İSTANBUL TECHNICAL UNIVERSITY ★ INSTITUTE OF SCIENCE AND TECHNOLOGY

EFFECTS OF INFORMATION TECHNOLOGIES ON MANAGEMENT OF SUPPLY CHAIN

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BILGI TEKNOLOJILERININ TEDARIK ZINCIRI YONETIMI UZERINDEKI ETKILERI

YUKSEK LISANS TEZİ

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PREFACE

Having understood the importance of the management of Supply Chain in today's global world and being involved in the management of information for supply chain business of Colgate -Palmolive Europe; I have prepared this research paper which describes supply chain and the effects of information technologies on its management.

I would like to give my special thanks to Dr. Halefsan Sumen who gave me the opportunity to work on this subject and guided in preparation of this research paper. I also would like to thank all my colleagues in Colgate-Palmolive who have supported and shared their knowledge with me. Finally, I would like to thank my family and Cenk Kuzucu who have always motivated and supported me in preparation of this thesis.

Ebru COSKUN

May 2002

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LIST OF ACRONMIES

AATP	:Allocated Available-To-Promise
APS	:Advanced Planning and Scheduling
ATP	:Available-To-Promise
CRM	:Customer Relationship Management
EDI	:Electronic Data Interchange
ERP	:Enterprise Resource Planning
MRP	:Materials Resource Planning
OPP	:Order Penetration Points
SCE	:Supply Chain Execution
SCM	:Supply Chain Management
VOF	:Value Offering Point

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BİLGİ TEKNOLOJİLERİNİN TEDARİK ZİNCİRİNİN YÖNETİMİNDEKİ ETKİLERİ

ÖZET

Tedarik Zinciri; ürünlerin hammaddeden son kullanıcıya ulaşana kadarki değişimi sırasındaki hammadde akışını ve bunun yanısıra bilgi akışını içeren aktiviteler bütünüdür. Tedarik zinciri yönetimi ise bu aktivitelerin, rekabetçi avantaj elde edebilmek amacıyla birleştirilmesi, entegre edilmesidir. (Handfield ve Nichols, 1999)

Entegre bir tedarik zinciri yönetimi oluşturabilmek icin, katılımcı tarafların kendi bilgilerini diğer taraflarla paylaşmaya ve diğerlerinin bilgilerini de işlemeye istekli olmaları gerekmektedir. Bilgiyi paylaşmak ancak, işe ait gerekli verileri sunabilen (ERP sistemleri gibi); üretim, dağıtım ve taşıma optimizasyonu saglamak amaciyla diğer tarafların verilerini işleyerek planlar, listeler ve taşıma programları yaratabilen doğru bilgi sistemleriyle mümkündür. Doğru araçlarin ve doğru optimizasyon metodlarının kullanılması hayati önem taşımaktadır aksi halde tedarik zinciri yönetiminden beklenen faydaları sağlamak asla mümkün olmayacaktır.

Öyleyse tedarik zincirini dogru yönetmenin avantajları nelerdir? İyi yonetilen bir tedarik zincirinin faydalarını kısaca şöyle sıralayabiliriz:

- Tedarik zincirine ait bilgilere gerçek zamanlı ulaşım imkanı şirketlerin sipariş karşılama fırsatlarını arttırmaktadır.
- Tedarik zinciri taraflarının bir ağ boyunca entegrasyonunun saglanması, envanterin bilgiyle yer değiştirmesine sebep olur ki bu da daha düşük envanter düzeylerine ulaşılmasını sağlar ve karlılıgı arttırır.
- Gelişmiş müşteri servisi ve büyüyen pazar paylarının kazanılmasını sağlar.

THE EFFECTS OF INFORMATION TECHNOLOGIES ON THE MANAGEMENT OF SUPPLY CHAIN

SUMMARY

The supply chain encompasses all the activities associated with the flow and the transformation of goods from the raw materials stage, through to the end users, as well as the associated information flows. Supply chain management is the integration of these activities through improved supply chain relationships, to achieve a sustainable competitive advantage (Handfield and Nichols, 1999)

To be able to create an integrated supply chain among partners, partners need to be willing to share their information and process others' information. Sharing of information technologies is only possible with the right information systems which provides the required business data (such as ERP systems) and the systems which processes (calculates) the data if the partners' to produce plan and schedules for optimizing production, distribution and transportation. It is vital that the right tools and the right optimization models are used.

So, what are the advantages of managing the supply chain correctly? Briefly, we can list the advantages of a well-managed supply chain as:

- Real-time visibility across the supply chain which enables the businesses to take advantage of order fill opportunities.
- Integration with supply chain partners across the network substitutes inventory with information, which results in lower inventories across the chain.
- Improved customer service and enhanced market share

1. INTRODUCTION

Supply Chain Management is the concept known as the management of the materials and the information across all the partners within an industry including customers' customers and suppliers' suppliers.

Supply Chain Management introduces the initiatives for competitive advantages to companies and it reinforces the use of technology for more accurate and faster communication among supply chain partners.

The 70 's have often been viewed as the decade of quality improvement, during which companies began to invest heavily in quality improvements, and Total Quality Management. In the 80's, with quality a given, the competitive landscape shifted to lean manufacturing, focusing on concepts such as just-in-time, flexible manufacturing, and zero inventory, in order to achieve manufacturing excellence. In the 90's, market globalization, shortening product life cycles, and the disintegration of many industries created the race to improve the supply chain.

In the last decade, industry after industry has embarked on aggressive initiatives to improve the operational efficiencies of their supply chains. Industry-wide efforts began with Efficient Consumer Response for the grocery industry and spread to other sectors such as food service, pharmaceutical, semiconductor, computer and electronics, telecommunications, and automobile. Companies investing in supply chain efforts have found significant improvements in inventory, customer service, response times, and operational costs. To support this, tremendous growth of supply chain management (SCM) technology solutions have been seen.

What will be the next competitive battleground in the 21st century? It will be managing to demand for the total value maximization of the enterprise and the supply chains. Managing to demand involves carefully selecting marketing instruments and working closely with customers so that the overall incoming demand for the enterprise and the supply chain will give rise to maximum values for all parties concerned. Ideally, all these instruments will eventually lead to higher consumer satisfaction. While supply chain management deals with the buy-side of the enterprise, demand based management addresses the sell-side of the enterprise.

The purpose of this research is to introduce the supply chain management concept and initiatives; and point the information technologies used in this area to achieve the expected benefits from the management of a supply chain. It emphasizes how information technologies effect supply chain management and how can it be used to manage the supply chain more effectively.

In this piece of work, the basics of Supply chain management and the initiatives of the supply chain management are being described. The effects of information technologies, as the inevitable backbone of the supply chain management, have been explained in detail.

Information technologies are no longer considered as “nice to have” instead it is believed that it is a “must”. Whoever uses the information technologies effectively in managing his business will have more chance to succeed in today’s world. Capturing the necessary data is one part of the race but filtering and changing the data into information effectively is the most important concept. Companies produce vast amounts of data everyday but they require advance tools to manipulate the data to reach the informative data which helps to manage their business. This research explains information technologies used in a supply chain which computing methods are used in optimizing the supply chain.

A Supply Chain holds very valuable information within the chain, which might be useful for the partners involved and information technologies allows partners to share this information to manage their relationships and introduces new concepts such as “vendor managed inventory” etc…This VMI concept is introduced and its benefits to supply chain management is discussed.

In the execution section of this work, one of the major FMCG (Fast moving consumer goods) manufacturer and its SCM implementations are explained in addition to the information flow design being used for specific implementations such as “Vendor Managed Inventory” and “Supplier Managed Inventory”.

2. BASICS OF SUPPLY CHAIN MANAGEMENT

2.1 Evolution Of Supply Chain Management

There are four main stages in the evolution of Supply Chain Management in (Hausman, 2001):

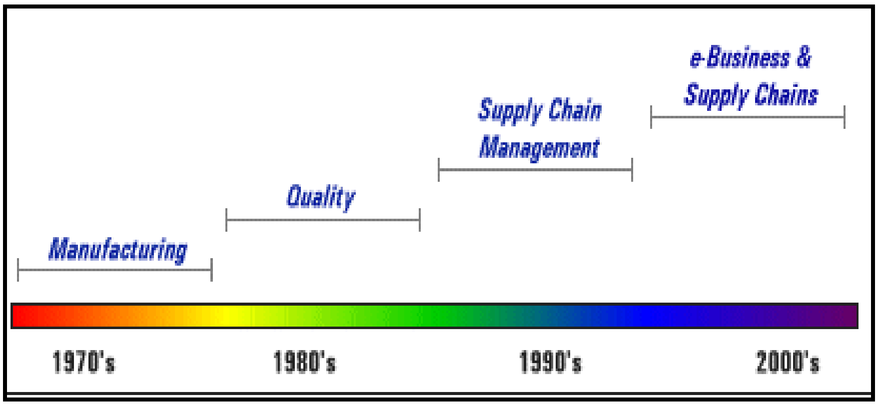


Figure 2.1 Business Initiative Trends in Manufacturing

Source: Executive Seminar Series, Stanford University, Introduction To Supply Chain Management, pg 13.

The stage, which is known as the first stage, is between years 1960 – 1975. The results of Industry revolution like process manufacturing affected this period and meanwhile the total quality had been applied in Japan under W. Edwards Deming's leadership. This period was known as the push era that focused on the physical distribution of finished goods. In addition, the management of the raw materials was totally separated from the manufacturing process. Production was balanced with reference to costumer requirements.

Second stage includes the years 1975 – 1990. In order to decrease the cost of production, the cost of inventory and the management of the vitality in costumer demand; Just-in-Time Manufacturing philosophy in Japan, gained importance. With the noticeable change in marketing techniques, customer requirements have now became the target. And a move from the push era into the pull era has started. Total quality applications started to gain importance in USA while the business leaders begin to recognize the importance of concept “Enterprise”. Computers are now used in material and information management.

Third stage starts with the late 80’s and ends in late 90’s. Companies realized that significant productivity increases could only come from managing relationships; information and material flow across enterprise borders. This resulted in the concept of supply chain management. Realizing that the inefficiencies in Supply chain caused inefficiencies in company’s actives, suppliers started to manage their operations by integrating every single component in the supply chain to achieve a competitive advantage in supplying the customers’ demands and to have a better position in company’s actives.

Fourth and the latest stage of this evolution starts with the late 90’s and reaches to today’s world. Internet gains importance and the establishment of digital markets serves new opportunities to the business world. Now the only way of taking the advantage of these opportunities is to operate the supply chain management effectively. During the following decade, it is going to be a matter of competition between supply chains. Moreover, the one who achieves to manage the supply chain will be the winner.

To be able to achieve a competitive advantage, companies have to establish the integration from suppliers’ supplier up to customers’ customer. In this stage the following concepts starts to gain importance (Ramdas and Spekman, 2000):

- Constraint Based Planning
- Efficient Consumer Response
- Time Based Manufacturing
- Collaborative Planning Forecasting and Replenishment
- Shared Services
- Flexible Manufacturing
- Just in Time Manufacturing
- Reverse Logistics
- Quick Response
- Category management

- Synchronization Management
- Theory of Constraints
- 3rd Party Logistics
- Change Based Strategy
- Channel Integration
- Value Chain
- Distribution Resource Planning
- Supplier Managed Inventory
- Vendor Managed Inventory
- Agile Manufacturing
- Flow replenishment/Fluid Distribution
- Flexible Distribution
- Channel Management

2.2 What Is Supply Chain Management?

2.2.1 Definition Of Supply Chain Management

Since its inception about 10 years ago, the field of supply chain management has become tremendously important to companies in an increasingly competitive global marketplace.

The term *supply chain* refers to the entire network of companies that work together to design, produce, deliver, and service products (Hausman, 2001).

A *supply chain* is the process of moving goods from the customer order through the raw materials stage, supply, production, and distribution of products to the customer. All organizations have supply chains of varying degrees, depending upon the size of the organization and the type of product manufactured. These networks obtain supplies and components, change these materials into finished products and then distribute them to the customer. Managing the chain of events in this process is what is known as supply chain management. (Ligus, 1999)

MIT's definition is, integrated supply chain management is a process-orientated, integrated approach to procuring, producing, and delivering products and services to customers. ISCM has a broad scope that includes sub-suppliers, suppliers, internal operations, trade customers, retail customers, and end users. It covers the management of material, information, and funds flows. (Metz, 1998)

A *supply chain* is a network of facilities and distribution options that performs the functions of procurement of materials, transformation of these materials into intermediate and finished products, and the distribution of these finished products to customers. Supply chains exist in both service and manufacturing organizations, although the complexity of the chain may vary greatly from industry to industry and firm to firm (Harrison and Ganeshan).

Supply chain, is a group of workflows and activities like procurement of the raw materials, warehousing, production, distribution and consumption of the goods by the customer; which enables the companies to interpret the customer demand in a most effective and accurate way (Chopra and Meindl, 2001).

Finally "Supply Chain" is a network of facilities including:

- Material flow from suppliers and their “upstream” suppliers at all levels,
- Transformation of materials into semi-finished and finished products, and
- Distribution of products to customers and their “downstream” customers at all levels.

Here is an example dealing with a computer printer

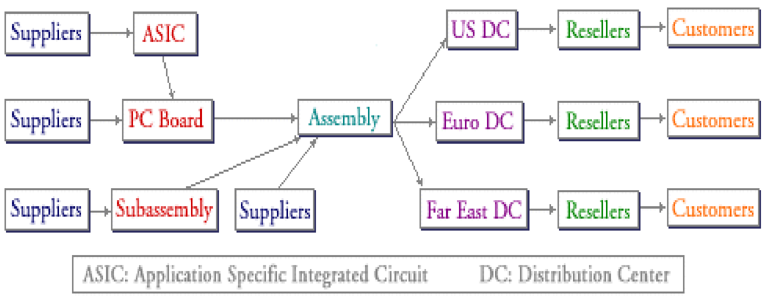


Figure 2.2 Supply Chain Map of a Manufacturer

Depending on the situation, the supply chain may include major product elements, various suppliers geographically dispersed activities, and both upstream and downstream activities.

There is more to supply chain management than just material flows; information flows and financial flows. Many supply chain improvements actually substitute information for inventory. As information is considerably cheaper than inventory, there are important gains to be made. Financial flows are critical because most companies measure their supply chain performance with metrics that involve Accounts Payable and Accounts Receivable- using the wrong metrics can adversely affect supply chain initiatives.

2.2.2 Supply Chain Management Challenges

Challenges to effective supply chain management often include the following

- Complex supply chain network (Example: wide array of suppliers)
- Complex product structure of building process (Example: product can be differentiated or “localized” either in the factory or in the field)
- Decentralized control/organizational “silos” (Example: inability of functional teams to work toward common supply chain initiatives)

- Increasing pressure of customer service
- Multiple sources of uncertainties (Example: demand supply and process uncertainties)

Variability and uncertainty are the most significant threats to a well-optimized supply chain network. There are three sources of variability in supply chains.

1. Demand Variability
2. Process variability
3. Supply variability

For many companies the breakdown of these three sources is as follows (**Hausman, 2001)** :

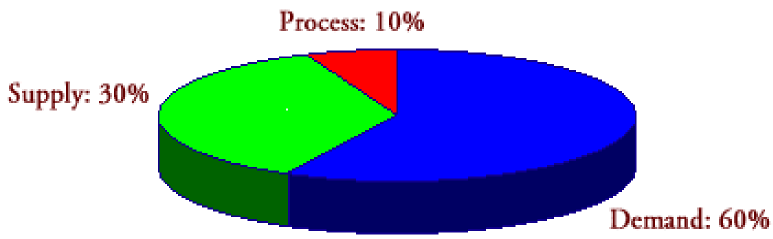


Figure 2.3 Typical Breakdown of Sources of Supply Chain Variability

Source: Executive Seminar Series, Stanford University, Introduction To Supply Chain Management, pg 13.

Estimating these numbers for a company's supply chain is an important step in improving supply chain operations.

Nonetheless, the payoff from successful supply chain management is high enough that most companies are finding innovative ways around these challenges.

2.2.3 The Push-Pull Point

The push-pull point relates to anticipated demand (forecasts) versus actual demand (firm orders). In most supply chains, the upstream activities respond to forecasts, while somewhere on the downstream side the chain waits for orders to be placed). The two following slogans, which belong to the most popular two fast food producers, could be good examples:

- "We do it all for you!" – Mc Donald's

- “Have it your way!” - Burger King

Consider how McDonald’s used to produce finished hamburgers “to forecast” – they didn’t know when patrons would come in for lunch, but they produced burgers in anticipation. On the other hand, Burger King waited until patrons actually placed customizable orders before the burgers were produced – this is more commonly as the “Build –to-Order” (BTO) model, while McDonalds’ former strategy was called “Built to Stock” (BTS). Both models have benefits and drawbacks, and many companies do a combination of both (Fisher, 1997).

Where the chain switches from push (BTS) to pull (BTO) is called the push-pull point. Through there are exceptions, BTS, and those downstream are BTO. It is important to know where the Push-Pull point is for our supply chain and that of our competition. In particular, technological changes may enable us to shift our Push-Pull point to obtain better performance (Fisher, 1997)..

