** – TPM capitalizes on proactive and progressive maintenance methodologies and calls upon the knowledge and cooperation of operators, equipment vendors, engineering, and support personnel to optimize machine performance. Results of this optimized performance include elimination of breakdowns, reduction of unscheduled and scheduled downtime, improved utilization, higher throughput, and better product quality. Bottom-line results include lower operating costs, longer equipment life, and lower overall maintenance costs.
- **Total Quality Management** – It is a management system used to continuously improve all areas of a company's operation. TQM is applicable to every operation in the company and recognizes the strength of employee involvement.

- **Quick Changeover (Setup Reduction and Single Minute Exchange of Dies - SMED)** – The technique of reducing the amount of time to change a process from running one specific type of product to another. The purpose for reducing changeover time is not only for increasing production capacity, but also to allow more frequent changeovers in order to increase production flexibility. Quicker changeovers allow for smaller batch sizes.
- **Batch Size Reduction** – Historically, manufacturing companies have operated with large batch sizes in order to maximize equipment utilization, assuming that changeover times were "fixed" and could not be reduced. Because Lean calls for the production of parts to customer demand, the ideal batch size is ONE. However, a batch size of one is not always practical, so the goal is to practice continuous improvement to reduce the batch size as low as possible. Reducing batch sizes reduces the amount of work-in-process (WIP) inventory. Not only does this reduce inventory-carrying costs, but also production lead-time or cycle time is approximately directly proportional to the amount of WIP. Therefore, smaller batch sizes shorten the overall production cycle, enabling companies to deliver more quickly and to invoice sooner (for improved cash flow). Shorter production cycles increases inventory turns and allows the company to operate profitably at lower margins, which enables price reductions, which increases sales and market share.
- **5S or Workplace Organization** – This tool is a systematic method for organizing and standardizing the workplace. It's one of the simplest Lean tools to implement, provides immediate return on investment, crosses all industry boundaries, and is applicable to every function with an organization. Because of these attributes, it's usually the first step recommended for a company start its journey to Lean manufacturing.
  As the name indicates, 5S consists of 5 phases, as described below:
  - **Sorting** – Eliminate all unnecessary tools, parts, instructions. Team should go through all tools, materials, etc., in the plant and work area and keep only essential items. Everything else should be stored or discarded.
  - **Straightening** – There should be a place for everything, and everything should be in its place. The place for each item should be clearly labeled or demarcated. Items should be arranged in a

manner that promotes efficient work flow. Workers should not have to repetitively bend to access materials. Each tool, part, supply, piece of equipment, etc. should be kept close to where it will be used (i.e. straighten the flow path).

- **Systematic cleaning** – Workplace should be kept tidy and organized. At the end of each shift, workers should clean the working area and be sure everything is restored to its place. This makes it easy to know what goes where and ensures that everything is where it belongs. A key point is that maintaining cleanliness should be part of the daily work - not an occasional activity initiated when things get too messy.
- **Standardizing** – Work practices should be consistent and standardized. Everyone should know exactly what his or her responsibilities are for adhering to the first 3 S's.
- **Sustaining** – Maintain and review standards. Once the previous 4 S's have been established, they become the new way to operate. Employees should maintain focus on this new way and do not allow a gradual decline back to the old ways. While thinking about the new way, they should also be thinking about better ways to operate. When an issue arises, such as a suggested improvement, a new way of working, a new tool or a new output requirement, review the first 4 S's and make changes as appropriate.

- **Visual Controls** – These are simple signals that provide an immediate and readily apparent understanding of a condition or situation. Visual controls enable someone to walk into the workplace and know within a short period of time what’s happening with regards to production schedule, backlog, workflow, inventory levels, resource utilization, and quality. These controls should be efficient, self-regulating, and worker managed, and include visual boards, Kanban cards, lights, color-coded tools, lines delineating work areas and product flow, etc.

4.4.3.4
Postponement

Postponement refers to efforts to customize products for delivery as late in the production process as possible to fulfill the demand cost effectively. It supports the just in time principle from the Toyota Production System.

Designing for postponements makes the concept easier to implement. These designs create needed commonality among end products. Assembling common parts or modules creates each unique product configuration. However, implementation requires multidepartment collaboration, including operations, marketing, procurement, and engineering.

Without commonality, plants may be efficient as far as individual products are concerned. However, total cost, including inventory and shipping, will be high due to proliferation of specialized parts and finished goods inventory.

Nahmias (2005) provides examples of postponement concept implementation in Benetton Group, who operates in the fashion clothes industry and also in Hewlett-Packard (HP), who operates in the printer industry.

4.4.4
Logistics

4.4.4.1
Introduction

Bowersox and Lahowchich (2008) state that Logistics is a critical area in the responsive supply chain business model. They argue that the logistical structure include the traditional functional areas of order management, transportation, inventory, warehousing and material handling. These five dimensions of logistical performance are integrated in an operating system and a facility network design. Included within these primary areas are important strategic and tactical matters, such as protective packaging, building and material handling design, facility location and network design, as well as reverse movement related to product warranty, recall, and disposal (commonly called reverse logistics).

4.4.4.2
Warehouse

Based on Baker and Canessa (2009), warehouses are a key aspect of modern supply chains and play a vital role in the success, or failure, of businesses today.
Two types of warehouse can be distinguished: distribution warehouses and production warehouses.

- The function of a distribution warehouse is to store products and to fulfill external customer orders typically composed of a large number of order lines (where each order line specifies a quantity of one particular product). The number of different products in a distribution warehouse may be large, while the quantities per order line may be small, which often results in a complex and relatively costly order picking process. Therefore, distribution warehouse are often optimized for cost-efficient order picking. The prominent design criterion is the maximum throughput to be reached at minimum investment and operational costs.
- The function of a production warehouse is to store raw materials, work-in-process and finished products, associated with a manufacturing and / or assembly process. Raw materials and finished products may be stored for long periods. This occurs, for example, when the procurement batch of incoming parts is much larger than the production batch, or when the production batch exceeds the customer order quantity of finished products. Storage of goods for long periods must be cost-efficient, and is usually done in large quantities in an inexpensive storage system, such as pallet rack. The prominent design objectives are low investment costs and operational costs.

Huertas et al. (2007) state that facility layout plays an important role in the business success of the company, and the most appropriate warehouse layout depends on its particular operational conditions, and characteristics such as modularity, adaptability, compactness, distribution of movements, accessibility and flexibility. Layout design is a problem-dependant, in other words, there is no best design, methodology or policy for all problems under consideration. Selecting the best layout for a given case is not trivial, because of the diversity of factors influencing a warehouse operation, such as docks location, aisles access, racks types, racks access.

Baker and Canessa (2009) also provide an overall framework with the key steps and main tools used, as well as the literature references on warehouse design, as illustrated in table 14:

Table 14 – Baker and Canessa (2009) Framework, Tools and Key References

Step	Tools and key references
1. Define system requirement	Refer to literature on business and supply chain strategy literature (e.g. Christopher (2005)) and scenario planning (e.g. Sodhi (2003)) Warehouse role framework is provided in Baker (2007a) and role checklist in Higginson and Bookbinder (2005)
2. Define and obtain data	Checklists and spreadsheet, or database, models are used Useful checklists appear in Rowley (2000), McGinnis and Mulaik (2000), Bodner et al. (2002), Frazelle (2002b) and Rushton et al. (2006)
3. Analyse data	Database and spreadsheet models are used Activity profiling techniques are given in Frazelle (2002b) Planning base, planning horizon and warehouse flow charts are described in Rushton et al. (2006)
4. Establish unit loads to be used	Analytic and simulation approaches are described in Roll et al. (1989)
5. Determine operating procedures and methods	A wide variety of techniques are used Rouwenhorst et al. (2000) set out a framework of the cluster of decisions that need to be considered Rushton et al. (2006) describe warehouse zoning Flexibility frameworks are set out in Baker (2006, 2007b)
6. Consider possible equipment types and characteristics	Spreadsheet models and decision trees tend to be used Heuristic, analytic and simulation methods are described in Ashayeri and Gelders (1985) A heuristic approach is set out in Naish and Baker (2004) Decision tree examples are given in Rowley (2000) and Rushton et al. (2006)
7. Calculate equipment capacities and quantities	Spreadsheet models, as well as historic performance measures, are used The analytic and simulation methods described by Ashayeri and Gelders (1985) are also relevant for this step
8. Define services and ancillary operations	Checklists are used by some practitioners
9. Prepare possible layouts	CAD software is generally used by practitioners Outline steps and methods are provided by Mulcahy (1994), Hudock (1998) and Frazelle (2002b) A warehouse relationship activity chart is described in Frazelle (2002b)
10. Evaluate and assess	Simulation software is useful at this step (e.g. see Kosfeld, 1998) and is commonly used by practitioners Analytic models are also used by practitioners
11. Identify the preferred design	Quantitative (e.g. financial business case) and qualitative (e.g. SWOT analysis) methods are used No specific process is described in the literature

Gu et al. (2010) state that warehouse design involves five major decisions:

- Determine the overall structure: The overall structure (or conceptual design) determines the functional departments, such as how many storage departments, technology employed and how orders will be assembled. At this stage of the design, the issues are to meet storage and throughput requirements, and to minimize costs.
- Department layout: It is the detailed configuration within a warehouse department, for example, aisle configuration in the retrieval area, pallet block-stacking pattern in the reserve storage area, and configuration of an automated storage/retrieval systems (AS/RS)
- Operation strategy: Refers to those decisions about operations that have global effects on other design decisions, and therefore, need to be

considered in the design phase. Examples are the decision between randomized and dedicated storage, or the decision to use zone picking.

- Equipment selection: Determine an appropriate automation level for the warehouse, and identify equipment types for storage, transportation, order picking and sorting.
- Sizing and dimensioning:
  - Warehouse sizing determines the storage capacity of a warehouse. There are two scenarios in modeling: 1) inventory levels are determined externally so the warehouse has no direct control over when incoming shipments will arrive and their quantities, and 2) warehouse can directly control the inventory policy.
  - Warehouse dimensioning: It translates capacity into floor space in order to assess construction and operating costs.

Rouwenhorst et al. (2000) provide three different angles from which a warehouse may be viewed: Processes, resources and organization. Products arriving at a warehouse subsequently are taken through a number of steps called processes. Resources refer to all means, equipment and personnel needed to operate a warehouse. Finally, organization includes all planning and control procedures used to run the system.

<u>Warehouse Processes</u>:

The flow of items through the warehouse can be divided in several distinct phases or processes:

- The receiving process is the first process encountered by an arriving item. Products arrive by truck or internal transport (in case of a production warehouse). At this step, the products may be checked or transformed (e.g. repacked into different storage modules) and wait for transportation to the next process.
- In the storage process, items are place in storage locations. The storage area may consist of two parts: The reserve area, where products are stored in the most economical way (bulk storage), and the forward area, where products are stored for easy retrieval by an order picker. Products in the forward area are often stored in smaller amounts in easily to access storage modules.
- Order picking refers to the retrieval of items from their storage locations and can be performed manually or (partly) automated. In succession,

these items may be transported to the sorting and/or consolidation process.

- At the shipping area, orders are checked, packed and eventually loaded in trucks, trains or any other carrier.

Warehouse Resources:

A number of resources can be distinguished as listed below:

- Storage unit, which products may be stored. Examples of storage units are pallets, carton boxes and plastic boxes.
- Storage system, which consist of multiple subsystems that store different types of products. Storage systems are very diverse, such as are driven in, case flow racks, shelves, push backs, just to enumerate some examples.
- The retrieval of items from the storage system can be performed manually or by means of pick equipment like forklift (e.g. single, double, triple and quad forklifts) or pallet jack.
- A computer system may be present to enable computer control of the processes by a warehouse management system.
- The material handling equipment for preparation of the retrieved items for the expedition includes sorter systems, palletizer and truck loaders.
- Personnel constitutes and important resource, since warehouse performance largely depends on their availability and commitment.

Chakravorty (2008) shows that the implementation of material handling systems involves, both human and technical factors, that interact over time, and go through three overlapping transitional stages. In the first stage, both human and technical problems exist; however, human problems dominate, and require conflict management skills to resolve. In the second stage, human problems improve, but technical problems persist, requiring formal problem-solving methods to resolve. Finally, in the third stage, both human and technical problems improve.

Warehouse organization:

Some processes require specific organizational policies:

- At the receiving process, an assignment policy determines the allocation of trucks to docks.
- At the storage process, items are transported to the storage system and are allocated to storage locations. Several storage policies exist. A

dedicated storage policy prescribes a particular location for each product to be stored, whereas a random storage policy leaves the decision to the operator. In between, a class based storage system (e.g. ABC Zoning) allocates zones to specific product groups, often based upon their turnover rate. Other storage policies include correlated storage or family grouping, aimed at storing products at nearby positions, if they are often required simultaneously. If the storage system has a separate reserve area, a storage policy for the reserve area is also needed.

- At the order picking process, orders are assigned to one or more order pickers. Various control problems deserve attention. First, the total pick area may be divided into picking zones, to be served by different order pickers, through a zoning policy. Two alternative policies exist: Parallel or Sequential zoning. Second, orders are picked one by one (single order picking) or in batches (batch picking). If a batch picking policy is selected, this directly implies that the picked orders must be sorted. Then, two sorting policies exist: Pick and sort (sequentially) and sort while pick (simultaneously). Third, a routing policy may define the sequence of retrievals and the route to visit the retrieval locations.
- At the shipping process, orders and trucks are allocated to docks by a dock assignment policy.
- Finally, allocation of tasks to personnel and equipment are addressed by operator and equipment assignment policies.

<u>Performance Management Execution</u>:

Ellinger et al. (2005) state that the success of many firms is becoming increasingly linked to the growth, development, and retention of human capital. Accordingly, managers and leaders are being urged to promote a more people-oriented approach to management, where communication is paramount and, every employee’s contribution is viewed as a significant factor in the firm’s ongoing efforts to satisfy customer price, quality, and service demands. However, logistics organizations have been particularly guilty of not placing sufficient emphasis on the growth and development of personnel. This is illustrated by the difficulties that firms have in retaining truck drivers and warehouse workers who are often modestly compensated, and must perform relatively mundane and repetitive tasks.

They presented managerial coaching, which is a leadership style based on the provision of constructive feedback that is designed to get the most out of people, in other words, improve work performance by showing them that they are respected and valued. Managerial coaching occurs as part of the day-to-day relationship between employee and supervisor, and is one of the strongest retention tools in a manager's arsenal.

Managerial coaching skills include questioning, listening, giving and receiving feedback, communicating and motivating, rather than the more traditionally recognized skills and qualities of a successful leader/manager like competitiveness, being in control, solving problems, and being seen as an expert. Successful manager / coaches are also proficient delegators who are prepared to accept short-term failures, if they lead to long–term development.

Numerous prescriptive works outline methodologies for effective managerial coaching. The following list outlines behavioral practices drawn from interviews with "best of breed" manager-coaches in business and industry contexts:

- providing observational, reflective and constructive feedback to subordinates;
- seeking feedback from subordinates about their progress on the job;
- providing resources, information, and materials for subordinates and removing external factors and obstacles that may be impeding performance;
- talking things through together to come up with options;
- stepping into subordinates' shoes to experience their perspectives and encouraging subordinates to see other perspectives;
- role-playing, personalizing learning situations with examples, and using analogies and scenarios;
- setting goals, outlining expectations and communicating their importance to subordinates;
- posing context-specific questions that encourage subordinates to think through issues themselves;
- mentally holding back and consciously not providing answers, solutions, or telling subordinates what to do; and not taking over employees' responsibilities but rather shifting them back to employees and holding them accountable

Ellinger et al. (2005) argue that managerial coaching has enormous benefits for firms and for the individuals they employ, as people who feel valued and respected by their employers tend to be more loyal and hard-working, because they get more out of their jobs. Without coaching and feedback, effective performance is not reinforced, ineffective performance is not identified, and employees will not know if their performances are meeting the expectations of their managers or supervisor, or the requirements of the firm's customers.

Warehouse Metrics:

Huertas et al. (2007) propose a set of metrics to evaluate warehouse performance as described below:

- Quality: Accuracy in storage, Accuracy in picking and Inventory
- Finance: Operational costs and Total storage costs per unit
- Cycle time: Commodity cycle time and Order cycle time
- Productivity: Labor productivity (employees / moved unit), Resource consumption (space, equipment, labor), Flow (moved units through the system in a given period), Throughput volume (moved units per day), and Productivity ratio (handled units per day / working hours per day)

It is important to mention that all concepts presented are valid for both a company owned or an outsourced warehouse operation and the decision for outsource or not, should be aligned with the company's strategic direction, financial objectives, and core function analysis. For more information on how to structure an outsource process, please refer to Greaver (1999) and Power (2008).

4.4.4.3
Distribution

A well run distribution operation is one operation that maximizes delivery asset (e.g. trucks) utilization at the same time that minimizes labor (e.g. drivers and delivery helpers) and delivers the expected customer service level (e.g. order or case fill rate).

In order to achieve the above objectives, companies need to establish the right fleet size and fleet composition, need to optimize daily vehicle routing to reduce distance traveled and drivers' working hours and also implement a performance management execution process. Each one of these three areas (fleet size, vehicle routing optimization and performance management) will be reviewed in detail below:

Fleet Size and Composition:

The fleet size and composition problem was first studied by Kirby (1959), and then by Wyatt (1961), and both of them, considered a homogenous fleet to be defined, taken into consideration seasonal demand, and the fact that deliveries should be done preferable by an internal fleet, but if the demand exceeds capacity, spot fleet could be hired to fulfill the demand.

Gould (1969) brought a new view for the fleet size problem, as he considered the heterogeneous fleet for both fleet type and size.

More recently, Beaujon and Turnquist (1991) presented a research that attempts to integrate vehicle fleet sizing decisions with optimization of vehicle utilization. A model is formulated to optimize both sets of decisions simultaneously under dynamic and uncertain conditions. They showed how the expected value formulation can be approximated as a nonlinear network programming problem, and propose a procedure for solving the network approximation.

Jin and Kite-Powell (2000) state that replacement theory deals with the optimal life of an equipment. In this context, optimal life is defined as the period between the time the equipment enters service and the time when it should be replaced for economic reasons. They argue that optimal life and replacement policy are important topics in the management of capital equipment. Generally, the operating cost of a piece of capital equipment rises as its condition deteriorates over time. When the cost reaches a certain level, the long-run cost associated with investing in a new piece of equipment becomes less than that of keeping the old equipment. At that point, replacement is called for. Thus, a basic replacement analysis usually examines both the trend in operating cost and the net cost of replacement, which is defined as the difference between the cost of the new equipment and the salvage value of the old one.

List et al. (2003) proposed a formulation and a solution procedure for fleet sizing under two situations: Uncertainty in future demands, that are to be served by vehicle fleet, and the productivity of individual vehicles, reflecting uncertainty in future operating conditions.

Wu et al. (2005) describe a fleet sizing problem in the context of the truck rental industry. They examine both operational decisions (including demand allocation and empty truck repositioning) and tactical decisions (including asset procurement and sales) in a linear programming model to determine the optimal fleet size and mix. The method uses a time-space network, common to fleet management problems, but also includes capital cost decisions. A two phase solution approach is developed to solve large-scale instances of the problem using Benders decomposition in the first phase, and Lagrangian relaxation in the second phase.

Zhang and Li (2007) presented an article that analyzes multi-periodic vehicle fleet size and routing problem, and dynamic vehicle fleet size. The authors decompose the model with Dantzig-Wolf decomposition method, and derive an exact algorithm for the model based on simplex method, dynamic programming method, and branch and bound method.

Manuela (2008) studied the fleet sizing and composition problem, and compared the Bin Packing approach with an Integer linear programming model, as illustrated in table 15. Based on the simulation performed, the integer linear programming generated lower costs for all instances compared with the Bin Packing model, except in one day.

Table 15 – Fleet Sizing Model Comparison (Manuela, 2008)

	Bin Packing	Programação Linear Inteira
Minimização	Custo	Custo
Restrição	Capacidade Tempo de Ciclo Frota No Clientes	Capacidade Tempo de Ciclo Frota No Clientes
Variáveis	Binário	Inteiro positivo
Programa	Solver + Macro	ILOG OPL Studio
Tempo de Simulação	2 horas	5 segundos
Input dos Dados	30 min	60 min
Vantagem	Pode alocar um veiculo a mais de uma região	Realiza simultaneamente a otimização de todas as regiões
Desvantagem	Demora muito tempo para se obter o resultado Para frotas muito grandes o software não tem capacidade de resolver	Não é possivel alocar um mesmo veiculo a mais de uma região O input dos dados na versão utilizada não tem interface com o excel

Based on the literature review, there are different approaches available to size and define the right fleet composition that companies should consider and apply, as well as they should define their fleet renew policy to ensure the fleet operation is a key enabler to deliver the customer service, cost effectively.

<u>Vehicle Routing Optimization</u>:

Based on Toth and Vigo (2002), the vehicle routing problem (VRP) consists to determine a set of routes, each performed by a single vehicle, that starts and ends at its own depot, and ensure that all the requirements of the customers are fulfilled, all the operational constraints are satisfied, and the global distribution cost is minimized. They also presented the main components of the VRP, as summarized below:

- **Road network** – It is usually described through a graph, whose arcs represent the road sections, and whose vertices correspond to the road junctions, and to the depot and customer locations. The arcs can be directed or undirected, depending on whether they can be traversed in only one direction (for instance, because of the presence of one-way streets, typical of urban or motorway networks) or in both directions. Each arc is associated with a cost, which generally represents its length, and a travel time, which is possibly dependent on the vehicle type or on the period during which the arc is traversed.

- **Customers** – Typical characteristics of customers are:
    - Vertex of the road graph in which the customer is located
    - Amount of goods (demand), possibly of different types, which must be delivered or collected at the customer
    - Periods of the day during which the customer can be served (time windows)
    - Times required to deliver or collect the goods at the customer location (e.g. unloading or loading times, respectively), possibly dependent on the vehicle type
    - Subset of the available vehicles that can be used to serve the customer
- **Vehicle fleet** – Typical characteristics of the vehicles are:
    - Capacity of the vehicle, expressed as the maximum weight, or volume, or number of pallets, the vehicle can load
    - Possible subdivision of the vehicle into compartments, each characterized by its capacity, and by the types of goods that can be carried
    - Material handling equipments for the loading and unloading operations
    - Subset of arcs of the road graph which can be traversed by the vehicle
    - Costs associated with vehicle utilization (e.g. per distance unit, per time unit, per route, etc.)
- **Drivers** – Drivers operate the vehicles, and must satisfy several constraints laid down by union contracts and company regulations, such as working periods during the day, number and duration of breaks during service, maximum duration of driving periods, overtime, etc.