2.2.4 Trade Off Curves

One of the fundamental tradeoffs in supply chain management is that between inventory levels and customer service. For any given supply chain, increasing levels of service (product/spare part availability) typically means higher levels of inventory.

Most companies have discovered their “ best place” on the curve, depending on what their customers require and what their competition offers. However, effective supply chain management can shift the entire curve downward, lowering the inventory levels without adversely affecting the customers (Ganeshan and Harrison).

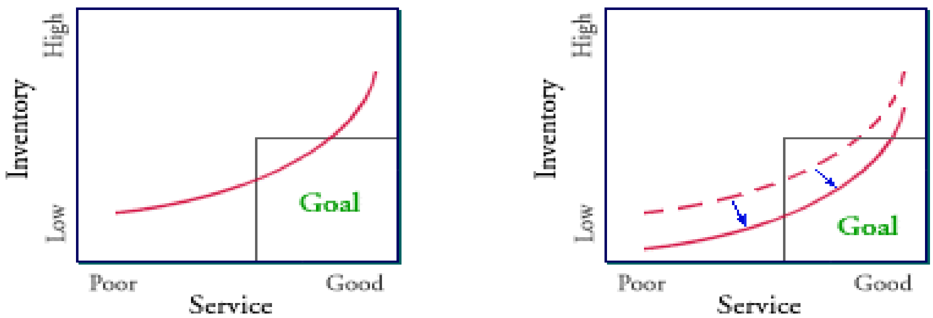


Figure 2.4 Inventory/Service Trade-Off Curve
Source: Fisher, M. L., 1997, What is the right supply chain for your product?, Harvard Business Review, Vol.75, No. 2, pp. 112.

Lowering the Inventory/ Service Tradeoff Curve provides better customer response with lower inventories.

One of the first steps in improving a supply chain is making sure that organizational responsibility for inventory levels and customer service are appropriately managed.

2.2.5 The Bullwhip Effect In Supply Chains

The Bullwhip Effect is a major cause of supply chain problems. It describes how small fluctuations in demand at the customer level are amplified as orders pass up the supply chain through distributors, manufacturers, and suppliers. As an example, consider disposable diapers. Babies generally consume diapers at a more or less consistent rate when aggregated over a large group of customers. Nevertheless, order fluctuations invariably become considerably larger as one moves upstream in this supply chain. Consequences of the Bullwhip Effect can be severe, including excess and fluctuating inventories, shortages and stock outs, longer lead times, higher transportation and manufacturing costs, and mistrust between supply chain partners (Fisher, 1997).

Common Causes for the bullwhip includes

- Demand signal processing
- Order batching
- Price fluctuations
- Allocation Gaming

When production materials or components are threatened to be in short supply, suppliers typically place them "on allocation", which means that suppliers distribute their limited inventory across all their downstream customers to make sure each one gets at least some of their order. Even if you ordered 10,000 monitors for January delivery, you may get only 5,000 due to shortages in availability. Allocation allows suppliers to meet some of the orders from all purchasers, so that no one is left with zero product. The idea is that giving everyone a portion of requirements is somehow better, in the long run, than giving some customers 100% of their orders and other customers nothing.

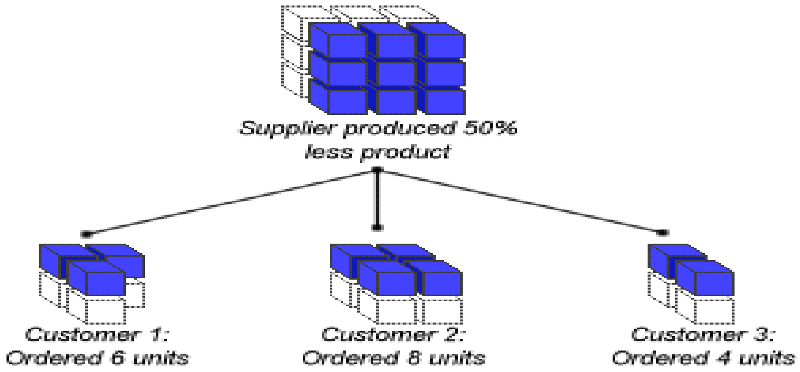


Figure 2.5 Allocation of Products

Source: Sterman,Prof. J.D., 1989. Flight Simulators for Management Education "The Beer Game", Sloan School of Management Massachusetts Institute of Technology

On allocation, downstream customers only receive partial shipments; the goal of allocation is to ensure that everyone gets a partial fill.

Invariably, some people will over-order to compensate, particularly if the shortage becomes widely apparent. There are many examples of this behavior, particularly for industrial products and components.

The problem with allocations is that many purchasers will attempt to "game" the system by putting in multiple orders, perhaps via different channels, to try to ensure they will get sufficient product. Then, once the product goes "off allocation", many of these duplicate, or "phantom", orders are cancelled. This practice is called allocation gaming or shortage gaming. Phantom orders obviously create a bullwhip effect since people over-order when shortages threaten, and then cut orders afterward.

2.2.5.1 Beer Game

"Beer Game" is a simulation, which has been developed by Massachusetts Institute of Technology (MIT) in 1960, for observing the performance of a Supply Chain and the possible bullwhip effect. In this game, a supply chain is represented by four key sectors.

1. Retailer
2. Wholesaler
3. Distributor

4. Factory (R, W, D, F)

One or two people manage each sector. Pennies stand for cases of beer. A deck of cards represents customer demand. Each simulated week, customers purchase from the retailer, who ships the beer requested out of inventory. The retailer in turn orders from the wholesaler, who ships the beer requested out of their own inventory. Likewise, the wholesaler orders and receives beer from the distributor, who in turn orders and receives beer from the factory, where the beer is brewed. At each stage, there are shipping delays and order processing delays. The players' objective is to minimize total team costs. Inventory holding costs are $.50/case/week. Backlog costs are $1.00/case/week, to capture both the lost revenue and the ill will a stock out causes among customers. Costs are assessed at each link of the distribution chain.

Each player has good local information but severely limited global information. Players keep records of their inventory, backlog and orders placed with their supplier each week. However, people are directed not to communicate with one another; information is passed through orders and shipments. Customer demand is not known to any of the players in advance. Only the retailers discover customer demand as the game proceeds. The others learn only what their own customer orders.

These information limitations imply that the players are unable to coordinate their decisions or jointly plan strategy, even though the objective of each team is to minimize total costs. As in many real life settings, the global optimization problem must be factored into sub-problems distributed throughout the organization.

The game is deceptively simple compared to real life. All you have to do is meet customer demand and order enough from your own supplier to keep your inventory low while avoiding costly backlogs. There are no machine breakdowns or other random events, no labor problems, no capacity limits or financial constraints. Yet, the results are shocking.

In virtually all cases, the inventory levels of the retailer decline, followed in sequence by a decline in the inventory of the wholesaler, distributor, and factory. As inventory falls, players tend to increase their orders. Players soon stock out. Backlogs of unfilled orders grow. Faced with rising orders and large backlogs, players dramatically boost the orders they place with their supplier. Eventually, the factory brews and ships this huge quantity of beer, and inventory levels surge. In many cases one can observe a second cycle.

Research reported in Sterman (1989) shows how this occurs. Most people do not account well for the impact of their own decisions on their teammates - on the system as a whole. In particular, people have great difficulty appreciating the multiple feedback loops, time delays and nonlinearities in the system, using instead a very simple heuristic to place orders. When customer orders increase unexpectedly, retail inventories fall, since the shipment delays mean deliveries continue for several weeks at the old, lower rate. Faced with a growing backlog, people must order more than demand, often trying to fix the problem quickly by placing huge orders. If there were no time delays, this strategy would work well. But in the game, these large orders stock out the wholesaler. Retailers don't receive the beer they ordered, and grow increasingly anxious as their backlog worsens, leading them to order still more, even though the supply pipe line contains more than enough. Thus the small step in demand from four to eight is amplified and distorted as it is passed to the wholesaler, who reacting in kind, further amplifies the signal as it goes up the chain to the factory. Eventually, of course, the beer is brewed. The players cut orders as inventory builds up, but too late - the beer in the supply line continues to arrive. Inventories always overshoot, peaking at an average of about forty cases.

But the biggest impediments to learning are the mental models through which we construct our understanding of reality. By blaming outside forces we deny ourselves, the opportunity to learn - recall that nearly all players conclude their roller coaster ride was caused by fluctuating demand. Focusing on external events leads people to seek better forecasts rather than redesigning the system to be robust in the face of the inevitable forecast errors. The mental models people bring to the understanding of complex dynamics systematically lead them away from the high leverage point in the system, hindering learning, and reinforcing the belief that we are helpless cogs in an overwhelmingly complex machine.

But the game illustrates more general lessons as well. The game creates a real organization, with 'teams' supposed to work together. Yet the pressures of events and limited mental models of the players quickly cause team cohesion to break down. The game provides a vivid experience with a complex system, where players can see how the collective results of individually sensible decisions can be disastrous; where they can see the connection between the structure of a system and the dynamics it generates.

2.2.6 Product Design For Supply Chain Management

Product Design often plays an important role in supply chain operation. Many products come in different varieties – meeting global demand for variety by holding multiple Stock Keeping Units (SKU's) of similar products can require vast inventories. By redesigning the product so that more inventory can be held in a customizable, "lowest common denominator" form, inventory can be reduced.

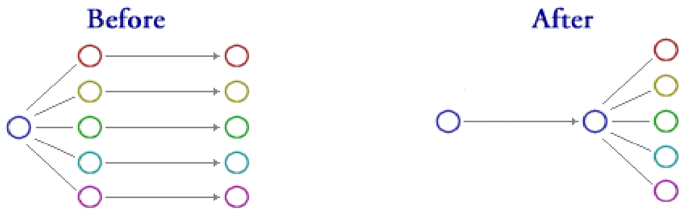


Figure 2.6 Role of Product Design

This strategy is known as "Postponement", or "Risk Pooling"; postponement of the point of product differentiation, or pooling of the risk of specific SKU forecast error. In the first figure, the product is built for a specific market before it is even shipped out of the factory (a costly decision if the unit does not sell, and particularly so if there are shortages of a similar product in other countries). In the second figure, product has been redesigned so that localization can occur as close as possible to the local market.

The Hewlett-Packard Deskjet Printer is a well-know example of product redesign for supply chain management. These printers are sold worldwide into markets requiring unique plugs, power supplies, and manuals in different languages. Originally, localization was performed at the factory, so that the printers were committed to specific markets before shipment from a US factory across the Atlantic. Lee and others (1993)

The product was then redesigned so that localization could take place at a distribution center in Europe. This meant that all the "semi-finished" DeskJet printers destined for Europe were still generic; any of those printers could be used to fill demand in any country in Europe. Using this postponement strategy, Hewlett-

Packard achieved a simultaneous decrease in inventory costs and an improvement service. This is a classic example of using Postponement to lower the “inventory/service” tradeoff curve we discussed previously. Lee and others (1993)

2.2.7 Supply Chain Operations Reference Model (SCOR)

Companies worldwide are using **SCOR** to examine the configuration of their supply chains, identifynd measure metrics, determine weak links, and achieve best practices in order to increase the efficiency of their operations. The Model is more than a tool for charting supply processes or activities. It is a business process reference model that links process description and definition with metrics, best practice, and technology. While remarkably simple, it has proven to be a powerful and robust tool set for describing, analyzing, and improving the supply chain

In collaboration with 69 members consisting of manufacturers, logistics / distribution service providers and software solutions suppliers Supply Chain Council introduced Supply Chain Operations Reference-model (SCOR). Numbers of companies have pooled their real-world supply chain experiences to build a flexible framework and a common language that can help companies improve their supply chain internally and externally. (SCC, 2001)

The model defines common supply chain management process, matches them against “best practices. It provides companies with powerful tool in improving supply chain operations. It allows manufacturers, suppliers, distributors and retailers with a framework to evaluate the effectiveness of their supply chain operations and to target and measure specific process operations.

The SCOR model was designed to enable companies to communicate, compare and learn from competitors and companies both within and outside of their industry. It not only measures supply chain performance but also effectiveness of supply chain reengineering. Further it has the ability to test and plan future process improvements.

The Supply Chain Operations Reference-model (SCOR) is a process reference model. Process reference models integrate the well-known concepts of business process reengineering, benchmarking, and process measurement into a cross-functional framework. (SCC, 2001)

A Process Reference Model helps organizations capture the "as-is" state of a process with the objective to achieve the desired "to-be" future state. Further it allows organization to quantify the operational performance, establish internal targets based on "best-in-class" results in similar companies

It describes standard management processes, exploring relationship among different processes.

It defines standard metrics to measure process performance and management practices that produce the best-in-class performance. Finally it characterizes the management practices and software solutions that result in "best-in-class" performance.

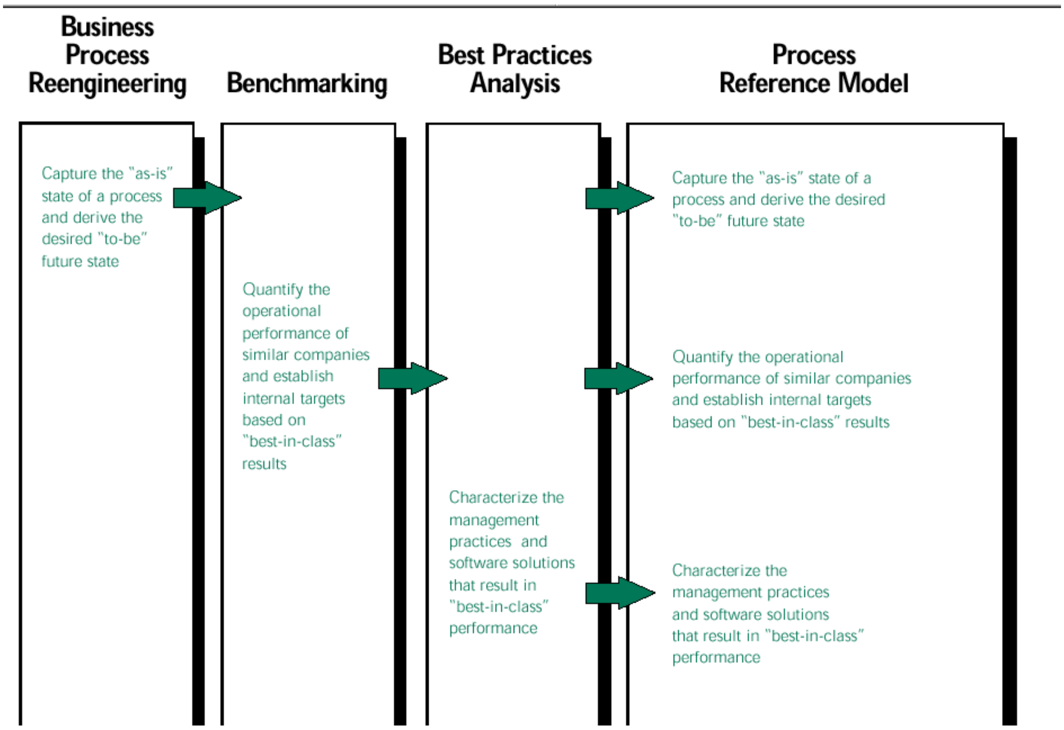


Figure 2.7 Process Reference Model Schema
Source: Supply-Chain Council, Supply-Chain Operations Reference-model Overview Version 5.0, Supply-Council ,Inc., 2001, pp 1.

At the core of this model is a "pyramid of four levels" that represents the path a company takes on the road to supply-chain improvement:

Level 1: Top Level (Process Types)

Level 1 provides definition of the Plan, Source, Make, Deliver and Return process types. This is the point where a company establishes its supply-chain competitive objectives. In other words, basis of competition performance targets are set.

The basic structure of the reference-model focuses on the five key supply-chain processes: Plan, Source, Make, Deliver and Return.

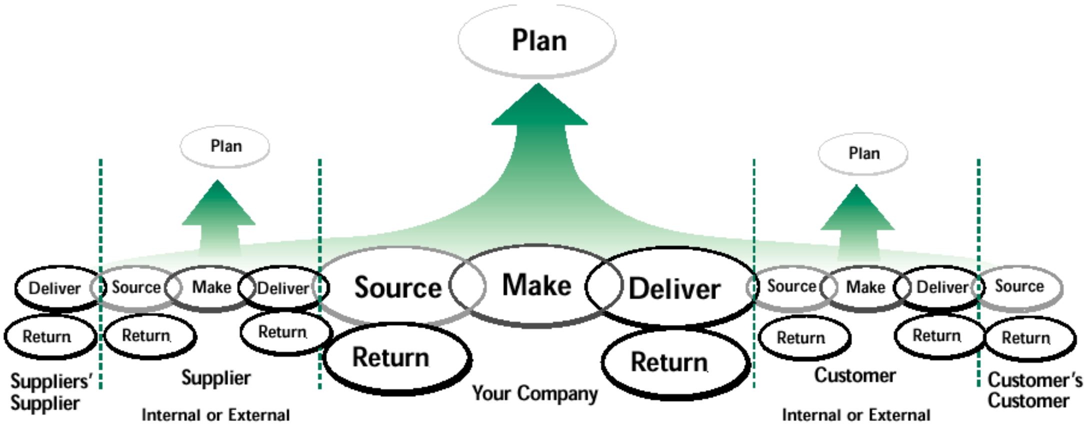


Figure 2.8: Five Distinct Management Processes, which SCOR is based on.