Several and often contrasting, objectives can be considered for the vehicle routing problem, and the typical ones are:

- Minimization of the global transportation cost, dependent on the global distance traveled (or on the global travel time), and on the fixed costs associated with the used vehicles (and with the corresponding drivers)

- Minimization of the number of vehicles (or drivers) required to serve all customers
- Balancing the routes, for travel time and vehicle load
- Minimization of the penalties associated with partial service of the customers.
- Minimization of total travel time
- Maximize volume delivered per mile

Figure 32 provides an overview of the basic vehicle routing problems, and then, each type of problem is briefly described:

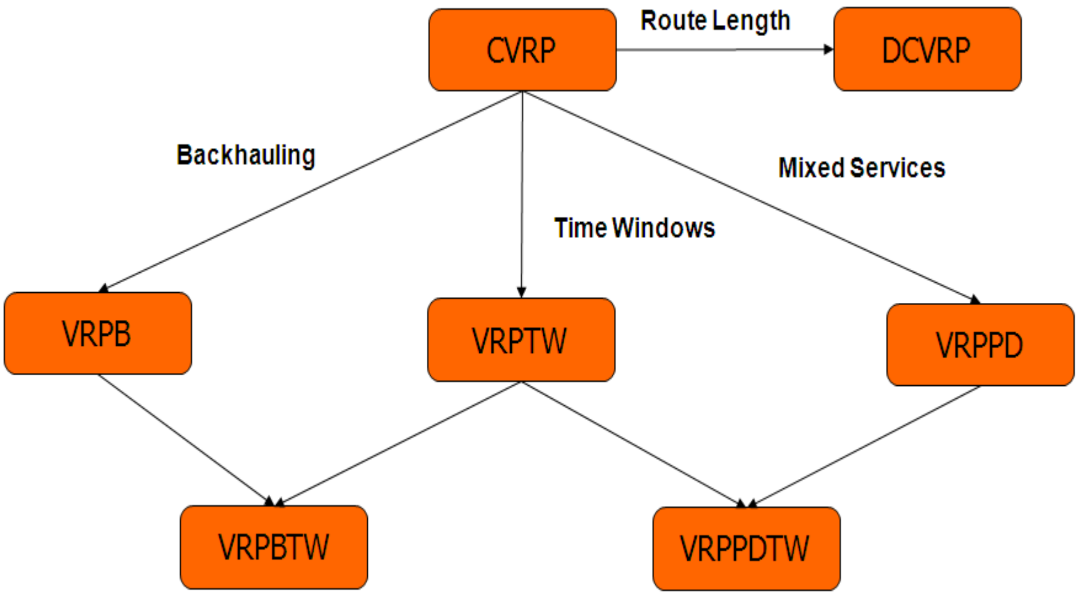

Figure 32 – Basic VRP problems and their interconnections (Toth and Vigo, 2002)

Capacitated Vehicle Routing Problem (CVRP):

The CVRP consists of finding a collection of exactly “K” simple circuits or routes (being “K” a set of identical vehicles available at the depot, each with available capacity “C”) with minimum cost, defined as the sum of the costs of the arcs belonging to the routes, such that:

- Each route visits the depot vertex
- Each customer vertex is visited by exactly one route
- The sum of the demands of the vertices (customers) visited by a route does not exceed the vehicle capacity (C).

The CVRP is known to be NP-hard and generalizes the Traveling Salesman Problem (TSP), which can be defined as “given a list of cities and their pair wise distances, the objective is to find a shortest possible tour that visits each city exactly once".

One variant of CVRP is the so-called "Distance-Constrained VRP" (DCVRP), where for each route, the capacity constraint is replaced by a maximum length (or time) constraint. In particular, a nonnegative length is associated with each arc, and the total length of the arcs of each route cannot exceed the maximum route length.

Vehicle Routing Problem with Backhauls (VRPB):

The VRP with Backhauls is the extension of the CVRP in which the customer set is partitioned into two subsets. The first subset, "L", contains "n" Line haul customers, each requiring a given quantity of product to be delivered. The second subset, "B", contains "m" Backhaul customers, where a given quantity of inbound product must be picked up.

The VRPB consists of finding a collection of exactly "K" simple circuits or routes with minimum cost, such that:

- Each route visits the depot vertex
- Each customer vertex is visited by exactly one route
- The sum of the demands of the line haul and backhaul customers visited by a route do not exceed, separately, the vehicle capacity (C)
- In each route, all the line haul customers precede the backhaul customers, if any.

The case of VRPB in which time windows are present is called "VRP with Backhauls and Time Windows" (VRPBTW).

Vehicle Routing Problem with Time Windows (VRPTW):

The VRP with Time Windows is the extension of the CVRP in which capacity constraints are imposed and each customer is associated with a time interval [a_i, b_i], called a time window. The time instant in which the vehicles leave the depot, the travel time for each arc, and an additional service time "s_i" for each customer should also be given.

The VRPTW consists of finding a collection of exactly "K" simple circuits or routes with minimum cost, such that:

- Each route visits the depot vertex
- Each customer vertex is visited by exactly one route
- The sum of the demands of the vertices (customers) visited by a route does not exceed the vehicle capacity (C)

- For each customer, the service starts within the time window [a_i, b_i], and the vehicle stops for "s_i" time instants.

Customers' time windows should be very careful defined as they increase the complexity of the routing problem to find a feasible solution, and also reduce optimization opportunities in terms of distance traveled.

Vehicle Routing Problem with Pickup and Delivery (VRPPD):

In the VRPPD, each customer is associated with two quantities, "d_i",and "p_i", representing the demand of homogeneous commodities to be delivered and picked up at customer, respectively. The VRPPD consists of finding a collection of exactly "K" simple circuits or routes with minimum cost, such that:

- Each route visits the depot vertex
- Each customer vertex is visited by exactly one route
- The current load of the vehicle along the route must be nonnegative and may never exceed the vehicle capacity "C"
- Often, the origin or the destinations of the demands are common, and hence, there is no need to explicitly indicate them.

The case of VRPPD in which time windows are present is called the "Vehicle routing problem with Pickup and Deliveries and Time Windows" (VRPPDTW)

Summary of the common methods used to solve the Vehicle Routing Problem:

- Mathematical Optimization:
  - Search for optimal solution through cost minimization functions
- Classical Heuristics:
  - These methods perform a relatively limited exploration of the search space, and usually produce good quality solutions within modest computing times.
  - Account for real life problem constraints.
  - Examples: Constructive methods (e.g. Clarke and Wright saving algorithm, Matching-based saving algorithms, Sequential insertion heuristics); Two phase methods (e.g. Elementary clustering methods, Truncated branch and bound, Route first, cluster second methods, etc.); Improvement heuristics (e.g. Single-route improvements, Multi-route improvements, etc.).
- Meta-Heuristics:
  - General solution procedures that explore the solution space to identify good solutions, and allows deteriorating and even infeasible intermediary solutions during the search process.

- More time consuming.
- Examples: Simulated annealing, Tabu search, Ant algorithms, Neural networks etc.

It is not the goal of this thesis to develop a detail review of the solution methods available for the vehicle routing problem. For more information about each one of the above methods, please refer to Toth and Vigo (2002).

Ballou (1999) provides several principles for good routing and scheduling as detailed below:

- **Load trucks with stop volumes that are in the closest proximity to each other:**

  Truck routes should be formed around clusters of stops that are nearest each other, in order to minimize the interstop travel between them, which will also minimize the total travel time on the route. Figure 33 provides two examples of cluster routing.

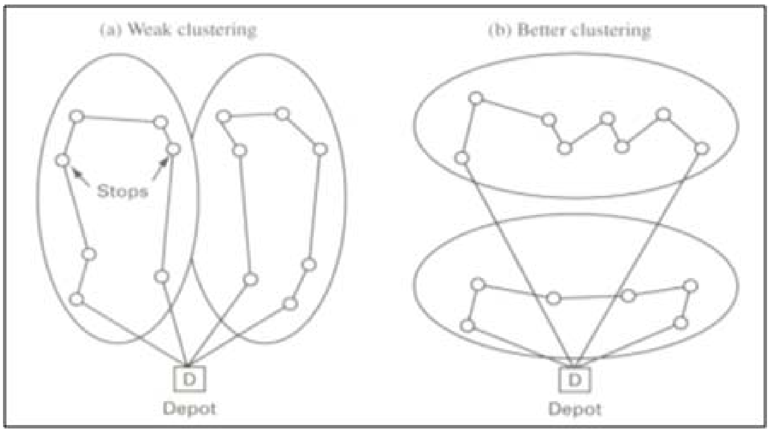

Figure 33 – Example of weak and good cluster routing (Ballou, 1999)

- **Narrow customer time window restrictions should be avoided:**

  Time window restrictions usually force route sequencing away from ideal pattern. Avoid asking your customers on what time they want to receive our products.

- **Stops on different days should be arranged to produce tight clusters:**

  When stops are to be served during different days of the week, the stops should be segmented into separate routing and scheduling problems for each day of the week, as illustrated in figure 34.

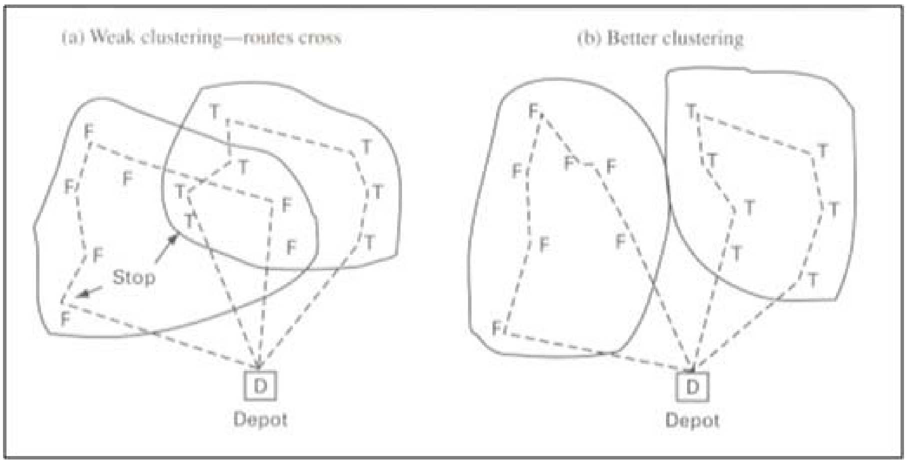

Figure 34 – Example of clustering routes in different days of the week (Ballou, 1999)

- **Pickups should be mixed into delivery routes rather than assigned to the end of routes:**

  Pickups should be made, as much as possible, during the course of the deliveries to minimize the amount of path crossing that can occur when such stops are served after all deliveries are made. The extent to which this can be done will depend on the configuration of the vehicle, the size of the pickup volumes, and the degree to which they may block access to the delivery volumes inside the vehicle.

- **The most efficient routes are built using the largest vehicles available:**

  Ideally, using a vehicle large enough to handle all stops in one route will minimize total distance, or time, traveled to serve the stops. Therefore, the largest vehicles among the multiple sizes in a fleet should be allocated first, providing that good utilization for them can be realized.

  Daganzo (2010) also confirms that in any practical situation, large vehicles should be used first in order to minimize the transportation costs. He suggested using vehicle capacity as large as the highway network would allow.

- **The sequence of stops on a truck route should form a teardrop pattern:**

  Stops should be sequenced so that no paths of the route cross, and the route appears to have a teardrop shape.

Track and Trace Systems:

Giaglis et al. (2004) state that real-time vehicle management is important in supporting supply chain execution systems, and also in minimizing related logistics risks. He argues that it has been demonstrated that a good, near-optimal, distribution plan is necessary but not sufficient for high performance distribution. This needs to be complemented by the ability to make and implement sophisticated decisions in real-time, in order to respond effectively to unforeseen events. The emergence of technologies and information systems allowing for seamless mobile and wireless connectivity between delivery vehicles and distribution facilities is paving the way for innovative approaches in addressing this requirement.

Cheung et al. (2008) developed a mathematical model for dynamic fleet management that takes into consideration dynamic data, such as vehicle locations, travel time, and incoming customer orders. The model is able to efficient re-optimize the route plan as dynamic information arrives, and it includes a genetic algorithm procedure for solving the static vehicle routing problem, and a quick heuristic procedure for dynamic updates of the vehicle routes as new data arrive.

A track and trace system can be defined as a logistics IT system that allows companies to track delivery trucks during the route in real time, and manage the operation in order to solve problems as they happen during the course of the delivery operation. These systems work integrated with routing optimization solutions, like UPS Roadnet or Descartes Roadshow, and use the route plan as the key input that drivers need to follow to reduce miles driven and missed time windows.

Example of functionalities for a track and trace solution:

- Track and manage individual performance by driver and by day
- Ability to provide closed loop system, comparing actual to schedule (hours, km) in order to improve routing planning integrity
- Ability to provide Estimated Time of Arrival (ETA) and send Advanced Shipping Notice (ASN) to customers
- Track service failures by reason code, and provide route and customer level detail, thus delivering "perfect order" report card capability
- Ability to provide delivery information to all different functional areas inside the organization (e.g. tell sell, customer service department, etc.) using web-based solution

- Allow drivers to receive planned information, and view route map and stop location on mobile device
- Ability to see planned and actual route in the same map, including playback past day routes
- Allows driver to inform in real time arrivals and departures from customers
- Allows driver to inform quantities delivered and payment information
- Allows driver to inform exceptions, sending messages (pre-defined or free messages)
- Helps fine tune customer geo-coding information (e.g. latitude and longitude)
- Have a control panel to monitor the operation in real time during the day
- Ability to create dashboard with customized set of KPIs
- Ability to track trucks during the route off line, and on line in real time, identifying exceptions in distance traveled, time stopped in a customer, arrive earlier or late, etc. All of the exceptions should be parameters defined by users.

In figure 35, the key components of a delivery track and trace system are presented. The first component is the mobile equipment (e.g. cell phone or hand held) which is used by drivers to enter delivery information as they perform the operation (e.g. arrival and departure from customers, product returns, etc.). The second component is GPS equipment that is responsible to send truck position in a pre-defined frequency (e.g. every 1 minute). Both GPS information and drivers input is sent to a control operational center in the warehouse facility, where route planners can visualize exceptions to the planned route in a dashboard, as illustrated in figure 36, and work with the drivers and delivery supervisors to solve the problems or escalate them to the right person inside the organization.

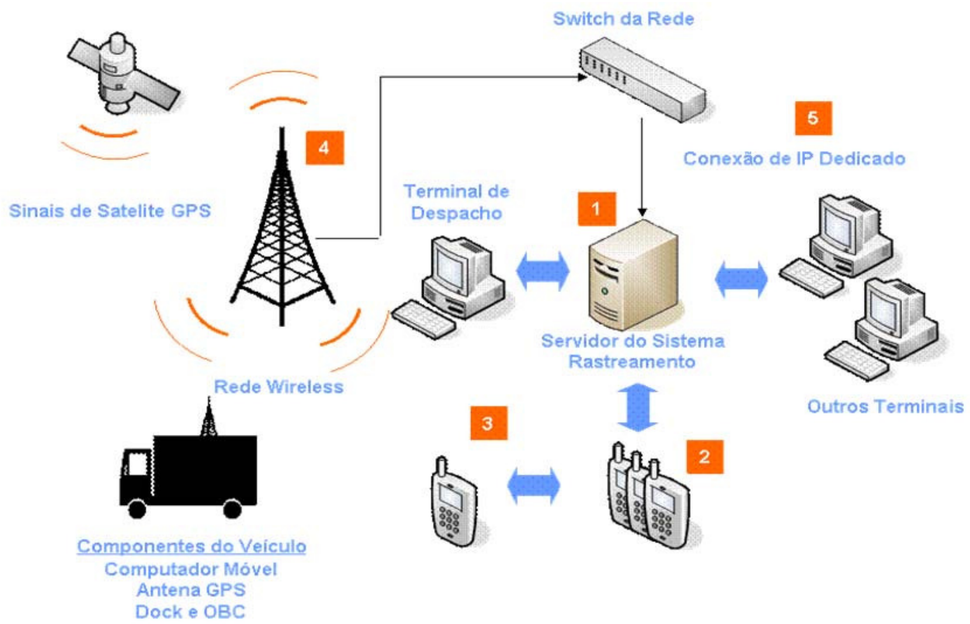

Figure 35 – Example of Architecture for a Track and Trace Solution

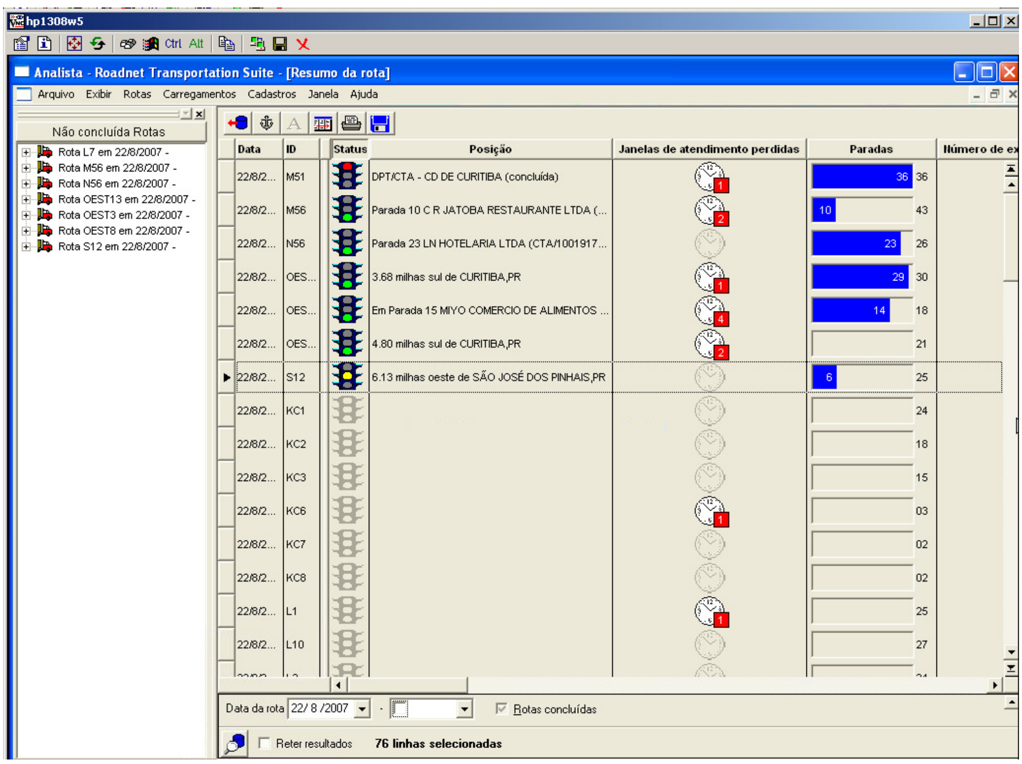

Figure 36 – Example of UPS Mobile Cast Track and Trace Dashboard

Based on the author’s experience on implementing track and trace systems in several different delivery operations in the beverage industry, the typical benefits of these systems are:

- Effectively manage delivery operation during the day, managing exceptions based on standard operating procedures.

- Improve customer service through increased order fill rate, order visibility, on time delivery.
- Improve routing planning through a closed loop system that will keep an updated set of parameters (service time, street speed, etc.).
- Improve logistics execution and reduce distribution costs (usually 10% to 15% reduction in km driven).
- Manage drivers' working time to reduce lawsuit possibilities due to overtime.

Performance Management Execution:

In the same way that was stated in the warehouse operation, performance management execution is also very important to the distribution operation as labor cost is almost 50% of the operational cost. To that end, it is proposed to apply the same managerial coaching approach, which is a leadership style based on the provision of constructive feedback that is designed to get the most out of people, in other words, improve work performance by showing them that they are respected and valued. Managerial coaching should occur as part of the day-to-day relationship between employee and distribution supervisor and is one of the strongest retention tools in a manager's arsenal. For more information about managerial coaching, please refer to section 5.4.4.2.

It is important to mention that all concepts presented for distribution optimization are valid for both a company owned or an outsourced distribution operation and the decision for outsource or not, should be aligned with the company's strategic direction, financial objectives, and core function analysis.

4.4.5
Customer Service

Ballou (1999) presents the elements of customer service according to when the transaction between the supplier and customer take place. These elements can be grouped into three categories, as detailed below:

- **Pre-transaction elements** establish a climate for good customer service, providing a written statement of customer service policy, such as when goods will be delivered after an order is place, the procedure for handling returns and back orders, methods of shipment, and procedures for prioritizing product allocation when there is a shortage, just to name a few examples. Establishing contingency plans for times when labor strikes or natural disasters affect normal service, creating organizational structures to implement customer service policy, and providing technical training and manuals for customers also contribute to good customer relations.

- **Transaction elements** are those that directly result in the delivery of the product to the customer. Setting stock levels, selecting transportation and delivery modes, and establishing order-processing procedures are examples. These elements, in turn, affect delivery times, accuracy of order filling, condition of goods on receipt and stock availability.
- **Post-transaction elements** represent the array of services needed to support the product in the field, to protect consumers from defective products, to provide for the return of packages (e.g. returnable bottles, pallets, etc.), and to handle claims, complaints, and returns. These take place after the sale of the product, but they must be planned for in the pre-transaction and transaction stages.

Corporate customer service is the sum of all these elements because customers react to the total mix.

Segmentation is one of the key strategies to deliver a high customer service level, cost effectively, and can be defined as the process of splitting customers or potential customers within a market into different groups, or segments, within which customers share a similar level of interest in the same, or comparable, set of needs satisfied by a distinct marketing proposition.

McDonald and Dunbar (2007) provide a brief review of the predetermined approaches frequently used to perform market segmentation, and basically, there are 5 approaches:

- Product and services
- Demographics
- Geography
- Channel
- Psychographics

There are different types of customer service organizational structures. However, two types are predominant in place nowadays:

- **Single point of contact with support from multifunctional teams**. In this type of structure, there is one single point of contact with all customers to solve operational requirements, like changing delivery dates and frequencies, developing customized solutions, etc. The person in charge of the contact will collect customer request and will work closely with each functional area of the company to review and implement the appropriate solution. Figure 37 provides an example of single point of contact structure.

Figure 37 – Author's Example of Single Point of Contact Structure

- **Dedicated Multifunctional Cell structure**. In this type of structure, representatives of different functional areas like Marketing, Logistics, Finance, IT, and Commercial work in the same office to serve a pre-defined customer or group of customers. This is a more specialized approach and is found in some companies of the consumer product industry, like Procter and Gamble. Figure 38 provides an example of multifunctional cells.