Source: Supply-Chain Council, Supply-Chain Operations Reference-model Overview Version 5.0, Supply-Council ,Inc., 2001, pp 3.

Plan: Demand/Supply Planning and Management

Under this process the company should assess supply resources, aggregate and prioritize demand requirements, plan inventory, distribution requirements, production, material and rough-cut capacity of all products and all channels. Make/buy decisions are evaluated under this heading. Decision related to long term capacity and resource planning, product phase in / phase out are undertaken in this phase.

- Balance resources with requirements and establish/communicate plans for the whole supply chain, including Return, and the execution processes of Source, Make, and Deliver. (SCC, 2001)
- Management of business rules, supply chain performance, data collection, inventory, capital assets, transportation, planning configuration, and regulatory requirements and compliance. (SCC, 2001)
- Align the supply chain unit plan with the financial plan. (SCC, 2001)

Source: Sourcing Stocked, Make-to-Order, and Engineer-to-Order Product

Under this process sourcing infrastructure is managed. Various activities like vendor certification and feedback, sourcing quality monitoring, vendor contracts are conducted. Also activities involved with receiving of material like: obtain, receive, inspect, hold and issue material are under taken here.

- Schedule deliveries; receive, verify, and transfer product; and authorize supplier payments. (SCC, 2001)
- Identify and select supply sources when not predetermined, as for engineer-to-order product. (SCC, 2001)
- Manage business rules, assess supplier performance, and maintain data. (SCC, 2001)
- Manage inventory, capital assets, incoming product, supplier network, import/export requirements, and supplier agreements. (SCC, 2001)

Make: Make-to-Stock, Make-to-Order, and Engineer-to-Order Production Execution This process is concerned with production, execution and managing "make" infrastructure. Specifically under production execution activities like manufacturing, testing, packaging, holding and releasing of product are undertaken here. Under managing " make" infrastructure, engineering changes, facilities and equipment management, production status, production quality, shop scheduling/sequencing and short-term capacity are planned and managed.

- Schedule production activities, issue product, produce and test, package, stage product, and release product to deliver. (SCC, 2001)
- Finalize engineering for engineer-to-order product. (SCC, 2001)
- Manage rules, performance, data, in-process products (WIP), equipment and facilities, transportation, production network, and regulatory compliance for production. (SCC, 2001)

Deliver: Order, Warehouse, Transportation, and Installation Management for Stocked, Make-to-Order, and Engineer-to-Order Product

This process consists of order management, warehouse management and transportation management. Under order management activities like maintaining and entering orders, generating quotations, configuring product are undertaken. Further create and maintain customer database, maintain product and price database, managing receivables and credit management also fall under this domain.

Warehouse management: Activities like pick up, package, creating customer specific packaging/labeling and shipment of products fall under the gamut of warehouse management.

Transportation and delivery infrastructure management: Under transportation management, activities like traffic management, freight management are undertaken. Delivery infrastructure encompasses of channel management rules, order management rules and managing delivery inventories and managing delivery quality.

- All order management steps from processing customer inquiries and quotes to routing shipments and selecting carriers. (SCC, 2001)
- Warehouse management from receiving and picking product to load and ship product. (SCC, 2001)
- Receive and verify product at customer site and install, if necessary. (SCC, 2001)
- Invoicing customer. (SCC, 2001)
- Manage Deliver business rules, performance, information, finished product inventories, capital assets, transportation, product life cycle, and import/export requirements. (SCC, 2001)

Return: Return of Raw Materials (to Supplier) and Receipt of Returns of Finished Goods (from Customer), including Defective Products, MRO Products, and Excess Products

Processes associated with returning or receiving returned products for any reason. These processes extend into post-delivery customer support

- All return defective product steps from authorizing return; scheduling product return; receiving, verifying, and disposition of defective product; and return replacement or credit.
- Return MRO product steps from authorizing and scheduling return, determining product condition, transferring product, verifying product condition, disposition, and request return authorization. (SCC, 2001)

- Return excess product steps including identifying excess inventory, scheduling shipment, receiving returns, approving request authorization, receiving excess product return in Source, verifying excess, and recover and disposition of excess product. (SCC, 2001)
- Manage Return business rules, performance, data collection, return inventory, capital assets, transportation, network configuration, and regulatory requirements and compliance. (SCC, 2001)

Level 2 : Configuration Level (Process Categories)

Level 2 defines 30 core process categories that are possible components of a supply chain. Organizations can configure their ideal or actual operations using these processes.

Level 3 : Process Element Level (Decompose Processes)

Level 3 provides the information required for successfully planning and setting goals for supply-chain improvements. This includes defining process element, setting target benchmarks, defining best practices, and system software capabilities to enable best practices.

Level 3 defines a company's ability to compete successfully in its chosen markets, and consists of (SCC, 2001):

- Process element definitions
- Process element information inputs, and outputs
- Process performance metrics
- Best practices, where applicable
- System capabilities required to support best practices
- Systems/tools

Companies "fine tune" their Operations Strategy at Level 3.

Level 4: Implementation Level (Decompose Process Elements)

Level 4 focuses on implementation, i.e. putting specific supply-chain improvements into action. These are not defined within industry standard model, as implementation can be unique to each company.

Companies implement specific supply-chain management practices at this level. Level 4 defines practices to achieve competitive advantage and to adapt to changing business conditions.

3. INTEGRATION AMONG SUPPLY CHAIN PARTNERS THROUGH INFORMATION TECHNOLOGIES

The idea that suppliers should work closely with customers to give them better value is not a new concept, yet close partnerships of this kind are still not at all common because, until quite recently, integrating the information systems of two or more companies was a lengthy, expensive, and technically difficult process. Developments in information technologies broadened the opportunities of integration between partners.

Today, the recent widespread adoptions of enterprise resource-planning systems, and the still more recent rise of the Internet, have made it much easier and cheaper for customers and suppliers to exchange data. In the world of electronic commerce, customers can easily find the best price and will choose their suppliers on that basis—unless they want something beyond it. Suppliers that can credibly promise to improve their customers' performance can avoid the commodity trap and reap cost benefits.

3.1 Improving The Customers' Performance

In the past, suppliers reengineered only their end of the supply chain, by reducing obsolete inventory or inventory in general, cutting throughput times, and so forth. Most of the changes that suppliers implement in their supply chains do not add much value from their customer's point of view. But what if a supplier could adjust its supply chains in ways that improved the service its customers received and thus their performance? This kind of reengineering is much trickier.

A supply chain is the process of transferring goods from their points of origin to markets or to end consumers. The supply chain of a packaged consumer goods manufacturer, for instance, comprises manufacturing, packaging, distribution, warehousing, and retailing. The concept of the customer's demand chain, which transfers demand from markets to suppliers, is significantly less familiar. To give one example, a retailer's demand chain would consist of assortment planning (deciding what to sell), inventory management (deciding the quantity of supplies needed), and the actual purchase. Together, these two chains form the demand-supply chain. They are linked in two places “the order penetration point” and “the value-offering point”. Holmstrom and others (2000) .

The order penetration point (OPP) is the place in the supply chain where the supplier allocates the goods ordered by the customer. For instance, goods might be produced after orders come in ("make to order") or allocated from a warehouse once the orders have been received ("ship to order"). Each order penetration point has different costs and benefits for the supplier and its customer (Figure 3.1). When the supplier allocates orders from its distribution center, it can deliver them quickly if they are in stock. Rapid delivery (a benefit for the customer) therefore depends on holding a large inventory (a cost for the supplier). Of course, the wider the product range, the bigger the inventory, so the supplier either incurs large inventory costs to minimize delivery times or cuts inventory and risks delays in fulfilling orders.

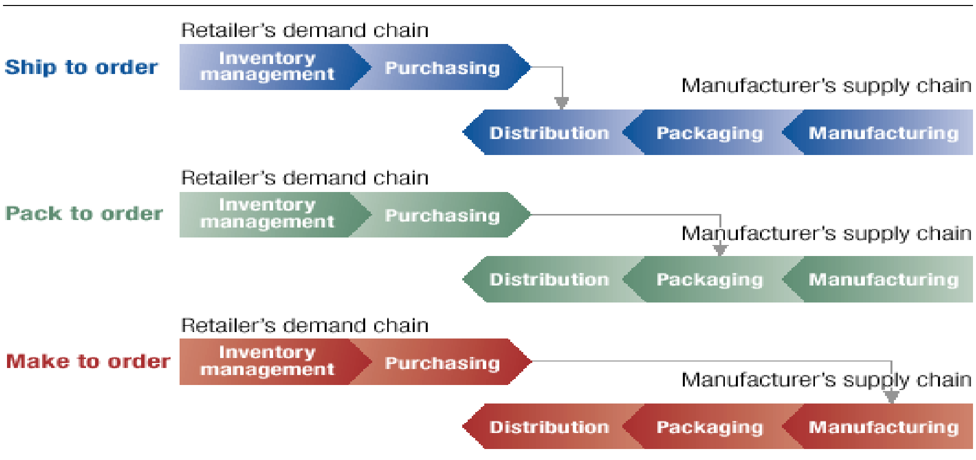


Figure 3.1 The Three Main Order Penetration Points

Source: Holmstrom, J., Hoover, E. W. Jr.,Louhiluoto, P. and Vasara, A., The Other End of the Supply Chain Management, McKinsey Quarterly 2000, Number 1, pp 65.

It is possible to move the OPP back to packaging or assembly: the point when goods are turned into finished products—when soap, for instance, is poured into boxes and sealed or components are assembled into personal computers. This approach ("pack to order") gives the supplier the benefit of lower inventory expenses, but the customer must wait for the goods to be packaged (a cost). To reduce that delay (a benefit for the customer), the supplier must bear the cost of additional packaging capacity. Moving the OPP back still further to manufacturing on demand makes it possible for the supplier to meet the specifications of individual customers (a benefit for them). But the delivery time rises (a cost for them), and the supplier's process efficiency declines each time a customized design replaces a standard one (a cost for the supplier and the customer alike).

For companies with a wide product range, ship to order process is very costly therefore they are more interested in moving the order penetration point towards the packaging phase which is known as the pack to order. Especially in the fast moving goods industry, the number of products may increase dramatically since the packaging may differ from customer to customer. Therefore moving the order penetration point to packaging may result in considerable benefits for the producers. At this point, the effective use of information technologies provides big opportunities for both the supplier and the customer. Information technologies can speed up the communication between partners with more accurate data. Since all the data is electronically saved, this reduces the bureaucracy and establishes close relationships between partners to speed up the ordering process. Reducing the time required for ordering process, this extra time can be used for packing the goods. This results in fewer inventories for the supplier with better customer service.

In order to be able to move the order penetration point to pack to order point, manufacturers should be able to predict the customers' demand more accurately to be able to keep less inventory and provide a good service level. Information technologies can offer very good tools to estimate forecasts depending on the historic data.

To sum up, the further back in the supply chain the supplier moves the OPP, the more steps there are to complete without disruption and the more difficult it becomes to fulfill orders promptly but this can be overcame with effective use of information technologies. The advantage to the supplier of this approach depends on the amount of cost savings it can achieve from lower inventory, on the one hand, compared with the reduction in sales that may be brought about by longer delivery times and higher total costs for customers, on the other.

The Value-Offering Point (VOP)—the second place where the demand and supply chains meet—is where the supplier fulfills demand in the customer's demand chain. Moving the VOP back in the demand chain largely benefits the customer, requiring more work from the supplier. Holmstrom and others (2000).

There are three principal VOPs (Figure 3.2).

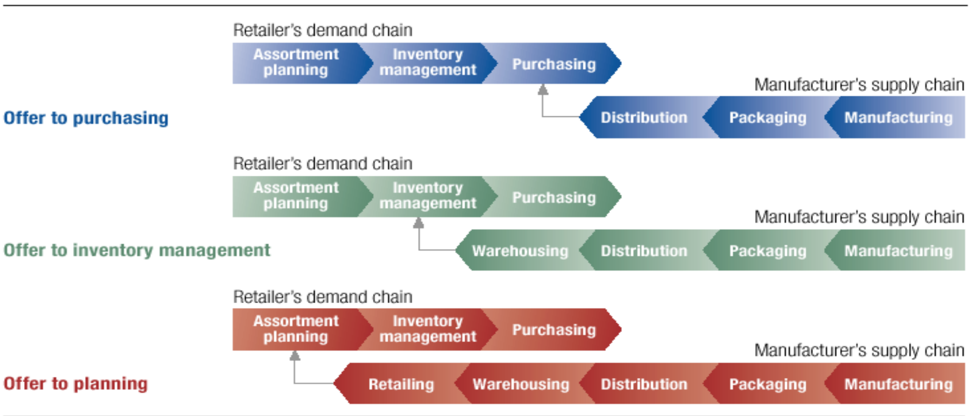


Figure 3.2 The Three Main Value-Offering Points

Source: Holmstrom, J., Hoover, E. W. Jr.,Louhiluoto, P. and Vasara, A., The Other End of the Supply Chain Management, McKinsey Quarterly 2000, Number 1, pp 66.

In the conventional, arm's-length buyer-seller relationship, the VOP is the purchasing department, which accepts an "offer to purchasing" by choosing the supplier and deciding when goods are needed. An "offer to inventory management" moves the VOP further back in the demand chain: by carefully monitoring the customer's inventory levels, a supplier can cut down on stock that is unlikely to sell and ensure that the customer never runs out of goods that move briskly. These benefits, however, mean more work for the supplier, since it must now have a separate inventory control process for each customer. This concept is known as the "Vendor Managed Inventory".

Vendor Managed Inventory needs to be supported with the right information technology tools. Supplier maps the inventory and consumption details with its current production and scheduling system (this system is usually the SCM execution or ERP system of the supplier) to develop an integrated system between partners. The development of advance planning and scheduling systems which provides integration tools with various ERP and legacy systems have encouraged the suppliers to move towards the “offer to inventory management” point to be able to give better customer service. Vendor managed inventory has generated opportunities to keep history of the customer demand and provide more accurate forecasts for the future.

An "offer to planning" moves the VOP back to merchandising (in the case of retailing) or production (in the automotive and personal-computer industries, for example). In other words, by joining forces to analyze the consumer demand categories served by products from the supplier, both retailer and supplier can avoid new products or promotions that lack a market. Suppliers are also expected to use this kind of collaboration to improve their delivery performance. The result is a more profitable use of retail space by retailers, but unless suppliers can charge a premium or increase their sales through this kind of collaboration, they don’t benefit from it.

A fourth (and still largely unexplored) VOP is the "offer to end user," such as Dell Computer’s direct-sales model for business clients. Rather than fulfill orders from wholesalers (an offer to purchasing), Dell went all the way back in the demand chain to the end consumer by fulfilling orders for customized PCs—complete with software and network configuration. All employees have to do is turn on their machines. Corporate customers reap an enormous advantage: the ability to eliminate half of their PC support teams, which spend most of their time setting up computers.

Although moving the VOP back in the demand chain is largely in the customer’s interest, the supplier can benefit if it simultaneously moves the OPP. Ordinarily, moving the OPP benefits one party at the expense of the other. But by coordinating movements in both the demand and the supply chains, suppliers can improve their customers’ performance and at the same time generate step changes in the efficiency of their own operations.

A manufacturer might, for example, be keen to move the VOP back to inventory management in order to help a customer reduce its lost sales and obsolescence costs, but to do so the manufacturer must assume the high expense of integration. In fact, managing the customer’s inventory gives the manufacturer much earlier access to information about that customer's demand. Such access permits the manufacturer to cut its own inventory costs by packaging products to order rather than stocking all its products at a distribution center; none of this comes at the expense of the customer's delivery times.

Likewise, Dell can profitably offer excellent service to end users—by pushing the VOP all the way back to them—only because it has pushed the OPP back in the supply chain by assembling PCs to order. Since Dell receives early information about customer demand, the company can take the time it needs to assemble PCs out of the front end of the process rather than the back end, where it would delay deliveries to customers. Dell has also eliminated inventory costs and can buy components later than its conventional competitors do, thus taking advantage of continually falling prices.

4. THE INFORMATION TECHNOLOGIES WHICH FORMS THE BASES OF SUPPLY CHAIN MANAGEMENT

The competitive marketplace of the 21st century demands robust and extended enterprise management solutions – initiatives that integrate product, process, and information flows within and across organizational boundaries. The challenge is to effectively use enterprise applications to identify, communicate and continuously improve internal and extended enterprise processes. Gulledge and others (2001)

Enterprise information technology (IT) of the late 1990s promised quick and dramatic gains in efficiencies and reduction in transaction costs. Although 84% of companies by now have implemented Enterprise Resource Planning (ERP) applications, only a select group of can point to a significant business value for their investment. Experience and research highlights two fundamental shortcomings in the enterprise initiatives of the e-Business era: Gulledge and others (2001)

1. In the hopes of reaping promised benefits quickly and cost-efficiently, organizations didn't take the time to perform comprehensive analysis and to align their corporate strategy with their **business processes** and the **process logic that the enterprise applications** imposed upon them.
2. Management cultures and technological capabilities hindered true **end-to-end integration** within process-oriented organizational framework.

APICS defines SCM as the "planning, organizing, and controlling of supply chain activities". The Supply-Chain Council (SCC) defines supply chain activities as "all customer interactions, from order entry through paid invoice; all product (physical material or service) transactions, from supplier's supplier to customer's customer; and all market interactions, from the understanding of aggregate demand to fulfillment of each order." When combined, the two definitions highlight the transformation in professional practice from an inward-looking materials, production and logistics management, to product, process and information flow management across the enterprise and its suppliers, customers and partners.

4.1 Enterprise Resource Planning

SCM, CRM and all the business intelligence tools are feed from the ERP (Enterprise Resource Planning) systems. So, what is ERP?

Enterprise Resource Planning or ERP is an industry term for integrated, multi-module application software packages that are designed to serve and support multiple business functions. An ERP system can include software for manufacturing, order entry, accounts receivable and payable, general ledger, purchasing, warehousing, transportation and human resources. Today ERP is the most prevalent software tool deployed. It is used successfully to standardize on the financial and transactional processing needs of the organization. The epitome of ERP is SAP - another 3-letter acronym. SAP is the largest successful ERP tool provider.(White, 1999)

An ERP system is a transactional system where the daily business functionalities processed and saved in an integrated (multi-module) environment. ERP is internally focuses and ensures all departments talk the same language. Evolving out of the manufacturing industry, ERP implies the use of packaged software rather than proprietary software written by or for one customer. ERP modules may be able to interface with an organization's own software with varying degrees of effort, and, depending on the software, ERP modules may be alterable via the vendor's proprietary tools as well as proprietary or standard programming languages. Benefits of ERP systems can be summarized as follows;

- Complete integration of systems across the departments in a company as well as across the enterprise as a whole.
- Automatic introduction of latest technologies
- Expertise database
- Better project management
- Better customer service

The focus of manufacturing systems in the 1960's was on Inventory control. Most of the software packages then were designed to handle inventory based on traditional inventory concepts. In the 1970's the focus shifted to MRP (Material Requirement Planning) systems that translated the Master Schedule built for the end items into time-phased net requirements for the sub-assemblies, components and raw materials planning and procurement.

In the 1980's the concept of MRP-II (Manufacturing Resources Planning) evolved which was an extension of MRP to shop floor and Distribution management activities. In the early 1990's, MRP-II was further extended to cover areas like Engineering, Finance, Human Resources, Projects Management etc i.e. the complete gamut of activities within any business enterprise. Hence, the term ERP (Enterprise Resource Planning) was coined.

By becoming the integrated information solution across the entire organization, ERP systems allow companies to better understand their business. With ERP software, companies can standardize business processes and more easily enact best practices. By creating more efficient processes, companies can concentrate their efforts on serving their customers and maximizing profit.

Industry analysts expect that every major manufacturing company will buy the software, which ranges in cost -- with maintenance and training -- from hundreds of thousands of dollars for a small company to millions for a large company. AMR Research of Boston says consolidation among the major players will continue and intensify. ERP vendors are expected to put more effort into e-commerce, CRM and SCM initiatives, with leaders redirecting between 50% and 75% of their R&D budget to these projects. (Lapide, 1999)

According to Gartner research group, the rapid evolution of ERP has already lead to a new corporate must-have, ERP II, which is supposed to help businesses gain more competitive edge in the future. The major difference is that ERP II involves collaborative commerce, which enables business partners from multiple companies to exchange information posted on eCommerce exchanges. (Leung, 2000)

ERP does not cross inter-company boundaries so ERP II which is known as the Advanced Planning and Scheduling, or APS comes to the scene. Another acronym we know, but APS tools providers represent those smaller vendors who have been focused on the planning component of an organization. ERP is synonymous with execution, and APS is synonymous with planning - the provision for the materials and processes to meet the needs of the customer when an order arrives. In other words, planning requires the anticipation of the customer’s needs, the anticipated needs of one's own organization, and those of the supplier base. Planning, or APS therefore typically includes such activities as Demand Forecasting. By forecasting a customer's demand accurately, an organization can take steps to go beyond simple ERP-focused asset efficiencies and move to exploiting asset effectiveness. ERP is all about efficiency; APS is all about effectiveness.

Even though ERP is an evolved and still evolving structure, it is focused on transactions. Each and every company today still responds to the same transaction as they always have: a customer order. Certainly, the communication of the Customer Order has been optimized and Electronic Data Interchange (EDI) is being used to share the data the suppliers, but the nature of the transaction has not changed very much over the years.

4.2 Supply Chain Management Softwares

Supply Chain Management (SCM) packages are back-end applications designed to link suppliers, manufacturers, distributors, and resellers in a cohesive production and distribution network and thus allow an enterprise to track and streamline the flow of materials and data through the process of manufacturing and distribution to customers. SCM applications represent a significant evolution from previous enterprise planning systems, such as MRP, in terms of their ability to integrate an enterprise's business partners into the production process. By enabling greater data sharing between these supply chain partners, SCM applications improve production efficiency and flexibility. The three primary goals of an SCM system are (Teckman, 2000):

1. *Decrease inventory costs by matching production to demand.* SCM forecasting applications utilize extremely complex-planning algorithms to predict demand based upon information stored in the company database. These applications also incorporate any changes in supply chain data into the forecast much faster than previous modes of calculation, allowing companies to more accurately predict demand patterns and schedule production accordingly.
2. *Reduce overall production costs by streamlining the flow of goods through the production process and by improving information flow between an*

enterprise, its suppliers, and its distributors. Logistics-oriented systems such as transportation management, warehouse management, and factory scheduling applications all contribute to reduced production costs. By ensuring real-time connectivity between the various parties in a supply chain, these applications decrease idle time, reduce the need to store inventory, and prevent bottlenecks in the production process.

3. *Improve customer satisfaction by offering increased speed and adaptability*. SCM applications allow enterprises to reduce lead times, increase quality, and offer greater customization, enhancing the customer relationship and improving retention.

The SCM process begins with forecasting and data mining applications analyzing information consolidated in the enterprise's database. Planning algorithms are used to generate a demand forecast upon which to base subsequent procurement orders and production schedules. Figure 4.1 illustrates this process

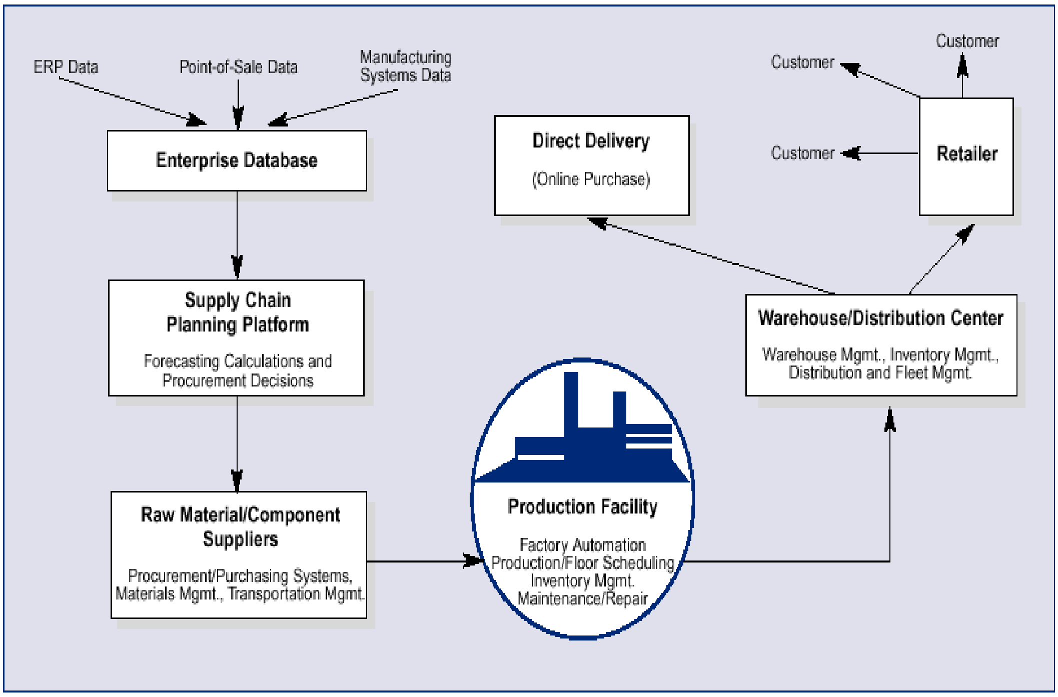


Figure 4.1: Simplified Supply Chain (Teckman, 2000)

Source: Teckman, D., January 2000 ,Extended Enterprise Applications, Cherry Tree & Co. Research,USA

Supply Chain Management represents the convergence of all facets of the manufacturing and sales process: anticipated demand, production and storage capacity, capital resources, time constraints, and profitability objectives. The value proposition of a SCM application is the capacity to integrate suppliers, manufacturers, and distributors into a dynamic Internet-, intranet-, or extranet-enabled system that takes all of these factors into account.

Through the increased collaboration between supply chain partners permitted by such a system, an enterprise in effect extends its operational boundaries. Suppliers are better able to anticipate the enterprise's need for materials, the enterprise is better able to schedule production processes and manage inventory levels, transportation companies are better able to coordinate material delivery and product distribution, and customers are better able to place and track orders.

Supply Chain Management market can be segmented into two sectors: Supply Chain Planning (SCP) and Supply Chain Execution (SCE).

• **Supply Chain Planning** applications are tools used to access and analyze information stored in the company database in order to forecast product demand and plan manufacturing accordingly. Sophisticated computing platforms run data through extremely complex planning algorithms and optimization routines in a comparatively short time frame to produce anticipated demand figures and corresponding procurement and scheduling requirements, the calculation of which used to take days. These systems may be applied to both operational decisions (such as shop-floor scheduling) and long-term strategies (such as factory construction and quarterly forecasting).

• **Supply Chain Execution** applications use the information generated by SCP tools to guide the physical production, storage, and movement of raw materials, assembly components, and completed products. These applications are able to interface with SCP and order management systems to determine production capacity, including cost or time constraints, and calculate a production plan which satisfies all requirements and can adapt quickly to any change in variables.

Linking a Supply Chain Management system to an enterprise's legacy ERP applications and other internal systems is only the first step in a pains taking and complex process. The bulk of the implementation work occurs beyond the boundaries of the enterprise and involves the integration of the SCM application with the systems of an enterprise's supply chain partners: raw materials and component suppliers, distributors, and shippers. Full integration involves linking incompatible and heretofore non-communicative software, hardware, and infrastructure systems. This connectivity increases collaboration in the forecasting, purchasing, production, and inventory management processes, and in synchronizing delivery and distribution schedules.

The difficulties associated with this task can be exacerbated depending on the financial condition, level of technical sophistication, and overall mindset of the supply chain partner. Partners constrained by financial, technological and cultural considerations can complicate integration immensely. Increasingly, SCM adopters will require the services of specialized integration partners who have the technical knowledge and experience to effectively surmount these and other obstacles.

4.3 Integration Requirements Between SCM And ERP Packages

Implementing supply chain application is the natural next step after finishing the ERP implementation project. Indeed, the two serve each other well. ERP captures all the product, sales, finance and inventory information that supply chain applications need to predict demand and optimize the flow of material through the chain.

Unfortunately, that symbiotic relationship does not translate into an easy integration between the two different systems. In all likelihood, the new supply chain implementation will not interface cleanly with the current ERP system.

Application integration has reached mainstream status in some enterprises, but too many are still waiting in the wings. With a growing need for internal integration, B2B integration and Web Services deployment, this reluctance to move to an structured, systematic solution for application integration is not defensible. In order to compete for new business opportunities, and to retain the current business relationships, the cost savings, process improvements, and increased responsiveness delivered by integration are critical. (Lapide, L.(c), 1999)

Supply chain applications must link to existing enterprise resource planning applications. CIOs should look at their existing architecture and determine how best to add supply chain applications to those already in place. ERP serves as the nerve center of the organization — the repository for storing and tracking internal information about inventory levels, pricing structures and other key supply chain factors.

Ideally, there should be a single point of visibility for inventory and order taking. Customers could place and track orders with a Web interface, and customer service representatives would have access to the same information customers see. A database would store and manage orders, and customers would be able to check inventory and order status in real time any time.

The opportunities to integrate the processes of the supply chain are practically unlimited. But within this scope we need to consider different dimensions of integration. (Lapide, L.(c), 1999)

- The standards along the supply chain (product coding, data modeling and structures...) for procedures and information systems.
- The geographic regionalizations and globalization, providing common processes (sourcing, manufacturing and distribution) for several countries, within and across regional trade markets.

Out-sourcing and in-sourcing must be constantly re-assessed with a strategic perspective. The integration must allow seamless co-manufacturing, co-packing... all sorts of collaborative working environments with the business partners.

IT or IS departments are encouraged to integrate their information systems within their strategic information systems plans by top level management in order to help operational level management in decision support and optimization effort of resources of company and trading partners’ within the pre-defined supply chain.

Need of integration of information systems is key in optimizing resources. Removing friction from the supply chain to cut costs is a common goal of most companies. Many have implemented wireless technology to improve the collection of data in a factory, warehouse, or distribution center. The increased visibility of real-time information can help companies reduce inventory and improve the accuracy of forecasts. (Lapide, L.(c), 1999)

Here is the list of the different type of information depending on the functional area need to be integrated with ERP packages in order to be used by Supply Chain applications. Integration requirements within SCM and ERP packages are evaluated by functional breakdown as follows;

- Demand Planning – Forecasting
- Demand Fulfillment – Demand Planning
- Supply Planning – Advanced Scheduling
- Transportation Planning

4.3.1 Functional Breakdown of Requirements

4.3.1.1 Demand Planning - Forecasting

Forecasting module acts as an early-warning system, predicting future customer demand, alerting of potential supply problems, and finding patterns undetected by traditional solutions. It enables the company to understand demand drivers, to more accurately predict customers' future needs, and to unify disparate planning processes through its scalable and web-based multi-model architecture. (Lapide, L.(a), 1998)

To help identify critical factors that drive demand, forecasting module offers multiple forecasting algorithms in conjunction with advanced causal modeling. Using 'best fit' techniques, it quickly determines the forecast algorithm that best suites your business, and the exclusive 'AutoTuner' feature automatically determines the optimal parameter settings, allowing you to significantly reduce cycle time.

Forecasting module also provides intelligent event modeling capabilities and allows for management overrides. By including both market planning and demand planning capabilities, it links product mix, promotion, and price analyses with traditional demand forecasting. And unlike conventional forecasting tools, it enables the simultaneous tracking and understanding of demand along multiple dimensions, including sales channels, geographies, and product hierarchies. Here is the list of the main items that require integration. (Lapide, L.(a), 1998)

- Historic Sales Data
- Daily Sales Data
- Customer Orders
- Customers and Customer Details

4.3.1.2 Demand Fulfillment – Demand Planning

Demand Fulfillment/Planning module can significantly improve a company's ability to make accurate delivery commitments. It provides a flexible modeling framework that permits an enterprise to define business rules in accordance with profit maximization and customer service objectives, ensuring that the order commitment process works within these defined parameters.

When product forecast becomes available, production planning determines the requirement of raw materials, machines, and labor based on the Bill-of-Material (BOM) of products. Production planning then develops schedules of production and distribution based on the available materials and resources. The resulting master plan of production provides a schedule of available supply, referred to as Available-to-Promise (ATP). (Lapide, L.(a), 1998)

With a master plan of production, Demand Fulfillment is able to distribute supply to sellers as Allocated Available-to-Promise (AATP) based on policies that capture seller prioritization, profit objectives, channel splitting by percentage, existing backlog, committed forecasts by subsellers, first-come-first-served, and so on. Logic built into the AATP process allows Demand Fulfillment to reserve portions of the ATP for high-priority orders or other potential demand opportunities. AATP is also used when the supply strategy resources are constrained and cannot meet market demands in either the short or long term. In these instances, supply is allocated in alignment with the service level goals and priorities of the company. Here is the list of the main items that require integration. (Lapide, L.(a), 1998)

- Firmed Planned Orders
- Scheduled Orders
- Forecasts
- Resources and Capacities
- Bill of Material
- On-hand Balances - Depending on your planning frequency

4.3.1.3 Supply Planning – Advanced Scheduling

The Supply Planning - Advanced Scheduling modules user view generates manufacturing schedules and enables you to fine-tune and analyze them in a graphic environment. AMS can retain existing schedules for some orders while generating new schedules for others. (Lapide, L.(a), 1998)

Supply Planning - Advanced Scheduling modules generate detailed schedules for using resources to produce a specific set of planned orders and customer orders. Here is the list of the main items that require integration.

- Available Resources and Capacities - Depending on your planning frequency
- Bill of Material and production routes
- On-hand Balances - Depending on your planning frequency
- Open Supply Information
- Customer Orders

4.3.1.4 Transportation Planning

Transportation Management is an enterprise-wide transportation planning system. It considers both demand and available resources in all links of the supply chain simultaneously, and derives efficient loads consolidations with least-cost carrier assignments. Integrated inbound and outbound planning, interactive decision support, and performance monitoring are fully integrated into one multi-user application capable of producing comprehensive solutions to complex transportation problems.