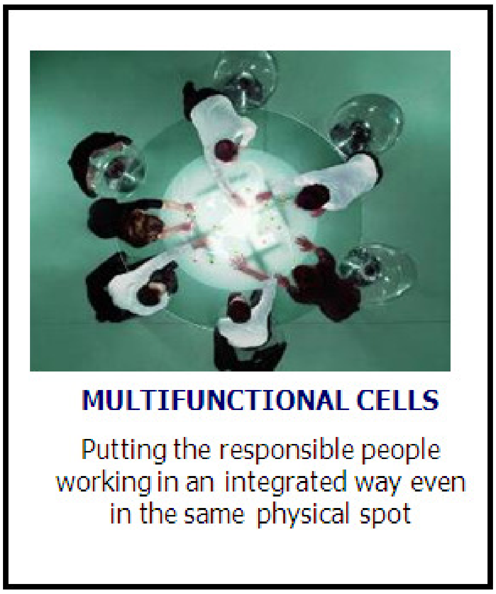

Figure 38 – Author's Example of Dedicated Cell Structure

A well defined and executed customer service policy can have a deep impact in the company financial returns, as illustrated in the figure 39 below:

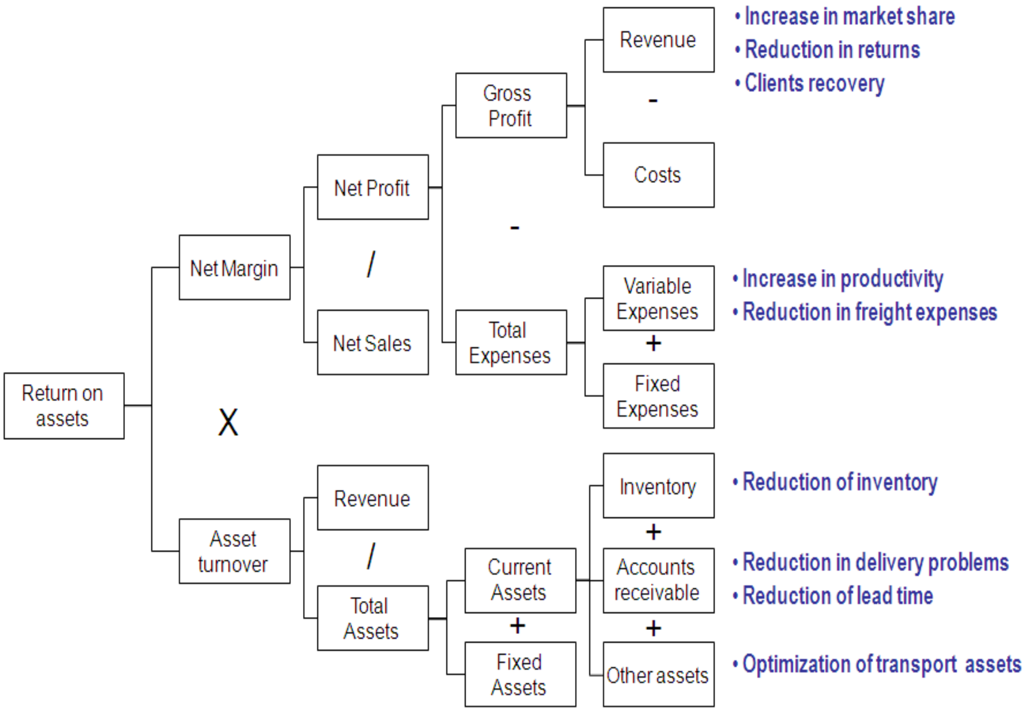

Figure 39 – Potential Impact of a well Executed Customer Service Policy

4.4.6
Senior Management Support

Bossidy and Charan (2002) state that there are seven leadership behaviors that form the building block of execution:

- Leaders should know their people and their business
- Insist on realism
- Set clear goals and priorities
- Follow through to confirm that actions and plans are executed
- Reward the “doers”
- Expand people’s capabilities
- Leaders should know themselves

Nalamalapu (2004) argues that leaders should have the following characteristics and behaviors:

- Admit their own mistakes
- Be able to adapt to new situations
- Be empathetic

- Leaders should sacrifice for and dedicate themselves to their missions
- Leaders should be disciplined
- Be effective communicators
- Lead by example

Fiedler's contingency theory shows the relationship between the leader's orientation or style and group performance under different situational conditions. Fiedler found that task oriented leaders were more effective in low and moderate control situations and relationship oriented managers were more effective in moderate control situations.
(http://www.valuebasedmanagement.net/methods_contingency_theory.html visited on Sept/25-2010).

In order to move towards a demand driven supply and operations management, it is important to have senior management support and engagement to make the necessary changes in term of tools, processes and organizational culture, as detailed below:

- Tools – It is necessary to implement new IT systems that will share demand and supply information, first inside the organization, and then, across the supply chain with customers and suppliers to allow sense and respond to real time demand.
- Processes – As the company moves towards a pull operation, new processes and operating procedures should be developed and implemented, which will require sufficient employee training and management leadership to ensure that new processes will be engrained into the shop floor. Senior management support is crucial to provide enough resources and leadership during this transition period.
- Organizational culture – The transition from a reactive push operation to a pro-active pull operation requires a change in the organizational culture, and senior management support is fundamental to allow HR design and implement required programs to embed the new culture in the organization.

Supply chain directors should also perform educational workshops with other directors and the CEO (chief executive officer) to allow them understands the differences between a "pure push" operation to a hybrid or a "pure pull" operation, depending on the objectives of the company.

4.5
Product Lifecycle Management (PLM)

In this section, it will be performed a literature review for each one of the 6 categories of Product Lifecycle management – New Product Forecast, Supply chain Approach for New Product, Risk Assessment and Management, Product Tracking & Visibility, Portfolio Optimization, Senior Management Support. This review allowed identify the DDSC characteristics for each category which was used to develop the 5 level maturity model.

4.5.1
Introduction

Based on Kahn (2005), product innovation – the development of new and improved products – is crucial to the survival and prosperity of the modern corporation. He stated that according to an American Productivity and Quality Control (APQC) benchmarking study, new products launched three years before the study, accounted for 27,5 of company sales, on average (American Productivity and Quality Center, 2003), and product lifecycles are getting shorter with a 400 percent reduction over the last 50 years as a result of an accelerating pace of product innovation. However, many products do not succeed, as only 56% of businesses' new product development projects achieve their financial goals, and only 51% are launched on time.
To cope with this new scenario, product lifecycle management as the integrated, information - driven approach to all aspects of a product's life, from concept to design, manufacturing, maintenance and removal from the market, has become a strategic priority in many company's boardrooms (Teresko, 2004).
For example, in the pharmaceutical industry, the development time for new drugs has almost doubled over the last 30 years, and the average drug development costs exceed US$ 800 million. Reshaping the lifecycle curve, so that, profitability starts earlier and maturity ends later is seen as a matter of survival (Daly & Kolassa, 2004).
The automotive industry is another vivid example of where success or failure is strongly influenced by the company's ability to proactively manage product lifecycles (Korth, 2003). Increased product complexity, greater reliance on outsourcing and a growing need for collaboration with a rapidly expanding list of business partners are the specific PLM challenges the industry faces (Teresko,

2004). Furthermore, in high-tech or fashion industries, accelerated technological and design changes explain why PLM is at the forefront (Supply Chain Manager Europe, 2005).

In the beverage industry, it can also be seen a huge increase in the number of SKUs commercialized in different markets and geographies, as illustrated in figure 40:

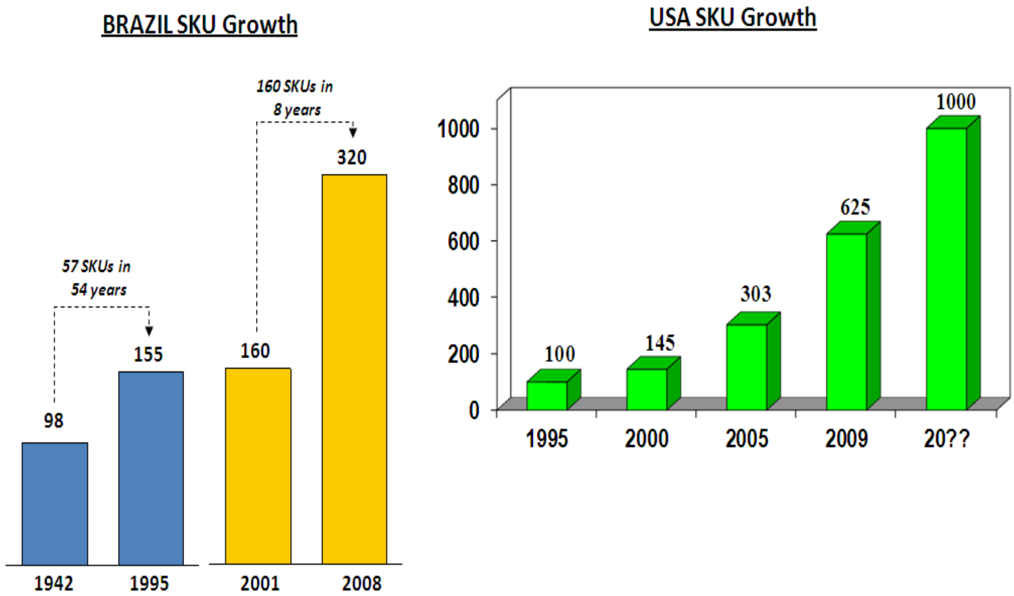

Figure 40 – SKU Growth in one Beverage Industry in Brazil and USA Markets

PLM confronts the need to balance fast response to changing consumer demands with competitive pressure to seek cost reductions in sourcing, manufacturing and distribution. It needs to be based on a close alignment between customer-facing functions (e.g. marketing, sales, customer service) and supply functions (e.g. purchasing, manufacturing, logistics) (Combs, 2004; Conner, 2004).

4.5.2
Proposed PLM Strategic Framework

In order to cope with this new scenario of high SKU proliferation and short product lifespan, it is proposed to apply the PLM strategic framework developed by the author that consists of 4 pillars and 2 foundational blocks as detailed in figure 41. Each one of the pillars and blocks will be detailed in the section below:

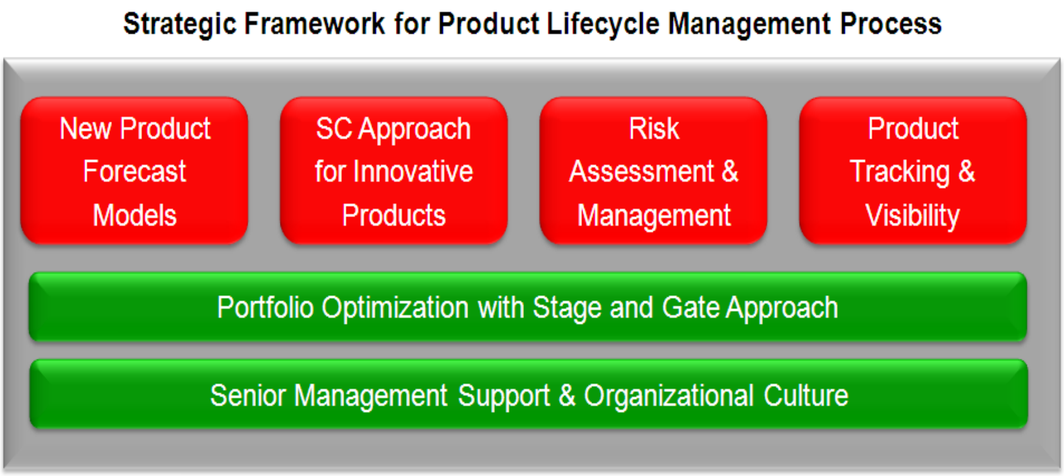

Figure 41 – Author's Proposed PLM Strategic Framework

4.5.2.1
New Product Forecast Models

New product forecast is an important capability to guarantee product availability in the early phases of introduction in the market. However, benchmarking research shows that new product forecast accuracy is only slightly above 50% on average one year after the launch.

Common issues related to new product forecasting are:

- Low accuracy (high forecast error) and high variability
- Low forecast credibility inside the organization and a lot of complaints from other areas
- Limited amount of data available for analysis or to be used in the forecast process (usually, sales data is available only for regular products)
- Slow operational process to adjust or change based on market / demand signals
- Inability to fully capture market complexity, cannibalization, market penetration rate, etc.
- Limited amount of time for analysis & forecast
- Information about new product introduction usually is not provided in appropriate time
- Operational problems usually increase forecast error (raw material availability, Out-of-Stocks in the market, inventory problems, etc.)

Kahn (2006) provides direction on how new product forecasting should be performed. He states that the first step is to establish the forecasting objective, as this will clarify the purpose and intent of the forecast so that a meaningful forecast can be made. Once the forecasting objective is established, consideration is needed regarding the forecasting level, time horizon, interval and form.

- Forecasting level refers to the focal point in the corporate hierarchy where the new product forecast applies. Common levels include the stock keeping unit (SKU) level, stock keeping unit per location (SKUL), product line, strategic business unit (SBU) level, company level, and industry level.
- Forecasting time horizon refers to the time frame for how far out one should forecast. New product forecasts may correspond to a single point in the future or a series of forecasts extending out for a length of time. Examples include a one to two year time horizon for most fashion products, two to five years for most consumer products goods, and ten-plus years for pharmaceutical products.
- Forecasting time interval refers to the granularity of the new product forecast with respect to the time bucket as well as to how often the forecast might be updated. For example, a series of forecasts can be provided on a weekly, monthly, quarterly, or annual basis.
- Forecasting form refers to the unit of measure for the forecast. Typically, early new product forecasts are provided in monetary form (e.g. U.S. dollars) and later provided in terms of unit volume for production purposes.

There are seven different types of new products, as described below:

- **New products focused on cost reductions** are products that do not have dramatic changes, but have changes that can influence consumer purchase behavior, especially when connected with implementing a new pricing policy or sustaining a cost advantage.
- **Product improvements** are product enhancements that improve the product's form or function and are often labeled as "new and improved" or "better flavor"
- **Line extensions** retain standard features of an original product (or set of products) and add unique features that the original product (or original set of products) does not have. The distinction between a product improvement and line extension is that the product improvement replaces the original product, so customers are migrated to the new product, while

in the case of a line extension both the original and new products are available for purchase.

- **New market products** are when a company takes its product to a new market where the product had not been offered.
- **New uses** are original products positioned in new markets without changing or only slightly changing the original product.
- **New category entries** are products that are new to the company, but as a category, not new to the consumer.
- **New to the world products** are technological innovations that create a completely new market that previously did not exist.

Kahn (2006) provides the Product-Market Matrix in figure 42 which organizes these seven types above into 2 dimensions (Market and Product), and states 4 different strategies:

- **Market penetration strategy** has the objective to increase market share or increase product usage. Cost reductions and product improvements are characteristic of a market penetration strategy.
- **Product development strategy** derives from an objective to capitalize on existing product technology and offer more options to the customer base. In this way, the company with a more diverse product line can fend off competitors. Line extensions are characteristically associated with a product development strategy.
- **Market development strategy** stems from a desire to expand sales volume of existing products through new markets. This would include geographic expansions, including international markets and targeting new market segments within the domestic market. New uses and new market products are characteristic of a market development strategy.
- **Diversification strategy** is pursued when the company wishes to expand its business into related businesses and unrelated businesses. A company pursuing this strategy confronts complexities associated with new customer markets and new product technologies. New categories entries and new to the world products are examples of diversification strategy.

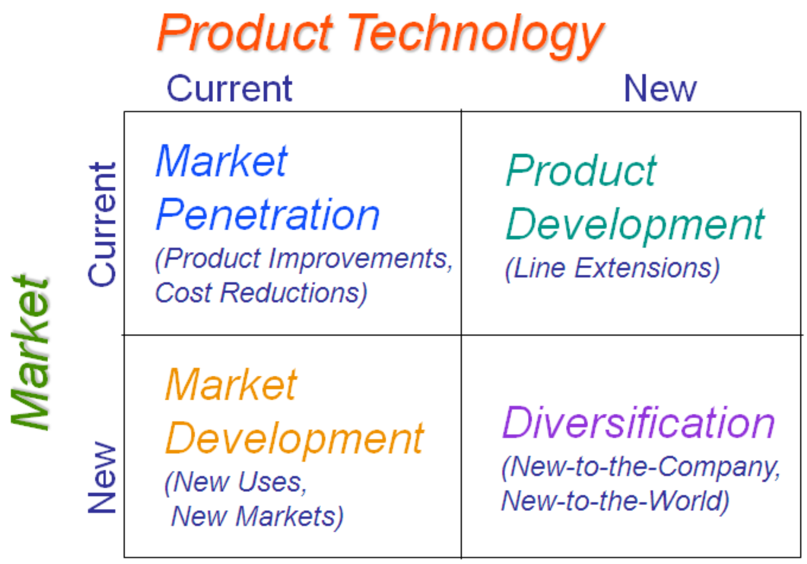

Figure 42 – Product-Market Matrix (Kahn, 2006)

There are five categories of new product forecasting techniques, as detailed below:

- **Judgment Techniques** represent those techniques that attempt to turn experience, judgment, and intuition into formal forecasts. There are 6 popular techniques within this category:
    - Jury of executive opinion: Top-down forecasting technique where the forecast is arrived at through the ad hoc combination of opinions and predictions made by informed executives and experts.
    - Sales force composite: Bottom-up forecasting technique where individuals (typically salespeople) provide their forecasts. These forecasts are then aggregated to calculate a higher level forecast.
    - Scenario analysis: Analysis involving the development of scenarios to predict the future. Two types of scenario analysis could be used – Exploratory which starts in the present and moves out to the future based on current trends, and Normative which leaps out to the future and works back to determine what should be done to achieve what is expected to occur.
    - Delphi method: Technique based on subjective expert opinion gathered through several structured anonymous rounds of data collection. The objective is to capture the advantages of multiple experts in a committee, while minimizing the effects of social

pressures to agree with the majority, ego pressure, and influence of a dominant individual.

- Decision tree: Probabilistic approach to forecasting where various contingencies and their associated probability of occurring are determined.
- Assumptions based modeling: Technique that attempts to model the behavior of the relevant market environment by breaking the market down into market drivers, and then by assuming values for these drivers, forecasts are generated.

- **Customer / Market Research Techniques** include those approaches that collect data on the customer / market and then systematically analyze these data to draw inferences on which to make forecasts. Four general classes of techniques are available:
  - Concept testing: Process by which customers (current and potential ones) evaluate a new product concept and give their opinions on whether the concept is something that they might have an interest in and would be likely to buy. The purpose of concept testing is to proof the new product concept.
  - Product use testing: Process by which customers (current and potential ones) evaluate a product's functional characteristics and performance. The purpose of product use testing is to proof the product's functionality.
  - Market testing: Process by which targeted customers evaluate the marketing plan for a new product in a market setting. The purpose of market testing is to proof the proposed marketing plan and the "final" new product.
  - Premarket testing: Procedure that uses syndicated data and primary consumer research to estimate the sales potential of new product initiatives.
- **Time Series Techniques** analyze sales data to detect historical sales patterns and construct a representative graph or formula to project sales into the future. Time series techniques used in association with new product forecasting include:
  - Trend analysis: A line is fit to a set of data. This is done either graphically or mathematically based on the actual demand as it occurs.

- Moving average: Technique that averages only a specified number of previous sales periods.
- Looks-like analysis: Technique that attempts to map sales of other products onto the product being forecast. Looks-like analysis is a popular technique applied to line extensions by using sales of previous product line introductions to profile sales of the new product.
- Autoregressive Moving Average (ARMA) / Autoregressive Integrated Moving Average (ARIMA) models: A set of advanced statistical approaches to forecasting that incorporate key elements of both time series and regression model building. Three basic activities (or stages) are considered: 1) identifying the model, 2) determining the model's parameters, 3) testing / applying the model.

* **Regression Analysis Techniques** use exogenous or independent variables, and through statistical methods, develop formula correlating these with a dependent variable. Four popular techniques are used:
  - Linear Regression: Statistical methodology that assesses the relation between one or more managerial variables and a dependent variable (sales), strictly assuming that these relationships are linear in nature.
  - Event modeling: Linea regression-based methodology that assesses the relation between one or more events, whether company-initiated or nonaffiliated with the company, and a dependent variable (sales).
  - Nonlinear regression: Statistical methodology that assesses the relation between one or more managerial variables and a dependent variable (sales), but these relationships are not necessarily assumed to be linear in nature.
  - Logistic regression: Statistical methodology that assesses the relation between one or more managerial variables and a binary outcome, such as purchase versus non purchase. A logistic regression model calculates the probability of an event occurring or nor occurring.
* **Other quantitative techniques** proposed by Kahn (2006) include those techniques that employ unique methodologies or represent a hybrid of

time series and regression techniques. Examples of these forecasting techniques are:

- Expert systems: Typically computer-based heuristics or rules for forecasting. These rules are determined by interviewing forecasting experts and then constructing “if-then” statements.
- Simulation: Approach to incorporate market forces into a decision model. A typical simulation model is Monte Carlo simulation, which employs randomly generated events to drive the model and assess outcomes.

4.5.2.2
Supply Chain Approach for Innovative Products

Fisher (1997) proposes a framework to define what is the best supply chain strategy for a company’s product. He argues that the first step in devising an effective supply chain strategy is to consider the nature of the demand for the products. In this case, many aspects are important, for example, product lifecycle, demand predictability, product variety, market standards for lead times and service (the percentage of demand filled from instock goods). He suggests classifying products into “functional” or “innovative”, in order to ensure a perfect match between the type of the product and the type of supply chain. Below is a summary describing the characteristics of Functional and Innovative Products:

Functional Products:

- Product do not change much over time;
- Have stable and predictable demand;
- Long life cycles;
- Lower potential growth.

Innovative Products:

- Great variety of products;
- Increase unpredictability (volatile demand);
- Short life cycles;
- Higher potential growth.

The next step is to decide whether the company’s supply chain should be “**Physically Efficient**” or “**Responsive to the Market**”, as described in the table 16:

Table 16 – Physically Efficient vs. Market Responsive Supply Chains (Fisher, 1997)

	Physically Efficient Process	**Market Responsive Process**
Primary purpose	Supply predictable demand efficiently at the lowest possible cost	Respond quickly to unpredictable demand in order to minimize stock outs and obsolete inventory
Manufacturing focus	Maintain high average utilization rate (reduce setups)	Deploy excess buffer capacity
Inventory strategy	Generate high turns and minimize inventory throughout the chain	Deploy significant buffer stocks or end products in the chain
Lead time focus	Shorten lead time as long as it does not increase cost	Invest aggressively in ways to reduce lead time
Approach to choosing suppliers	Select primarily for cost and quality criteria	Select primarily for speed, flexibility, and quality
Product-design strategy	Maximize performance and minimize cost	Try to postpone product differentiation for as long as possible in the supply chain

After determining the nature of the product demand (e.g. functional and innovative products) and the supply chain priorities (e.g. responsive or efficient), managers can employ a matrix to formulate the ideal supply chain strategy. Fisher proposes to plot the nature of the demand for each of the product families and its supply chain priorities, as illustrated in figure 43, in order to allow identify whether the process used for supplying products is well matched to the product type, which means, an efficient process for functional products and a responsive process for innovative products.