Transportation Management defines and solves the transportation problem and manages the execution of the resulting plan. It also manages information about the company’s facilities, vendor locations, carriers, and other data needed to develop a cost-effective transportation plan. Transportation modules are sophisticated algorithm that builds loads for shipping centers. Here is the list of the main items that require integration. (Lapide, L.(a), 1998)

- Customer and Vendor information
- Daily Truck Location – Depending on your planning frequency
- Supply information – Purchase Orders

- Customer Orders

As mentioned, Supply chain applications do not keep the track of transactional basis information, that's why Supply Chain Applications should be fed by ERP or any other external sources with current on hand balances, daily available resource and capacities and current truck locations. The thing that before running the planning process in Supply Chain applications, it should be confirmed that all the relevant data is in the system and this makes Supply Chain implementations harder because of the need for any other external applications like Barcoding, GPS, Warehouse Management Systems in order to get the required data into the system.

4.3.2 Supply Chain Optimization

All self-respecting supply chain vendors today promise to create the very best possible solution to a problem whilst considering various constraints and managing tradeoffs between conflicting objectives. These tradeoffs include minimization of inventory whilst maximizing customer service or procurement volume discounts versus total production costs. The broad description for these approaches is Supply Chain Optimization (SCO). (Lapide (b), 1998).

Some cynics say that the real world can never be modeled with mathematics, but the informed will counter that you certainly can usefully model a problem such that very significant savings can be made. As always, the devil is in the detail. Breaking down optimization reveals the following:

- **Objectives** – What are we trying to optimize?
- **Drivers** – What factors are affecting process efficiency?
- **Constraints** – What hard and soft restrictions need to be adhered to?
- **Domains** – What is the scope - department, plant, enterprise, or supply chain?
- **Algorithms** – What mathematical solve method is being utilized to calculate the answer?

Thinking this way lets users best understand the relative capabilities of software packages. Specialists should not blindly quote Linear Programming (LP), Mixed Integer Linear Programming (MILP), Simulated Annealing (SA), Genetic

Algorithms (GA), Heuristics, and Constraint Anchored Optimization (CAO) as being the answer to all the questions.

In addition to the anatomical breakdown, users should be advised of a number of real world considerations and recommendations (Lapide (b), 1998):

- Some solve algorithms may not scale to your needs, due to the exponential impact of multiple constraints creating gargantuan calculations.
- The deeper the sophistication of the solution, the more fragile it will be, which means it will occasionally break, because it gets very solution specific.
- Most of the leading supply chain applications use some common mathematic engines supplemented by in-house developments.
- Optimization strength will often be quite variable across vertical industry problems.
- The project should focus on specific domain-based problems first rather than trying to do larger enterprise or supply chain models.

Optimization is more of an art than a science despite its operation research origins, but should be embraced for the value it can bring.

Supply Chain Optimization (SCO) can be described by focusing on the following factors:

- Enumerating variables and constraints
- Quickly sorting possible ways to move materials through the supply chain
- Producing the best mix of choices

SCO is most useful in situations where a company or a product has a complex supply base, a complex manufacturing process, a complex distribution system, and volatile demand. Essentially, whenever there is uncertainty in the behavior of supply chain operations or in market demand, SCO could benefit a company. It was felt that SCO would not be as useful—it may even be unnecessary—in a make-to-order environment with few supply points and a simple supply chain. (Lapide (b), 1998).

SCO software as a tool to help people in various functional areas of a company broadens their focus to encompass the entire supply chain, from raw materials to the final customer. With this “supply chain perspective,” the functional teams would have a common language to make better decisions about optimizing the flow of products through the supply chain. SCO can be used in the following areas sourcing, making versus buying, production allocation, supply chain design and sales and operations.

Supply chain optimization is being recommended to the following industries;

- Distribution-intensive (Food & Beverage, Consumer Packaged Goods)
- Asset- or capacity-intensive (Semiconductors, Steel)
- Material-intensive (Apparel, Electronics)

Each type of industry benefits from SCO, but each should optimize different things. For distribution-intensive industries, transportation optimization and inventory deployment were regarded as the two areas where SCO would be most effective. In the asset-intensive industries, optimizing throughput times, product mix, and setups were identified as important. In material-intensive industries, decisions about what to produce, where to produce it, and who to source materials from in order to generate high margins were noted.

Optimization solvers use and are named for the different methods or algorithms deployed to find solutions. These methods can be grouped into four categories:

- Linear programming
- Heuristics
- Genetic algorithms
- Exhaustive enumeration

4.3.2.1 Mathematical Programming Methods

Mathematical programming methods are used for problems that can be modeled with equations that describe the constraints and objectives. Mathematicians have proved that if a problem can be described using certain sets of equations, then an optimum solution can be computed following a prescribed algorithm or technique. This is in contrast to other methods that search for an optimum but offer no guarantee that it can be found**.** (Lapide (b), 1998)

4.3.2.1.1 Linear Programming

The most commonly used mathematical programming technique is linear programming (LP). This method works only if all the constraints and a single objective can be expressed as linear equations (i.e., a linear equation looks like this: ·X ijk - Dj Z kj = 0). If this holds, the optimum solution that either maximizes or minimizes the single objective can be generated. LP assumes that the decision variables can be expressed as regular, continuous numbers. If some decisions can only be expressed as an integer or whole number, LP does not work. For example, if the decision is to incur a production changeover or setup, this can only be expressed as a "yes" or "no" or mathematically as a "0" or a "1." (Lapide (b), 1998).

To handle this, mixed integer programming (MIP) was developed. This method also only works if all the equations are linear. In contrast to LP, however, while an optimum solution can be generated, it may take too long. The good news is that MIP does have a way to tell how much better an optimum solution would be if it could be generated. Other mathematical programming methods include dynamic programming and nonlinear programming. However, these methods are not often used in supply chain planning optimization.

4.3.2.1.2 Heuristics

Heuristic methods are predicated on trying to improve a known feasible solution following prescribed steps. Heuristics do not guarantee that an optimum solution can be found, nor do they determine how much better an optimum solution might be. As an illustration, a simple heuristic for maximizing an objective might follow a three-step approach:

1. Start all decision variables at zero value.
2. Continue increasing decision variables one at a time as long as the objective continues to increase.
3. Stop when increasing all decision variables no longer increases the objective.

While this heuristic method might not lead to the optimum, solutions will usually get better or stay the same. Simply put, heuristics are based on the logic a reasonable person might follow in looking for an optimum. Some scheduling optimization solutions use heuristic logic based on the Theory of Constraints (TOC) espoused by Eli Goldratt. These methods focus on critically constrained resources or “bottlenecks” to develop a schedule. The TOC approach revolves around a drum, buffer, and rope concept. First, TOC uses the critically constrained resources to develop a master plan or drum that the plant or system “beats to” or to which the pace is set. Buffers, such as work-in-process inventories and surplus time in the schedule, are put in place to ensure maximum utilization of the critically constrained resources that ensure they do not sit idle. Lastly, all non-critically constrained resources are “tied” together according to the drum, creating so-called ropes that pull work through the system. In addition to TOC, there are many types of heuristic methods that are proprietary knowledge ware of the vendors. Some of these are based on known, published approaches such as Simulated Annealing and Repair-Based Scheduling methods. .” (Lapide (b), 1998).

4.3.2.1.3 Genetic Algorithms

Genetic algorithms are predicated on a biological selective breeding concept of survival of the fittest. The methods attempt to find an optimized solution from a large set of possible solutions by comparing them and selecting the best ones of the group. The ones that survive this test are then mutated or crossbred to establish another set of solutions. This search method continues testing from generation-to-generation for some duration of time, thereby developing a reasonably optimized solution. These methods work well when a baseline schedule or plan exists. For example, sequencing a number of orders through a single assembly-line operation to maximize on-time delivery or to minimize changeover is an optimization task where genetic algorithms could be used.

4.3.2.1.4 Exhaustive Enumeration

Not always considered a formal optimization technique, the exhaustive enumeration method evaluates all possible combinations of decisions to find the best combination. This method is used when there are relatively few decision-variable combinations to consider. For example, a job shop with 1 machine and 10 orders to sequence would generate 3.6 million potential combinations for evaluation. While this is a lot for a human to handle, it is an easy task for a computer. ." (Lapide (b), 1998).

Generally, optimizing each piece of a plan in isolation from other plans does not guarantee that optimization is achieved for the total planning process. For example, developing an optimal production plan in isolation from distribution does not guarantee that the total production/distribution plan is optimal. Vendors are addressing this concern in the following ways:

- Moving toward synchronized concurrent planning from synchronized sequential planning
- Providing functionality that helps to synchronize planning levels
- Moving toward real-time planning and execution

Each of these vendor trends attempts to provide users with a more holistic approach toward optimization. They each address planning processes that may be somewhat subdivided but that support optimized plans across the entire supply chain. Each trend is discussed below.

A Move Toward Synchronized Concurrent Planning

Figure below is a graphical representation of a synchronized sequential supply chain planning process. In this process, demand planning is done first. The resulting forecasts are used as input to the distribution planning process (including planning for inventory, transportation, and warehousing). The distribution plans developed by this process are then used as input to the manufacturing planning process. Lastly, the output of this process is used as input for the procurement planning process. The planning process is synchronized, since any change in "downstream" plans is automatically reflected in the "upstream" planning processes. From a product perspective, Manugistics' supply chain planning suite was the first major solution providing this type of synchronized sequential planning approach. (Suleski, 1998)

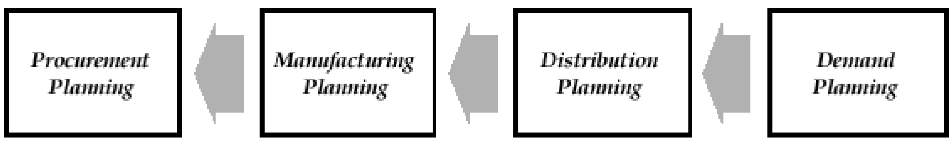


Figure 4.2 Synchronized Sequential Planning Approach
Source: Lapide, L., 1998, Perspectives on Optimization, Advanced Manufacturing Research, Inc., Boston.

The synchronized sequential approach works well in integrating supply chain planning and in moving it to a consumer demand "pull" environment. It has, however, two problems from an optimization perspective:

One is, each planning component's resource constraints are typically not considered, nor is there any attempt to optimize an objective.

And the second is, separate optimization of each planning process rarely produces an optimized plan in the context of the whole supply chain.

Some optimization processes solve these two problems through "synchronized concurrent" planning (See Figure below). In synchronized concurrent planning, the demand, distribution, manufacturing, and procurement plans are jointly or simultaneously developed. All constraints along the supply chain and optimizing objectives, such as cost or profitability, are considered within the planning process. Many vendor applications have moved or are moving toward this planning approach.

For example, Manugistics' *Supply Chain Navigator* provides synchronized concurrent planning.

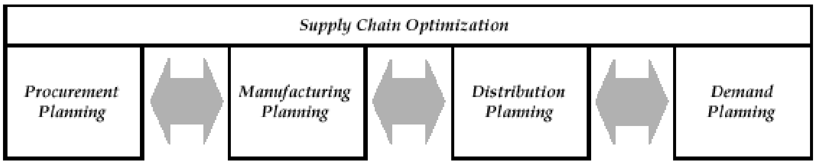


Figure 4.3 Synchronized Concurrent Planning Approach

Source: Lapide, L., 1998, Perspectives on Optimization, Advanced Manufacturing Research, Inc., Boston.

Planning Levels Are Being Synchronized To Ensure Optimality. In most optimization frameworks, optimal solutions generated at higher levels in a planning hierarchy are used as starting points or constraints and the optimization is taking place at lower levels. In a planning environment where optimization is a goal, plans at different levels may need to be synchronized to ensure that the supply chain is continually operating in an optimized fashion. (Suleski, 1998)

The Figure below depicts the difference between architectures that do and those that do not have synchronization functionality. Disjointed plans and data levels do not ensure that optimization is achieved. To ensure synchronization and consistent optimization across hierarchical planning levels, SCM applications use several approaches:

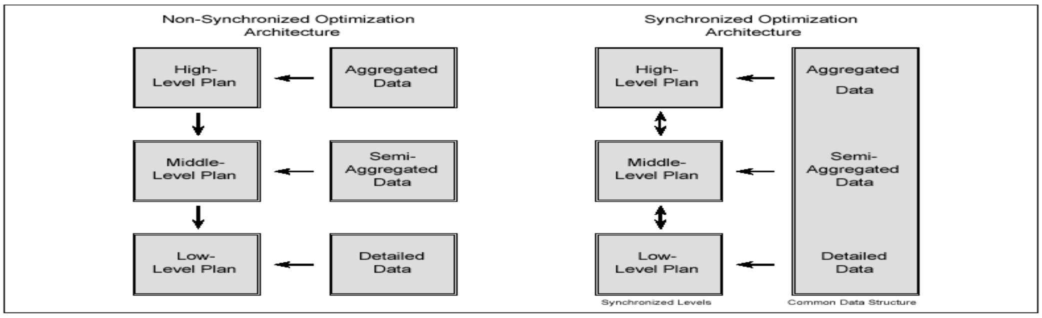


Figure 4.4 Optimization Architecture Approaches used in SCM Applications

Source: Lapide, L., 1998, Perspectives on Optimization, Advanced Manufacturing Research, Inc., Boston.

- The use of *telescoping* planning horizons
- The use of a *common data structure* for all planning levels
- The monitoring and control of the degree of synchronization. In a *telescoping* planning horizon, "time buckets" vary over time (typically increasing):
- The first few weeks may be planned in *continuous* time, like minutes or hours.
- The next few months might be planned in weeks.
- The last periods of the planning horizon might be represented in months or quarters.

This approach helps ensure synchronization along the time dimension for the different planning levels. Vendors also address the synchronization issue by using a *common data structure* for all planning levels. This common data structure ensures that aggregated data is always derived from and synchronized with detailed data—possibly down to the lowest level of base data (e.g., ERP transaction data). If needed, these solutions also allow a planner to build models using detailed data. For example, if a lower-level work task or portion of a plant's routing is always a major bottleneck, a user can include it in higher level plans to ensure that the solution is optimal and feasible.

Some vendors address the synchronization issue by incorporating functionality to monitor and control the degree of synchronization among planning levels. As a planner works with the system, if a lower-level plan gets significantly disharmonious with higher-level plans, the higher-level plans are regenerated. Paragon Management Systems has designed its APS product suite to ensure synchronization among planning levels in this way. Numetrix's *Collaborative Enterprise Network* product takes a slightly different approach. The application monitors the degree of synchronization among plans and sends a planner an alert message when they are out of synchronization.

As computers get more powerful, companies are shrinking planning cycles and achieving real-time planning and execution. In turn, this moves them toward achieving real-time optimization, as well as reducing the need for hierarchical planning processes with long cycle and lead times. A reduction in these planning cycles would lead to the following improvements:

• Reduced supply chain inventories

• More responsive supply chain operations with improved customer service

Up to now, reducing planning cycles with the use of applications has been limited by the speed at which an optimized plan can be generated. While some manufacturers have moved from planning in a batch mode, many have not. Applications are getting closer to generating optimized plans in real-time.

To do this, some vendors, such as i2 Technologies and Ortems, use memory-resident planning applications loaded into and executed in main memory. This speeds up the application substantially. Other vendors, such as Manugistics, have designed applications to use both memory and hard disk space. Generally, both approaches achieve the goal of faster plan generation. Neither approach works better in all planning environments.

A variety of design issues must be considered to develop the architecture or framework of a supply chain planning optimization application:

- The balance between modeling flexibility and built-in functionality
- The ability for the user to maintain control of optimized solutions
- The use of third party optimization components

- Special functionality for handling multiple objectives
- Functionality for supporting special optimization problems

Vendors have addressed these issues in a variety of ways, many times depending on a specific vendor's history and market focus.

Optimization depends heavily on the ability of the application to model real world issues. This can be done with built-in modeling functionality, such as predefined models for setting safety stocks. Rather than built-in functionality, an application may provide flexibility with general-purpose modeling capability that allows users to create models—such as defining safety stocks models. Applications need to provide users with a balance between built-in capability and flexibility. Some vendors provide general-purpose modeling applications that allow users the flexibility to optimize across a broad range of decisions. These products allow users to tailor the optimization to their own environment, letting them optimize decisions uniquely important to them (Suleski, 1998).

Other vendors offer built-in capabilities rather than general-purpose modeling application functionality. While these applications limit the ability to optimize unique decision environments, they minimize the implementation configuration efforts for specific supply chain problems. For example, Manugistics has recently added optimization capability to its product suite tailored for consumer products and distribution - intensive companies. While this provides less flexibility to optimize, it reduces configuration efforts. Logility is developing similar optimization capability.

Generally, optimization solutions must be understood and controlled by a user. Optimized solutions are frequently not reasonable or executable and need to be adjusted by the planner. These are decision-support, not decision-making systems! In fact, one APS vendor claims that around 40% of software development efforts are spent solely on enabling user control functionality.