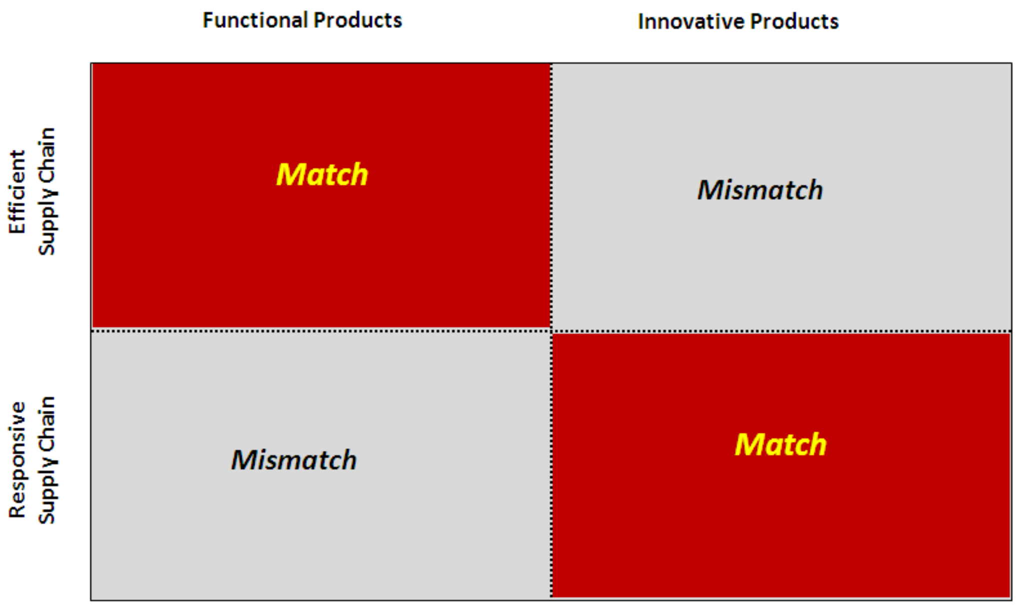

Figure 43 – Fisher (1997) Approach for Matching Supply Chains with Products

When thinking about innovative products, uncertainty about demand is intrinsic to this type of products and should be accept by companies. Once a company has accepted the uncertainty of demand, it can employ three coordinated strategies to manage that uncertainty:

- First, company can continue to strive to reduce uncertainty by, for example, finding sources of new data that can serve as leading indicators or by having different products share common components as much as possible, so that, the demand for components becomes more predictable.
- Second, company can avoid uncertainty by cutting lead times and increasing the supply chains' flexibility so that it can product to order or at least manufacture the product at a time closer to when demand materializes and can be accurately forecast.
- Third, once uncertainty has been reduced or avoided as much as possible, it can hedge against the remaining residual uncertainty with buffers of inventory or excess capacity.

Lee (2002) expanded the framework developed by Fisher (1997) and introduced the concept of supply uncertainty. He argues that uncertainties around the supply side of the product are equally important drivers for the right supply chain strategy.

A stable supply process is one where the manufacturing process and the underlying technology are mature and the supply base is well established. On the other hand, an "evolving" supply process is where the manufacturing process and the underlying technology are still under early development and are rapidly changing, and as a result, the supply base may be limited in both size and experience.

In a stable supply process, manufacturing complexity tends to be low or manageable. Stable manufacturing processes tend to be highly automated, and long-term supply contracts are prevalent. In an evolving supply process, the manufacturing process requires a lot of fine-tuning and is often subject to breakdowns and uncertain yields. The supply base may not be as reliable, as the suppliers themselves are going through process innovations.

The figure 44 provides some examples of products that have different demand and supply uncertainties. Lee's advocates that it is more challenging to operate a supply chain that is in the right column of the figure below than in the left column, and similarly, it is more challenging to operate a supply chain that is in the lower row of the figure below than in the upper row. He argues that before setting up a supply chain strategy, it is necessary to understand the sources of the underlying uncertainties and explore ways to reduce these uncertainties.

	Demand Uncertainty	
Supply Uncertainty	Low (Functional Products)	High (Innovative Products)
Low (Stable Process)	Grocery, basic apparel, food, oil and gas	Fashion apparel, computers, pop music
High (Evolving Process)	Hydro-electric power, some food produce	Telecom, high-end computers, semiconductor

Figure 44 – Examples of Products with Demand and Supply Uncertainty (Lee, 2002)

Lee (2002) suggests strategies to reduce demand and supply uncertainties, as detailed below:

- **Demand uncertainty**:
  Information sharing and tight coordination can allow companies to regain control of supply chain efficiency. Sharing of demand information and synchronized planning across the supply chain are crucial for this objective.
- **Supply uncertainty**:
  Free exchanges of information - starting with the product development stage and continuing with the mature and end-of-life phases of the

product life cycle – have been found to be highly effective in reducing the risks of supplier failure.

Sharing product rollover plans with suppliers is a key way to manage the risks of product transitions. Another way to reduce supply uncertainty downstream is to collaborate in the early phases of product design.

4.5.2.3
Risk Assessment & Management

Kahn (2005) states that a well planned and executed risk assessment and analysis should be part of any significant product development project. Risk assessment and analysis serve as the project manager's binoculars to see into the future. By spending time and money early to examine what might go wrong and how it might happen, managers can make effective plans to avoid those problems and / or minimize their impact, while staying on schedule and budget for the launch. He also states that project manager should apply a robust risk analysis approach to identify general potential problems in the early phase of the new product development, and later, in the development process, should use Failure Mode and Effects Analysis (FMEA), in order to have a more detailed view of each part of the design and ensure that it is aligned with the plan.

The author developed and proposes to apply the risk assessment detailed below as part of the analysis in the early phases of new product launch:

- Consider 10 standard risk factors to be evaluated by project manager. These factors were identified based on the author's experience and should include Level of innovation, product coverage in the market, forecast complexity, time to market, product shelf life, manufacturing complexity, raw material characteristics, storage and operational requirements, distribution complexity, expected profitability, etc. (detail description of each factor is available in table 17)
- Use a pre-defined scale to weight each risk factor. A weight of 5 means a high risk, a 3 means medium risk, and a 1 means a low risk
- For each risk factor, there is a pre-defined functional area inside the company that will be responsible to give the score for the factor in one particular project.
- Maximum score is calculated as the Σ (Highest score for each factor x Weight for each factor)

- Final risk score for a specific new product launch is calculated as the Sum of the weighted scores for each factor / Maximum score
- Based on risk assessment results, identify the level of risk for the project as defined below:
  - Less than 50% - Launch with LOW risk
  - Between 50% and 70% - Launch with MEDIUM risk
  - Greater than 70% - Launch with HIGH risk
- Project team should identify the areas with more critical potential risks and develop mitigating actions to reduce exposure.
- Apply Failure Mode and Effects Analysis (FMEA) technique for each project with high risk during the project development. FMEA is a 6-Sigma technique that can be applied to new product development and will allow the project team to systematically examine each important aspect of the product launch to identify, prioritize and set mitigation strategies for potential gaps / weaknesses in the new product introduction, avoiding potential future problems.

Table 17 – Author's Proposed List of Risk Factors

Risk ID	Risk Factor	Responsible	Standard Score	Definition
1	Level of Innovation	Marketing	3	Complete new product for a new market / channel
			2	New product for an existing market or Product for a new market
			1	Product extension or improvement
2	Product Coverage in the market	Marketing	3	Product is planned to cover all channels in the market
			2	Product is planned to cover a few channels in the market
			1	Product is planned to cover few customers
3	Time to Market	Marketing	3	Information about launch is available less than 20 days to launch the product in the market
			2	Information about launch is available less than 60 days to launch the product in the market
			1	Information about launch is available less than 120 days to launch the product in the market
4	Forecast Complexity	Sales	3	Forecast requires to use more advanced models (conjoint, multiple regressions, ATAR, etc)
			2	Similar products were already launched and we can use their historical information to forecast (Looks like, Curve Fitting, etc.)
			1	Some sales data is available to forecast with basic models (moving average, exponential smoothing, etc.)
5	End Product Shelf Life	Quality	3	Shelf life <= 60 days
			2	Shelf life between 60 and 120 days
			1	Shelf life greater than 120 days
6	Manufacturing Complexity	Manufacturing	3	Product is produced external in a Copacker or in a facility from another Bottler
			2	Product is produced internally in the franchise
			1	Product is produced in most of the sites of the franchise
7	Unique Raw Materials (top 5)	Manufacturing	3	Product with unique ingredients
			2	Ingredients are used by some other products in equal or major volume
			1	Ingredients are common with several other formulations in equal or greater volumes
8	Storage and Operational Requirements	Logistics	3	Product requires specific storage, handling and / or picking requirements
			2	Product requires only specific storage requirements (e.g. racks)
			1	Product does not require any specific operational requirement
9	Distribution Complexity	Logistics	3	Product requires special storage characteristics inside the truck and special handling attention during the delivery process
			2	Product requires special handling attention during the delivery process
			1	Product does not require any specific requirement during delivery
10	Expected Profitability	Finance	3	Expected profitability is higher than average
			2	Expected profitability is equal to company average
			1	Expected profitability is slightly lower than average

4.5.2.4
Product Tracking & Visibility

One of the key characteristics of demand driven supply chains is the ability to read and sense the demand, and have an agile supply network capable of reacting very fast to fulfill market demand. In order to achieve this desired state, it is critical to establish processes and implement tools that will allow having visibility of demand levels in the market and also tracking product performance in the market to compare planed vs. actual performance in different dimensions.
Based on the author's experience, it is suggested to consider the following examples of tracking:

- Total volume evolution
- Volume mix by market channel
- Repeat purchase frequency evolution
- Repeat purchase frequency by market channel
- Price compliance

When moving to a more mature demand driven state, companies can benefit from tools like CPFR, VMI, Inventory visibility, which provide actual demand and inventory information between customers and the company increasing agility and flexibility to adjust production and distribution based on real demand signals.

4.5.2.5
Portfolio Optimization with Stage & Gate Approach

Portfolio optimization is an analytical process used to determine the merits of adding, retaining, or deleting items from the product portfolio of a business. It can be summarized as a way to make sure that a company does not keep what they don't need. Portfolio optimization is important as all SKUs become liabilities to an organization at some point in their lifecycles. The key is to establish repeatable processes to identify when that point is reached and execute plans to capture as much revenue and profit as possible, before discontinuing each item. The aim is to separate underperforming SKUs from those that contribute significantly to the business results.
Portfolio optimization is used in the following situations:

- To make room for Innovation: Convince company's customers to add new products to the category and find a place for a new item on the crowded shelf in their stores.
- To increase competitiveness: Straggling competitive SKUs can take up space and bring down the profitability and productivity of the entire category, lowering the category's utility in the minds of buyers and putting the entire category's space allocation at risk.

  A proactive portfolio optimization exercise not only introduces the opportunity to eliminate competitive items, but also can enhance the overall vitality of the category.
- To correct out of stock issues: Large size and high volume items can suffer from out-of-stock issues which lower potential sales. Portfolio optimization is critical to free up space for the items going out-of-stock. The high velocity items will benefit through increased profitability due to customers not being forced to go to other locations to find the high demand item.

Kahn (2005) states that a systematic new product framework such as a Stage – Gate™ process is the solution that many companies have turned to in order to overcome the deficiencies that plague their new product programs. Stage – Gate™ frameworks are simply roadmaps for driving new products from idea to launch successfully and efficiently. He argues that about 68 percent of U.S. product developers have adopted Stage – Gate™ frameworks, according to the 1997 PDMA best practice study. The 2003 APQC benchmarking study reveals that 73% of businesses employ such a framework and identified a stage-and-gate process as the strongest best practice, employed by almost every best performing business.

Follow below a typical 5 stage-gate process:

- **Stage 1 – Scoping**: A quick investigation and sculpting of the project. This first and inexpensive homework stage has the objective of determining the project's technical and marketplace merits. Stage 1 involves desk research or detective work – little or no primary research is done here. Prescribed activities include preliminary market, technical assessment, and business assessment.
- **Stage 2 – Build the business case**: The detailed homework and upfront investigation work. This second homework stage includes actions, such as a detailed market analysis, user needs and wants studies to build

"voice of the customer", competitive benchmarking, concept testing, detailed technical assessment, source of supply assessment, and a detailed financial and business analysis. The result is a **business case** – a defined product, a business justification, and a detailed plan of action for the next stages.

- **Stage 3 – Development**: The actual design and development of the new product. Stage 3 witnesses the implementation of the development plan and the physical development of the product. Lab tests, in-house tests, or alpha tests ensure that the product meets requirements under controlled conditions. The "deliverable" at the end of stage 3 is a prototype product that has been lab tested and partially tested with the customer.
- **Stage 4 – Testing & validation**: The verification and validation of the proposed new product, its marketing and production. This stage tests and validates the entire viability of the project: the product itself via customer tests, beta tests, or field trials; the production process via trial or limited production runs; customer acceptance by way of a test market or a trial sell. Also, the financial justification required prior to full launch is obtained.
- **Stage 5 – Launch**: Full commercialization of the product – the beginning of full production and commercial launch and selling. The post-launch plan – monitoring and fixing – is implemented, along with early elements of the life-cycle plan (new variants and releases, continuous improvements).