The major purpose of user control is the inability to enter all details into the optimization model. For example, an optimized solution may suggest that a customer's due date be pushed out because it is critical in achieving a low-cost solution. The manufacturer, however, may have already pushed out the due date for the customer's last three orders. This would be an unacceptable solution. To ensure that optimization applications provide reasonable, executable solutions, most vendors provide graphical user interfaces (GUIs) to facilitate manipulating data and modifying solutions. This functionality includes the following:

- Graphical drag-and-drop planning boards
- User-defined constraints and rules
- Control of the optimization procedure

Many graphical planning boards allow users to change a variable (e.g., a date or order) and immediately see the impact on the objectives and assess new constraint violations.

Vendors also give users control over the solution by allowing them to incorporate unique constraints or rules into the model. For example, a planning application might allow a user to specify that customer due dates can be relaxed by one or two days, or the user may approve the maximum level of overtime. While this is useful functionality, some users are tempted to abuse it by changing the objective. This is conceptually an invalid approach to an optimization problem. Solutions that are not reasonable are best changed by altering the constraints. Some vendors allow users to control the progress and performance of the solver method. This is usually done by allowing the planner to set a time limit on the solver and then pause. This lets the planner evaluate the solution so far. If it is good enough, the user can finalize the plan. If it is not, the user can have the solver search longer for a better plan.

Some vendors use optimization components from third party vendors to shorten development time. This approach also allows the vendor to focus ongoing development resources on the planning application while the third party takes on the responsibility for improving the optimization component. The leading optimization component vendor is ILOG. The company offers three optimization components including market-leading LP/MIP acquired from CPLEX. The CPLEX solution is embedded in many applications including those from the following vendors:

- Manugistics
- i2 Technologies
- CAPS Logistics
- SynQuest

Some vendors allow planners to define multiple objectives. For example, both customer service and costs can be optimized together—despite the fact that two or more objectives cannot be optimized at the same time. Maximizing customer service is not likely to minimize costs; quite the opposite usually holds true. To accommodate planners that want to strike a balance among competing objectives, some vendors provide solvers that find an optimized solution using the objectives in priority sequence. i2 Technologies offers this type of solver using a "hierarchical" LP/MIP algorithm.

Another way in which applications allow planners to use multiple objectives is through the use of weights. This is accomplished by creating a single objective that is a combination of the different objectives, weighted by a number. For example, a customer service objective might carry a weight of 90 (out of a possible 100), while a cost objective might carry a weight of 70. The solvers in these applications optimize a single, composite weighted objective. ProMira, recently acquired by Manugistics, provides this functionality, incorporating a graphical slidebar interface to make it easy for a planner to set the weights.

Some special planning environments involving trim and blending optimizations cannot be accommodated by many supply chain planning applications. Some vendors have incorporated such capability to be integrated into their supply chain planning suites.

While the use of optimization in supply chain planning is extremely appealing, the technology may not be for everyone. Rather than by employee headcount reduction alone, these solutions are justified by such supply chain benefits as the following:

- Inventory reduction
- Improved customer service
- Increased asset utilization
- Improved corporate profitability

We need the list of the concerns that guide companies when they want to purchase and implement optimization tools;

- Optimization is generally beneficial in complex manufacturing environments where many interrelated decisions need to be made. These include environments with many resource constraints and large numbers of products, plants, suppliers, and distribution centers. Planners in these environments need computer support to make optimized decisions. In contrast, planners may not need optimization support in simple, mature environments, where methods based on experience may already yield nearly optimal decisions.

- In strategic and higher-level tactical planning, the pursuit of optimized solutions is typically more important than it is for low-level tactical and operational planning. In the former, the feasible set for decisions is much larger, meaning there are more opportunities to make poor decisions. Also, these decisions have greater revenue and cost implications.
- The answer to "Where is the most pain in my supply chain?" will be important in deciding what portion to optimize. In supply-con-strained industries that experience material shortages, optimizing the use of these materials in the manufacturing process is important. In make-to-order environments, especially in discrete manufacturing, optimized production schedules are crucial. For distribution-intensive environments, planning must focus on optimizing manufacturing and distribution operations simultaneously.
- Optimization is more useful in mature, relatively non-volatile manufacturing industries where product demand and manufacturing processes are more predictable. In these planning environments, realistic models can be constructed to support all levels of planning. In volatile manufacturing environments, optimization will be less useful for strategic and tactical planning. In these environments, planning focuses on supply chain readiness and responsiveness rather than on operational efficiency. Optimization will be more useful for operational planning, when the level of uncertainty is substantially reduced (e.g., when many customer orders are already placed).

5. INFORMATION TECHNOLOGY INTRODUCES NEW CONCEPTS TO THE SUPPLY CHAIN WORLD

5.1 Continuous Replenishment Program And Vendor Managed Inventory

CRP is an efficient replenishment concept within the Efficient Consumer Response (ECR) arena. It focuses on improving the flow of products in the supply chain, both forward to the customer and eventually the end consumer, and backward to the supplier (Ahlerup, 2001).

Both of these concepts are introduced with the developments in the information technology arena since they highly depend on information technology solutions. It is now possible to integrate the two systems (both the Vendor's and the customer's) with the use of information technologies.

The goals of CRP are to:

- Increase inventory turns
- Reduce inventory levels
- Decrease stock-outs
- Improve customer service levels
- Boost warehouse efficiency
- Enhance your trading partners' perception of value.

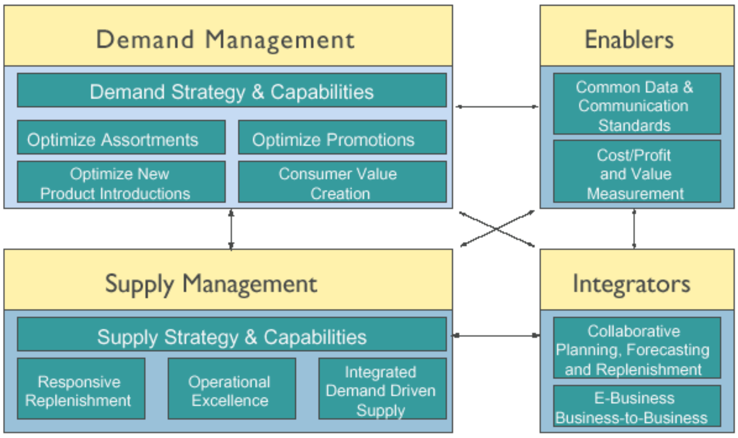


Figure 5.1 CPR Schema

Source: Ahlerup, T., 2001 Continuous Replenishment Program And Vendor Managed Inventory, Intentia Solution Publications, pp 3.

Efficient Consumer Response (ECR), Quick Response (QR),Vendor Managed Inventory (VMI) and other similar efforts have had a great impact on today's latest trends, such as Collaborative Planning, Forecasting and Replenishment (CPFR). VMI should be viewed as a stepping-stone towards a collaboration process or part of such a process. Its scope is not as wide as the scope of CPFR, but in many situations, VMI alone is found to be an extremely efficient method of controlling the supply chain.

A term widely used when implementing CRP, Vendor Managed Inventory (VMI) is an arrangement where the supplier, not the customer, decides when and how much of the customer's stock is replenished. It is a way to cut costs and keep inventory levels low throughout the supply chain. VMI focuses on assuring that products are replenished to stock in the most efficient way, without manual information such as orders having to be transferred between customer and supplier. Instead, automatic electronic messages are used to keep track of the current stock situation and planned sales forecasts, so you can determine when it is time to refill the stock and avoid stock-outs.

VMI initiatives emerged in the late 1980s when department stores such as Wal-Mart moved to automate VMI. The apparel industry has continued to be a pioneer in VMI ever since. Ironically, industries facing complex situations have been among the last to adopt automated VMI. For example, supermarkets have typically taken longer than department stores to implement VMI. The sheer number of items in consumers' shopping carts and on the supermarket shelves–often more than 25,000 in one store–have meant greater complexity in tracking and using sales data. VMI automation at its peak can be seen in industries such as automotive and paper manufacturing (Ahlerup, 2001).

The objectives of VMI are to:

- Increase sales
- Improve customer service
- Increase gross margins
- Reduce overall inventory in the supply chain
- Stabilize vendor's production.

Another interesting issue that is part of the VMI process is whether the customer should be invoiced directly at shipment or after selling the products to their own end customers. This concept is called consignment stock. By definition, consignment stock is a marketing arrangement whereby physical control of merchandise, but not title, is transferred from one business (the consignor) to another (the consignee). As consignee, the title to the goods remains with the consignor until the goods are sold. As a result, consignment stock may not be shown as an asset in the consignee's books.

5.1.1 A CRP and VMI Model

In the example that follows, it is assumed that the vendor (supplier) manages the inventory level and availability at the distributor's (customer's) warehouse, based on forecasted demand and current stock level information sent from the distributor.

From the supplier's perspective, a VMI model generally entails:

1. Receiving stock levels from a customer
2. Receiving sales forecasts from a customer
3. Generating replenishment orders when needed
4. Sending dispatch advice to a customer
5. Receiving sales reports from a customer
6. Sending invoices to a customer

In the first step, the supplier receives up-to-date information on product availability, mainly electronically through Electronic Data Interchange (EDI). However, the supplier also needs a near-future sales forecast of products to predict when and how much to refill in stock. After this, the supplier creates a planned replenishment order for the customer. The entire concept of VMI is based on the supplier generating the replenishment order, not the customer (Waller and others, 2001).

When the time comes to deliver the products, dispatch advice is sent, mainly electronically, from the supplier to the customer. The customer can then prepare to receive the products. After this, normal delivery takes place and the inventory balance is updated.

What happens next is mainly determined by the agreement between the supplier and customer. For example, a consignment agreement can state that the supplier will not be paid until the customer has sold or used the products. In that case, the customer sends a sales report back after using the products, which triggers the invoicing process for the supplier. The other alternative is to invoice the customer directly at shipment.

As in many other cases where the supplier and buyer must collaborate, the rules and working guidelines must be clearly stated and agreed upon in advance for the relationship to work. One of these rules is definitely the payment rule.

5.1.2 The Technology Backbone of CRP and VMI

For many suppliers, producers, distributors and retailers worldwide, EDI has become the backbone for computerized business-to-business communication. Meanwhile, the use of the Internet has exploded and new technologies, such as eXtensible Markup Language (XML), have recently surfaced (Waller and others, 2001).

Many people are concerned that the benefits of electronic commerce standards such as EDI will be swept away by the excitement of the Internet. However, we believe that it is not realistic that EDI will be replaced by the new technologies overnight. It will probably be a gradual process, where XML is used further back down the supply chain, possibly with second- or third-tier suppliers, where EDI has been too complex and expensive to implement. Or, XML might be used when real worldwide standards are available to enable the new technologies to provide more flexible and responsive communication between the parties.

The most widely used technology in VMI is still EDI. Typically, the manufacturer reviews inventory stock balances daily by receiving EDI files from the distributor or retailer. The manufacturer then uses the inventory information along with other known information, such as sales forecasts and promotional activities, to calculate and create an anticipated replenishment order for the customer. After receiving an electronic acknowledgment of the planned replenishment, the manufacturer ships the order. When the product is received at the customer site, payment is made with an electronic funds transfer from the customer's bank. Another common scenario is that the customer receives an invoice only after sending a sales report EDI message to the manufacturer.

In the CRP-VMI process, these EDI messages can usually be seen:

- Inventory report
- Sales forecast
- Order response
- Dispatch advice
- Sales report
- Invoice

5.1.3 Benefits

A traditional answer to addressing customer service problems has often been to increase inventories. If inventory is in the pipeline, including the stores, then consumers will never have to face products being out of stock. Unfortunately, inventory bears a high cost in terms of capital consumption and expense. Also, in the food and beverage industry, higher stock cannot be the solution, since issues such as shelf life and promotions make it impossible to simply increase inventory (Ahlerup, 2001).

One main goal of continuous replenishment programs like VMI is to keep stock levels at a minimum throughout the supply chain. VMI benefits suppliers and customers (or distributors and retailers) alike. Some of VMI's many benefits are listed below.

Supplier benefits:

- Visibility to the customer's point-of-sale data simplifies forecasting.
- Promotions can be more easily incorporated into the inventory plan.
- Customer ordering errors, which in the past would often lead to a return, are reduced.
- Stock level visibility helps identify priorities (replenish stock versus a stock-out).
- The supplier can see the potential need for an item before the item is ordered.
- Customer benefits:
- Fill rates from the supplier, and to the end consumer, improve.
- Stockouts and inventory levels often decrease.
- Planning and ordering costs decrease since the responsibility is shifted to the supplier.
- The overall service level is improved by having the right product at the right time.
- The supplier is more focused than ever on providing superior service.

Dual benefits:

- Data entry errors are reduced due to computer-to-computer communications.
- Overall processing speed is improved.
- Both parties strive to offer better service to the end consumer. All parties involved benefit when the correct item is in stock when the end consumer needs it.
- A true collaborative partnership is formed between the supplier and the customer.

Long-term benefits include more efficient promotion handling, improved product introductions, more efficient product distribution and an eventual increase in sales.

Trading partners who focus on changing business relationships definitely maximize their bottom lines by using VMI. Those who have embraced VMI have seen the following benefits (Ahlerup, 2001):

- Eliminated repetitive purchasing activities (85% reduction in receiving costs)
- Lowered cost of processing claims (95% reduction)
- Reduced inventory (40% to 50%)
- Increased inventory turns (from 3.1 to 5.5)
- Solidified customer-vendor relationship

Under VMI, manufacturers, retailers and distributors can focus on the same issue–how to sell more products to the end consumer more efficiently. This changes the manufacturer's focus from getting the distributor to buy more to helping the distributor sell more. This change in relationship is surely the most exciting feature of VMI.

The success of Procter and Gamble's program with Wal-Mart helped make VMI a cornerstone practice of Efficient Consumer Response (ECR), a grocery-industry initiative to remove excess inventory from the pipeline and synchronize consumer demand with production. And for many of the companies that have tried it, VMI has produced remarkable results. Sales, service and profitability are all improved by turning the tables on the traditional trading relationship (Ahlerup, 2001).

However, critics of initiatives like VMI claim that the farther you move up the supply chain, the less visibility you have. Ironically, VMI was created as a means of providing increased supply chain visibility. Industry experts believe that VMI works best when a manufacturer restocks a product that does not have much variation and is not subject to seasonal fluctuations in demand.

VMI is not a new concept. In fact, the basic concept of automated inventory replenishment by suppliers has been around in the retail world for more than 30 years. However, as with other trends, VMI will likely be redefined or replaced. We can see that similar trends such as Supplier Managed Inventory (SMI) or Joint Managed Inventory (JMI) are merely different ways of looking at the same thing.

Today, focus is shifting beyond VMI toward programs like Collaborative Planning, Forecasting and Replenishment (CPFR). With CPFR, a retailer sends data to a manufacturer over the Internet, and the manufacturer then uses the data to generate a replenishment forecast that will be shared with the retailer before it is executed.

Unlike VMI, the manufacturer and retailer jointly decide on replenishment actions in the CPFR scheme that was designed by both parties.

The business goals are clear:

· Cut costs

· Reduce inventory along the supply chain

· Avoid stock-outs and thereby ensure consumer loyalty.

6. COLGATE-PALMOLIVE

Colgate-Palmolive is a $9 billion global consumer products company, tightly focused on Oral Care, Personal Care, Household Surface Care, Fabric Care and Pet Nutrition. Colgate sells its products in over 200 countries and territories around the world under such internationally recognized brand names as Colgate, Palmolive, Mennen, Softsoap, Protex, Sorriso, Kolynos, Ajax, Axion, Soupline, Suavitel, and Fab, as well as Hill's science diet and Hill's Prescription Diet Pet foods.

The company began in 1806 when William Colgate, an English immigrant, setup a starch, soap and candle business in Newyork and since than it grew rapidly and gained a well know position in the fast moving goods industry all around the world.

Today's business world is changing faster than ever. Organizations are rethinking and changing the way they do business. If there ever was a time for organizations to be innovative and to lead in information technology, this is the time. Global Information technology has a unique role within the Colgate Corporation. Colgate owns its IT professionals responsible for developing and implementing technical strategies to improve business processes throughout the organization. One of their major initiatives in the 90's was to choose and successfully rollout SAP R/3 across most of their global operations. Colgate began rolling out the SAP core solution in 1995 to improve operations through consistent, global support for financial analysis, logistics planning and other business processes. The SAP implementation was also an enabler for a standardization drive across Colgate that encompassed all general naming conventions, formulas, raw materials, manufacturing data and processes and financial information.

Building on the success of the Colgate Palmolive SAP implementation, SAP has chosen Colgate Palmolive as a partner for a high proportion of their new developments in the fast moving consumer goods industries.

Colgate-Palmolive manages all its brands globally, and in November of 1999, it kicked off the Colgate Global Supply Chain initiative to do the same for its supply chain. Colgate wanted to leverage the investment in its core SAP R/3 solution to further enhance supply-chain performance worldwide. The business goal: improve service to retail and internal customers, reduce inventory, and improve margins.

Colgate selected mySAP Supply Chain Management (mySAP SCM) to power its supply chain management initiative. Using SAP Advanced Planner and Optimizer (SAP APO), Colgate got the metrics it was looking for. It improved on-time and complete orders from 70% to 98% for vendor-managed inventory (VMI) replenishment. It increased compliance levels for inter-company replenishment. And it improved customer order fulfillment to 95%. Colgate also lowered inventory by 10% and reduced overall order cycle times.

MySAP SCM delivers solutions on three key fronts. It enables Colgate to gain visibility into global logistics data. It allows Colgate to optimize its operations through use of advanced mathematical planning functions. And it provides a platform for collaboration with Colgate customers and partners.

Within the Colgate Global Supply Chain initiative, Colgate identified three major supply-chain strategies. The first was to roll out a VMI program with key accounts to significantly reduce channel inventory and cycle times. Colgate also wanted to implement cross-border sourcing program, moving it from a regional to a global sourcing model. This transition improves forecasts, reduce safety stock, consolidate assets, and leverage economies of scale worldwide. Finally, Colgate wanted to implemented collaborative planning process with its downstream subsidiaries to manage promotional demand and to synchronize activities across the supply chain.

Within Colgate, VMI is a pull process by which the company replenishes customer distribution centers based on daily transmission of the inventory and demand information. Current VMI focus is North America, where 40% of cases shipped form 5 plants is managed using VMI. The implementation includes 40 distribution centers at 12 customers covering all categories of Colgate products (about 1000 SKUs).

The VMI Business process is supported by mySAP SCM's supply network planning capabilities. Daily inventory levels and demand from customer distributions centers are transmitted to my sAP SCM, which then calculates the replenishment orders. mySAP SCM incorporates plant capacity information to determine the production requirements and any supply constraints. The replenishment orders are then transmitted back to the customers via EDI for acknowledgement and for handling customer information-processing requirements. The benefits Colgate has realized through VMI including 98% on-time and complete order compliance and a on-day replenishment order cycle – will be multiplied as the implementation expands across other regions.

6.1 Vendor Managed Inventory (VMI) And Co-Managed Inventory (CMI)

6.1.1 Colgate-Palmolive's Definition For VMI and CMI

The difference between VMI and CMI is as follows:

VMI allows the Vendor (Colgate) to automatically replenish the Customer with inventory at its Distribution Center based on a prior agreement of service and inventory levels. A Vendor VMI Analyst manages the replenishment situation and highlights any issues to the Customer.

CMI requires the Vendor (Colgate) to suggest replenishment to the Customer's Distribution Center based on a prior agreement, but allows the Customer to Collaborate on the order and accept or change the order before it is shipped from the Vendor. The main reasons for implementing VMI is to reduce inventory levels in the supply chain, reduce costs, strengthen relationships with Colgate-Palmolive's Customers, minimize potential out of stocks.

VMI process is applicable for the consignment materials of Colgate-Palmolive, which means that Colgate places inventory at the customer's location and retains the ownership of the inventory. Payment is not made until the item is actually sold by the customer.

Replenishing the Customer:

There are 2 criteria to be considered in the replenishment of the customer.

1.Target Stock Levels:

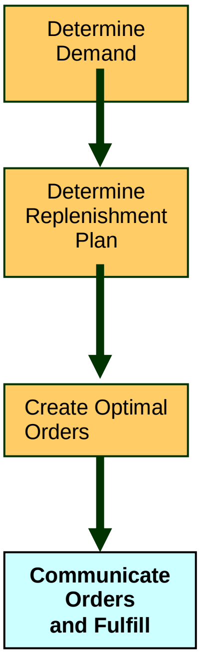
For instance the Carrefour/CP Argentina (pilot customer for Latin America – Colgate) uses an average of the last 28 days withdrawal history from Carrefour to create a Moving Average Forecast and the "Target Stock Levels" will be a number of days coverage based on that Forecast.

2. Future Demand:

All VMI and CMI customers drive their future replenishments by recognizing:

- Turn Forecasts generated over the next 6 weeks based on history
- Special Events or Promotions entered in Demand Planning

6.1.2 Vmi General Process Overview



- Demand and Inventory information is received from customer systems by EDI and data is translated as necessary.

- Calculate required replenishment quantities based on inventory targets, service levels, lead time and forecast
- Recommend a time-phased replenishment plan

- Convert replenishment plan into orders within time horizon
- Optimize orders based on shipping and picking characteristics (e.g. layers, pallets, weight, etc.)
- Create/recommend orders in SAP

- Transmit order information
- Fulfill orders

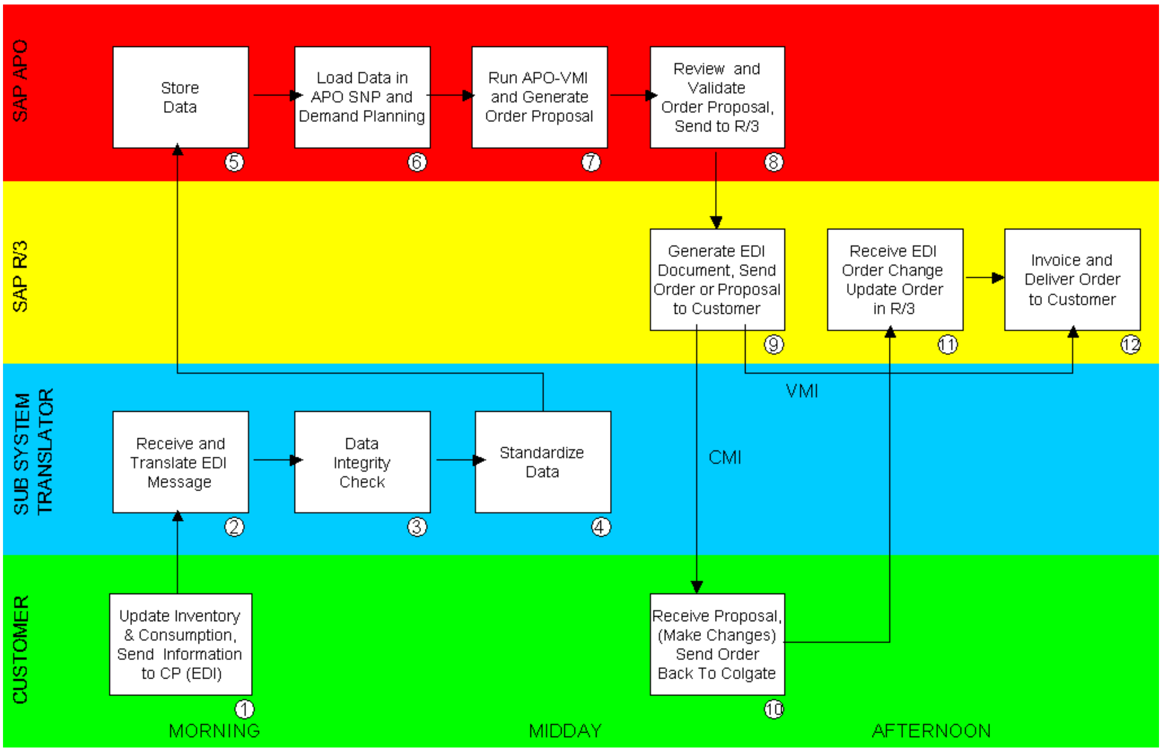


Figure 6.1 Global VMI/CMI Process Flow

Step 1: Update Inventory & Consumption, Send Information to CP (EDI)

Customer updates its information in its internal systems daily and prepares agreed upon file to be sent via EDI into Colgate's system.

Step 2: Receive and Translate EDI Message

Customer EDI Data is sent daily and contains:

- Physical Inventory by Location
- On Orders into Customer Location from Colgate
- Customer Shipments (Consumption)
- Customer DC outages
- Special Events/Promotions
- Data translation includes mapping from Customer to Colgate Material, then R3 Material Determination to map to any internal Colgate materials.

APO receives data via an IDOC and APO stores the customer data for processing and reporting.

Step 3: Data Integrity Check

IDOC is posted, if it is posted without error, process continues. If the IDOC ends in error, users are expected to fix/edit to repost the data.

Step 4: Standardize Data

1. Translation and standardization of EDI data:

- Customer provides the EAN code of the material for matching in SAP. If more than one EAN code by Sales Org exists, mapping refers to Material Determination to determine Colgate Material #.
- Purchase order numbers can be assigned in advance and saved in the system. For CMI, it is assumed that the Customer will send a PO in after they review the Colgate Order Proposal.

2. In-transit Data:

- For the Argentina Pilot customer APO creates an In-transit once a Sales Order Goods Issues.
- The In-transit "times out" after the Expected Arrival Date.

3. Enhance the 'on order' data received from the customer (In Process)

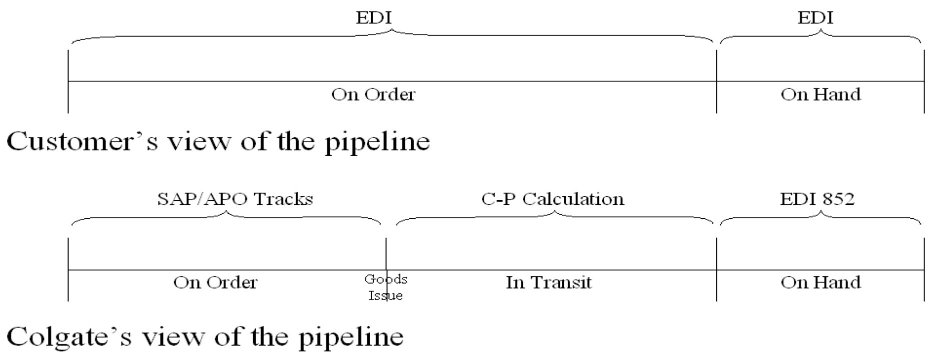


Figure 6.2 Point of View - Pipelines

On Order Data from Customer includes

- Orders not yet Goods Issued from Colgate's system
- Orders that have been Goods Issued but not yet received (In-transit)

Step 5: Store Data

Data is stored in APO within Demand Planning and the data is stored at lowest level (material by location) on daily bases. APO Data for the Argentina Pilot does not include Product Hierarchy information, BW (business warehouse) Reporting capabilities should merge this data. Helps not to have to realign historical data

Step 6: Load Data in APO SNP and Demand Planning

← Past | Future →

Day	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Daily Demand History	7	5	9	4	8	6	6	8										
Daily Turn Forecast									7	7	7	7	7	7	7	7	7	7
Promotional Requirements											100						50	
Total Forecast									7	7	107	7	7	7	7	7	57	7

Figure 6.4 Forecast Calculations within a Time Horizon

Demand History is stored at a daily level and a daily turn forecast is generated as a straight-line average of the demand history. Promotional requirements are either manually keyed in at the daily level, or submitted by the customer and held in DP. Customer only provides actual history.

- Argentina pilot customer creates a 28 days moving average forecast.
- Promotional Data is entered by Customer Service, as Carrefour currently does not send this data electronically.

Step 7: Run APO-VMI and Generate Order Proposal

APO process interfaces with R/3 for product master data, customer orders, and inventory information:

“Available to Deploy” is based on subsidiary needs. All VMI and CMI orders will be created based on Available to Deploy inventory and “ATD” inventory is equal to:

- On Hand Inventory at the warehouse
- Any Open Sales Orders at the warehouse is deducted from the current inventory to calculate the ATD

CMI Customer Process:

- APO sends R3 a Sales Order (with a temporary/fake PO#)

- R3 Sales Order has an Order Type of ARCM.
- Order Proposal to CMI Customer includes R3 Sales Order #.

CMI Customer will review and have ability to change order and adds their PO, reference the SAP Sales Order #.

- R3 then rejects the original SAP Order and creates a New Sales Order based on what the Customer Requirements are. This order uses the EDI Order Type.
- R3 Sales Report “EDI - Orders: Sales Org/Customer” allows CS Rep to monitor orders by Order Type past agreed upon response time.

VMI Customer Order Process:

- APO sends R3 a Sales Order (with predefined PO#)
- Order Proposal to VMI Customer
- Customer Service Rep manages flow of order

Step 8: Review and Validate Order Proposal, Send to R/3

Reports (Via BW Explorer)

–Inventory coverage (dynamic-before/after order proposal)

- Below minimum coverage (SKU level)
- Over maximum coverage (SKU level)
- Total average coverage

–Out of Stock

- SKUs currently out of stock
- Projected stock-outs

–KPI Reporting: Post Go Live Development

- Turns
- DC to Store Case Fill
- Logistics efficiency

–Load Weights

–Pallet efficiency

–Order Proposal vs. Customer Confirmation: Post Go Live Development

- % Change in Materials, % Change in Total Cases by Order
- Ability to roll up to Customer Location Level

Alert Monitor:

– Inventory coverage (dynamic-before/after order proposal)

- Below minimum coverage (SKU/Location level)
- Over maximum coverage (SKU/Location level)
- Out of Stock
- SKUs currently out of stock
- Projected stock-outs

Step 9 and 11: Generate EDI Document and Send Order or Proposal to Customer / Customer receives EDI Order or proposal and replaces or changes the proposal in R/3. This process is needed to categorize and split processing for VMI/CMI customers

– VMI orders are moved into R/3 for immediate release.

– CMI orders are held in R/3 until they are approved by the customer.

- VMI & CMI Orders differentiated by "Order Type" in the R/3 system.
- CMI Customer Response rejects original Sales Order and replaces with new Sales Order, using the EDI Order Type.

In addition, reports are developed to compare the original versus the changed Order

Step 10: Receive Proposal, (Make Changes) Send order back to Colgate

1. Customer Reviews Colgate Order Proposal

2. Customer can Change:
   – Item Quantity (increase or decrease)
   – Add Items
   – Delete Items

3. Customer Sends Colgate:
   – EDI Order with Purchase Order

– Cross Reference Colgate Sales Order #

Colgate EDI Translation Logic is same as described earlier

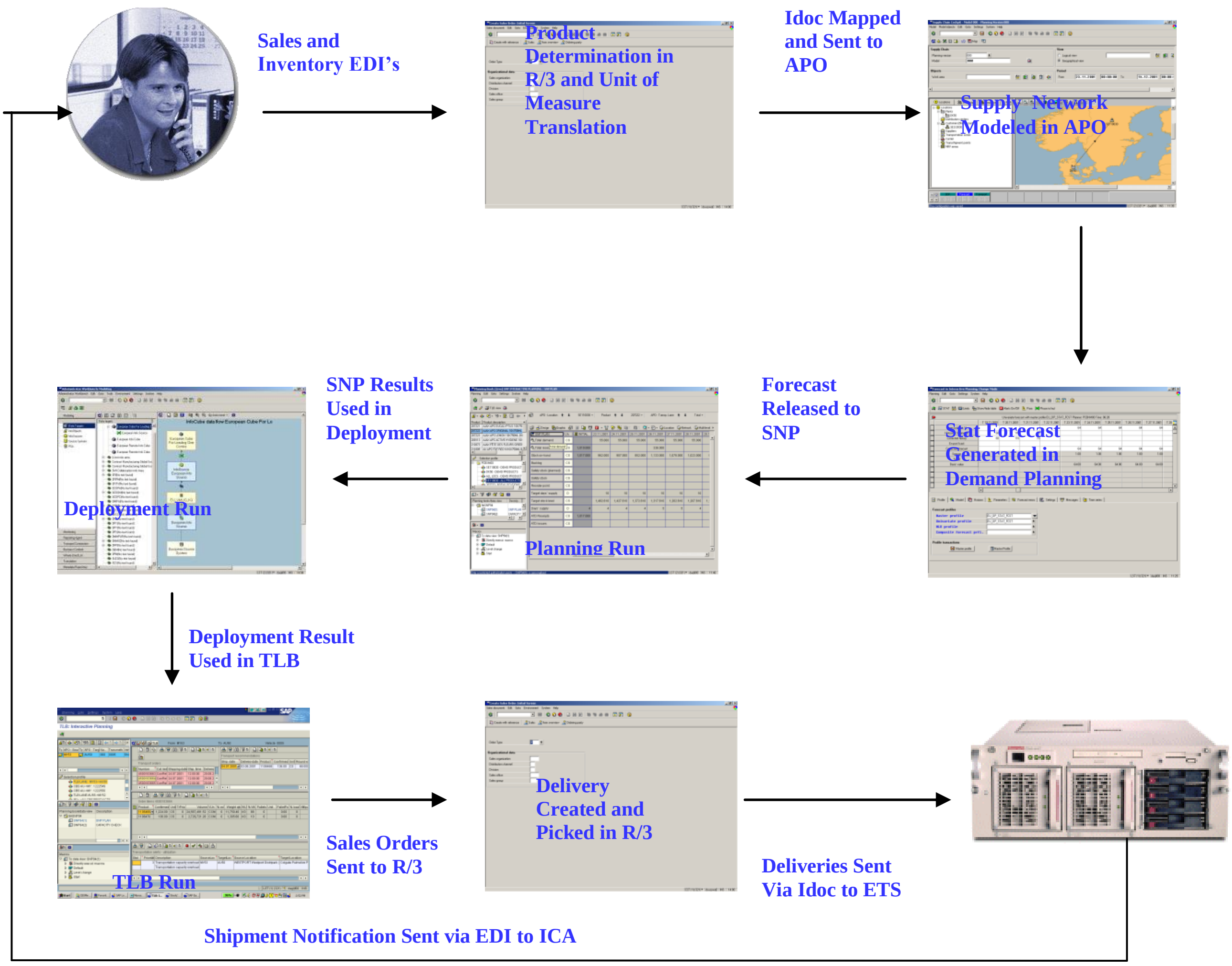


Figure 6.4 VMI Data Flow

- Customer Info. & Master Data in APO
- A Statistical Forecast is generated in Demand Planning (DP)
- Forecast is released to Supply Network Planning (SNP)
- Heuristics is run (Planning Job to calculate replenishment based on forecast figures, target days supply, stock)
- Deployment is run, using results of Heuristics (checks requirements against available stock at warehouse, creates a Transport Recommendation.
- Transport Load Builder (TLB) is run to optimise truck load, based on lot size, pull horizon, shipping calendars.
- TLB creates an order proposal/transport recommendation in APO.
- Proposal is checked by VMI analyst & released to R/3.