12 – 18 months after the launch, the post launch review occurs. The performance of the project versus expectations is assessed, along with reasons why events occurred and what lessons were learned. The team is disbanded and recognized and the project team is terminated

Preceding each stage is a gate. These are the quality control checkpoint in the process, opening the door for the project to proceed to the next stage. Here, the project team meets with senior management, the gatekeepers, seeking approval and resources for their project. Each "go/kill" specifies deliverables (what the project team must deliver for that gate review), criteria for a go decision (for example, a scorecard as outlined above, upon which the "go/ill" and prioritization decisions are based), and outputs (an action plan for the next stage, and resources approved).

Two types of gates are possible:

- The first type of gate is called a *rigid gate* where all necessary criteria must be passed in order to continue the project. Indeed, it is possible in the case of a rigid gate that the failure to reach even a single threshold could derail a new project.

- The second type of gate is called a *flexible or permeable gate*, which allows a limited number of tasks, frequently those with long lead times, to move forward to the next stage without having to pass all criteria.

Kahn (2005) presents the top 6 gate criteria used by gate, as detailed in the table 18 (numbers represent the percentage of firms in sample reporting to use each criterion):

Table 18 – Kahn (2005) Criteria used by Gate

Gate 1	**Gate 2**	**Gate 3**
Market potential (86%)	Technical Feasibility (85%)	Product Performance (86%)
Strategic Fit (85%)	Sales Objectives (81%)	Sales Objectives (79%)
Technical Feasibility (84%)	Product Performance (79%)	Quality Objectives (78%)
Sales Objectives (81%)	Product Advantage (77%)	Profit Potential (75%)
Product Advantage (79%)	Strategic Fit (76%)	Customer Acceptance (73%)
Profit Potential (71%)	ROI (73%)	Product Advantage (72%)

Benefits of a Stage-Gate™ Approach:

- Puts discipline into a somewhat ad-hoc, chaotic process
- A visible process - known & understood by all stakeholders inside the operation
- A roadmap for the Project Leader - defines his/her duties and deliverables
- Forces more attention to quality of execution - the Gates become quality control check points for product launch / retire
- Makes for a complete process - no critical errors of omission; no missing steps

- Multifunctional - inputs from all sides involved in the launching / retiring processes
- A faster process via parallel processing

Practical lessons to improve gate decisions based on author's experience:

- Gatekeeper team should consist of a different set of individuals than those actually conducting the product launch/retirement. (Individuals that spend months or years working on a project tend to get emotionally attached to it, making it difficult to view progress objectively.
- Have clearly defined criteria (marketing, supply chain, commercial and financial) that must be met both overall and at each stage.
- Communicate Gate decisions to the entire organization to increase awareness and commitment. (Have a standard "meeting notes" format to document all decisions).
- Have project continuation / termination decisions made by a cross-functional team rather than one person. Team generally makes better decisions than individuals acting alone.
- More innovative new products should require a higher level of tracking and monitoring (e.g. more stringent criteria, consider adding extra review points, etc.)

4.5.2.6
Senior Management Support & Organizational Culture

APQC (2004) performed a benchmark study to identify best practices in new product development with 105 companies from different industries and business segments, and one of the key findings were the importance of senior management support and commitment to develop a innovative culture inside the organization (79% of best performers have this practices implemented in their organizations), and also 65% provide strong support and empowerment to the team members, as detailed in the figure 45:

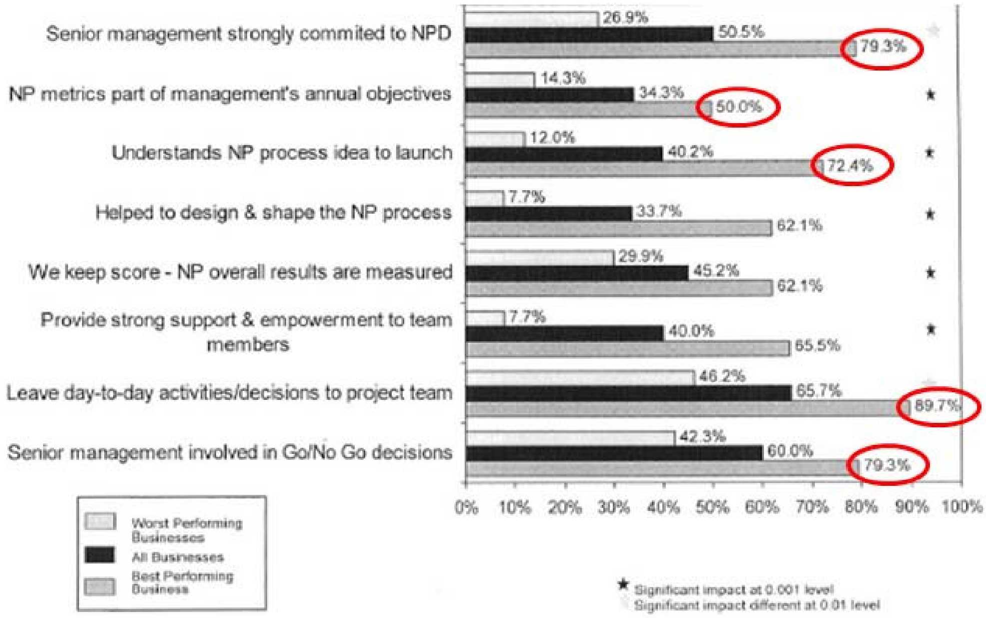

Figure 45 – APQC (2004) study shows the percentage of businesses where senior management demonstrates commitment to new product development

Another finding from the benchmark study is that an innovative climate inside the organization is seen as one of the most important drivers of successful product development. 12 elements were identified and split into two main factors or themes – the first is the general climate and the second centers on specific actions and programs to promote a positive climate. The graphics in figures 46 and 47 present each one of the elements:

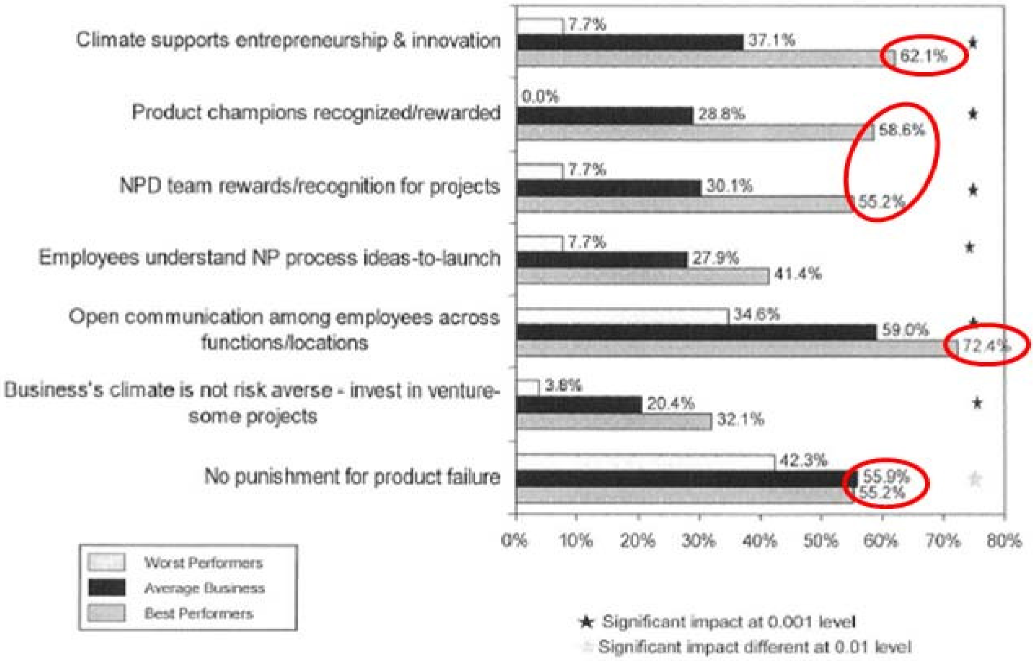

Figure 46 – APQC (2004) study shows the percentage of businesses that have each element of a positive climate for innovation

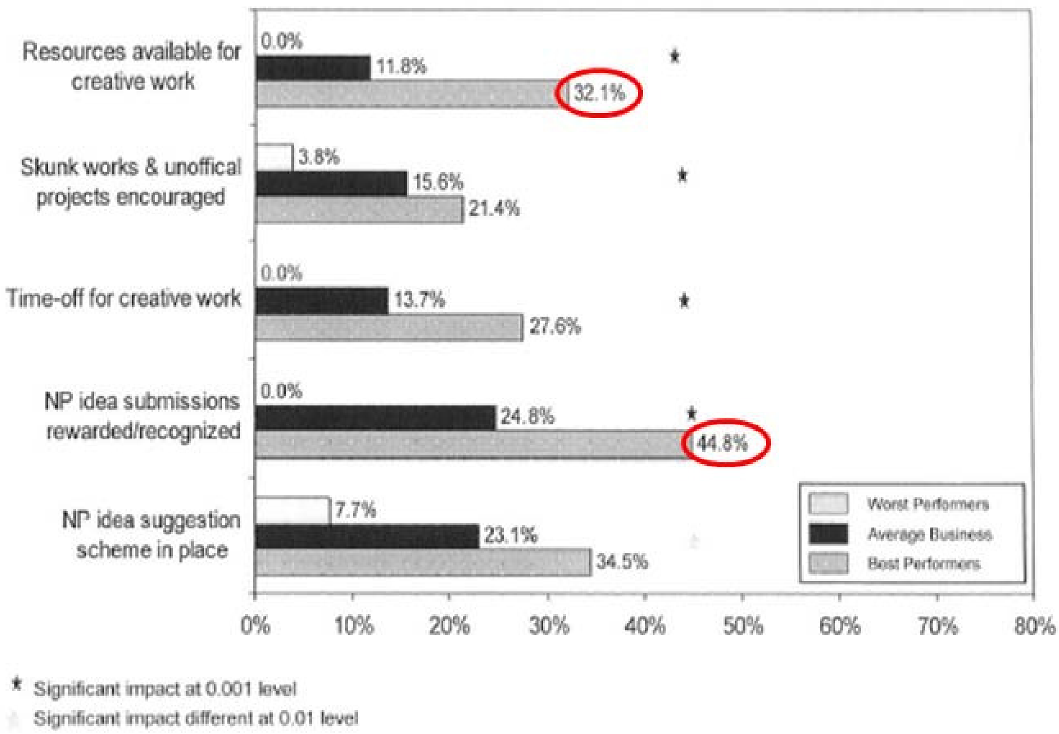

Figure 47 – APQC (2004) study shows the percentage of businesses with specific actions and programs to promote positive climate for innovation

Key points for senior management attention based on author's experience:

- Provide proper direction and leadership: Senior management should foster a climate of open communication, high motivation, involvement with the project launch or retirement, and willingness from each functional area to cooperate with the project team.
- Foster an innovative culture: To really succeed with new products, senior management should align annual objectives, rewards and recognitions programs and performance management in a way that motivates and align the whole organization towards proposing and implementing innovative ideas, services and products.
- Create a culture of "don't be Afraid to try": It is very important that all employees feel that they will not be punished if they try solutions "out of the box" to help the organization increase sales volume and profitability.
- Have clear metrics to support decision making: Establish a PLM dashboard to track performance of both new product introduction and product retirement aligned with business plan goals.