- SAP order created & number fed back to APO.
  - Order / delivery is processed in R/3 & details fed back into APO.
  - Shipping Notification is sent to customer via EDI.

6.2 Supplier Managed Inventory (SMI)

SMI is a process where a supplier becomes totally responsible for inventory management of the materials used by Colgate. The supplier will manage the replenishment of materials used by Colgate without being prompted by a release, being cognizant of Colgate's usage forecast. Suppliers will determine the quantity of materials to be shipped, shipment dates and method of transportation.

6.2.1 Colgate - Palmolive's Mission:

To work jointly in a cross functional environment to increase the beat rate of our information and provide a pipeline type material supply by providing our partners with timely and accurate information allowing them to reduce costs, waste, inventory and NVA while maximizing customer satisfaction.
To use B2B and Internet Functionality to increase the "Beat Rate" of information between Colgate - Palmolive and its partners by:

- Sharing data openly
- Increasing data timing and accuracy
- Shifting decision making to the most capable party (supplier)

Expected Benefits:

- To improve data accuracy and frequency
- Reduce macro managing of SMI business by production planners
- Operational cost advantage
- To provide flexible and user-friendly reporting to the suppliers
- Gives possibility to download the data to an excel spread sheet or text file
- Only internet access required (no GUI installation is required
- Global Solution with real scalability
- Roll up capability across R/3 & Non-R/3 instances
- Reduced inventory level (Working Capital)
- Increased customer satisfaction

- Reduced cycle times

The APO Collaborative System allows supplier to display their material's demand data from each of the Colgate facilities that they supply via the Colgate – Palmolive Collaboration Website. The Collaborative System website is accessed via Internet Explorer at https://collaboration.colpal.com

In reaching the final SMI system solution Colgate has identified the gaps between the current business process and the best practices through gap analysis. Gap analysis results are presented below

Table 6.1 Gap Analysis Results

Item	Current Process	Gaps Identified	To reach Global Best Practice		Business Process Vision	Requirements to Reach Vision
			Minimum Requirements	Advanced Level		e.g. Resources, capital, business process changes
Data Supplied						
Frequency	Reports are posted to a CP internet website on a daily basis Mon-Fri. There are no weekend updates since MRP is not run on the weekends. Weekend supplier deliveries are based on limited data. Forecast is a 13 week rolling forecast. Some vendors (~20%) receive data via	Suppliers do not receive updated planning data over weekends, uncertainty in forecast, usage, inventories can result in need to hold excess inventory or stockouts. This also requires increased NVA activies for the plant planner.	Daily forecast, inventory, usage, and good receipt data posted to the internet on a 7 day basis. Information provided for current week. EDI transfer made available if requiested by supplier. Daily&weekend APO/MRP runs required.	Internet transaction server to provide frequent updates.	Forecast data is shared after MRP/Heuristics Run. Other inputs (usage, inventory, receipts) available on a demand pull basis. Vendor can define selection criteria.	Obtain Global alignment on the standard - program this standard into the system. Logon profiles / authorisations created. EDI formats agreed and in place. MRP active 7 days / week.
Reports	There are 4 separate static reports for each vendor to each separate CP usage location. Historical data is for current week only.	Reports can not be easily manipulated to complete vendor data analyses. Report data can not be easily combined or sorted.	A single report covering all information for a specific item to each location.	Interactive reports	Data will be presented in a user friendly format that can be easily interpreted and manipulated. For example, this may range from on-line sorting to drill down capabilities. Vendor has the ability to "roll up" data based on SKU and across plant locations. Data can be manipulated for analysis.	Standard report agreed with business and coded with online interaction via table views. Active downloads available to Excel. Logon profiles / authorisations created and assigned to users
Inventory	Inventory adjustments are made based on routine or as needed cycle counts. A one week frequency is typical on common	Large and/or infrequent inventory adjustments can disturb vendor planning and result in excess vendor inventory buffer or	Inventory adjustment frequency is determined based on demand, safety stock, etc...		Inventory adjustment cycle frequency needs to be determined to avoid significant fluctuations that would be detrimental to the SMI process.	Process identified and agreed by business to identify SMI inventory cycle issues and process for resolution obtained.
Status	There is no communication to the suppliers when MRP run has not been completed. Vendors are directly interfacing with planners to resolve issues.	Suppliers are uncertain as to the status/accuracy of internet data downloads. Vendors would like to see exception reports on internet data posting.	Vendor is informed as to the status of internet reports (internet or eMail)		Vendor has R/3 access for status or Internet site identifies current status or e-mail sent out where issue exists	E-Mail process exists for exception communication. R/3 access provided via ITS or posting on Internet site for status based upon completed jobs.
Liabilities						
Payments	The consignment liabilities report is prepared at the end of the month and faxed to the suppliers for review.	- Vendors would like to see summary of CP usage prior to end of month to identify potential issues.	-The consignment liabilities report should be made available on a demand pull basis by the suppliers.		Vendors will have access to the consignment liabilities report (summary of liability movements / total cost) on a routine basis.	Coonfirm standard for CL Report and obtan global alignment within SMI process. Modify report and create associated trsnaction access and assign to access profiles. Add into Trasnaction server / Internet site by vendor.
					The payment process is based on an end of month backflush summary of finished goods production. Usage is compared to goods	
Information Flow						
Feedback	The current system is an open loop system from CP to supplier. There is no transfer back to CP on the delivery schedule.	Transfer back to CP of actual delivery schedule required to improve the planning process. No visibility or exception generation.	Vendor sends Fax / Email with delivery schedule	Vendor transmits data file for transfer to R/3	Vendor has R/3 access and can input delivery schedule directly to CP.	Transaction modified / created. Logon profiles / authorisations created. EDI formats agreed and in place. MRP active 7 days / week.
CP Resources	There is a high degree of plant planner interaction to handle specific vendor items. Planners may need to schedule individual deliveries.	A significant amount of NVA time is spent by the planner to manage the SMI process. There should be a means to provide more "real-time" storage inventories for specific	More frequent update of information,e.g. weekend updates	Telemetric transfer of actual inventory levels where needed.	Telemetric transfer of actual inventory levels where needed. Data can be directly inputed to supplier MRP system for delivery planning.	Identify technical setup. Create process to identify needs and technical setup requirements.
KPI's						
KPI's	There is no formal system in place to quantify supplier performance. Non-standard events must be tracked manually.	Specific KPI's are required to track vendor performance to provide vendor incentives and a means of continuous improvement.	Vendor is informed of impact to CP production and costs for significant events.	Specific KPI's are tracked. Non standard events such as unplanned schedule	R/3 handles KPI tracking. KPI's are used for continuous improvement in service level and reduction in TDC (vendor and CP).	Obtain business alignment on Global KPI's. Produce technical specification for standard R/3 / BW reports. Code reports in system, test and roll-out

6.2.2 SMI Information Flow

All the figures displayed on the Colgate – Palmolive Collaboration Website reference the transactional data stored in SAP R/3 System.

Initially data is extracted from Sap R/3 at agreed frequency (current process is updated on daily bases). Extracted data includes:

1. Daily received quantities from the supplier for each material and Colgate Plant (1 month in the past)
2. Daily usage quantities(1 month in the past)
3. Forecasts for each material and Colgate Plant (Total requirements / 2 months in the future)
4. Current stock position
5. Safety Stock Level for each material

This extracted data is then uploaded to SAP - APO data infocubes. Finally the planning phase takes place and the calculated figures are stored in back-up infocubes which are accessible by the web reports.

Following chart gives the data flow in the details.

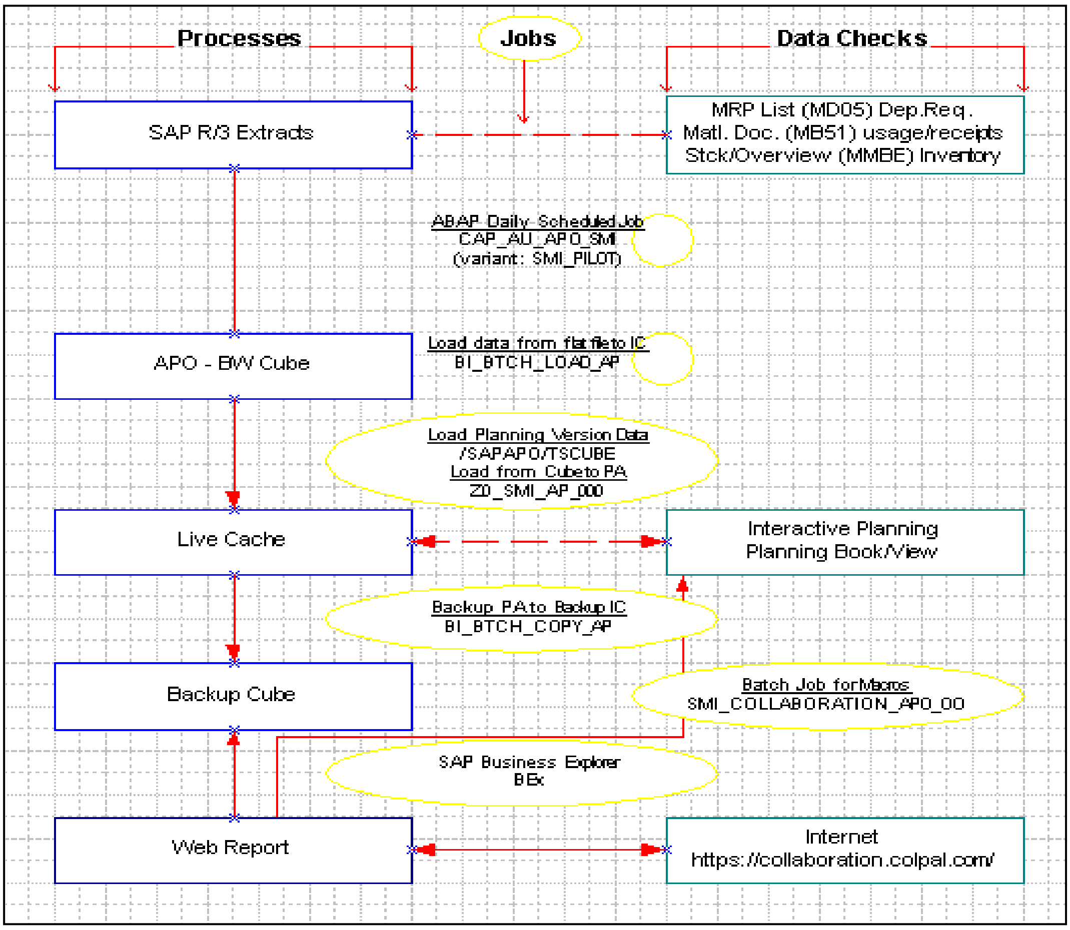


Figure 6.5 SMI Data Flow

6.2.3 Achieved Goals by Colgate and It's SMI Partners

Colgate believes their suppliers gain benefits from a SMI partnership with Colgate. Participating suppliers are the sole source for the material item at the Colgate manufacturing location, and have 100% visibility of our demand requirements. They have the ability to use Colgate as a terminal (bulk raw materials), and thus release storage for alternative uses.

In addition, suppliers have the ability to use SMI as a marketing point of difference. Depending on individual circumstances, it may be possible for suppliers to generate freight/logistics savings, and a potential reduction of inventory.

One of the major benefits for Colgate is to develop and strengthen strategic partnerships with key suppliers. Other more tangible benefits is the reduction of inventory and working capital, elimination of material carrying costs (i.e. cost of interest), and improvement in cash flow position. Finally, Colgate believes that SMI enables the elimination of 'non-core' activities, and the freeing up of resources.

7. CONCLUSION

Information Technology has started to develop after World War II and was pioneered by Americans. In 1961, when the first journey to the moon was completed, a new era for computers has been understood by all industries. At last, end of 1960's, the first electronic transmission has been achieved and it was all of the beginning of today's Internet world.

When the world of business started to become global, information and data processing became important. More customer and supplier information required for running the business and managing the operational efficiency and effectiveness. Information has become the most valuable asset of the companies in order to compete with its competitors. Today it is no surprise that amazon.com has two warehouses approximately 100 meters cubes per each, for storing its processing servers.

At first, the integration of information within the company was a huge step for companies, which provided more visibility and accurate information through out the company. As a result of this requirement, nearly %84 of companies by now have implemented Enterprise Resource Planning (ERP) applications.

After adopting re-engineering and continuous process improvement techniques to improve in-house processes, firms have begun to consider their relationships with their supply chain partners, shifting their attention to the extended enterprise, the full set of relationships that link supply chain activities from acquiring raw materials to end use consumption. Their goal is to reduce costs throughout the system and to leverage supply chain partners' skills to improve the firm's, in fact the entire supply chain's, competitive advantage. Recent developments in information technology have helped fuel this trend. For example, companies now strive to substitute information for inventory. A firm's ability to capture and use information has widened the gap between outstanding and mediocre supply chain performance. In addition, market trends towards higher product variety and greater customization have complicated the task of managing supply chains without using information technologies.

Between 10% and 13% of a developed country's gross domestic product (GDP) can be attributed to logistics-related costs for the movement of parts, components, and finished goods between suppliers, manufacturers, and customers. Today's globally dispersed supply chains make having access to logistics data — and staying connected to trading partners— business imperatives. Maximizing logistics' operational economies, predictability, and effectiveness requires that accurate and up-to-date logistics information be available to all facets of enterprise operations — from sales and marketing, to manufacturing, to supply chain managers.

Businesses are increasingly servicing global customers and relying on globally dispersed supply partners to provide parts and components used in new product assemblies. Effectively running such distributed operations requires organizations to manage three key "flows":

1. The flow of goods;

2. The flow of finances; and

3. The flow of information.

Logistics operations are at the core of all three flows, providing the critical links between customers, channels, manufacturers, and suppliers. All business entities must strive to incorporate better logistics related information into all business processes.

Faced with global competition, increased pricing, time-to-market pressures, and investor demands, executives identify key objectives as cutting costs and enhancing operational performance. Many executives are beginning to understand the beneficial impact of logistics in both these areas and are making integration and improvement of logistics operations a key business strategy.

Maximizing logistics' operational economies, predictability, and effectiveness requires accurate and up-to-date logistics information available to all facets of enterprise operations.

Emerging visibility and exception management solutions provide a Web-based platform to automate, synchronize, and monitor inter enterprise relationships between multiple parties, providing the connectivity, messaging, and alert mechanisms necessary to proactively view and collaboratively manage logistics operations.

In Future, SCM vendor should provide

- The full integration of logistics with incumbent systems — primarily financial and contractual systems;
- Native Web-based, real-time access to inbound and outbound global product movement information; and the sharing of logistics with trading partners and customers via direct (system to system) communication

Customer demand has replaced supply as the primary driver of value chains in the New Economy. Supply chains of the Internet era are based on “demand pull” rather than “supply push”. Customers are no longer interested in buying physical products. Since customers judge a firm on the entire experience, from initial contact through purchase and delivery, the fulfillment experience is critical to customer satisfaction and loyalty. But whether a company takes orders on the web, or through the traditional channels of phone, fax or EDI, fulfillment remains a challenge in today’s faster-paced business climate. During order processing, companies need to perform the real-time evaluation of all supply chain constraints: financial, sourcing and manufacturing, distribution, and logistics. They need to offer pre-sale fulfillment information and options, commit to accurate delivery dates, source multiple items from disparate suppliers and deliver them as a single order, and balance customer service with the net landed cost. Considering the product variety within a company, it is impossible to access and filter the required real-time data without the help of information technologies.

Supply Chain Execution and Supply Chain optimization softwares along with the ERP systems provide a range of opportunities to manage a supply chain efficiently. Information technologies confer value in three key areas: revenue growth, profit maximization and enhanced customer service and market share.

· **Revenue growth**: Having real-time visibility across the supply chain (alternate sources, parts, cancelled orders, capacity etc.) enables businesses to take advantage of order fill opportunities that are otherwise lost. Some softwares Intelligently offer the “right” product mix with cross-selling/up selling increases revenue per customer.

· **Profit maximization**: Integration with supply partners and sharing demand/ supply visibility across the network substitutes inventory with information. This results in lowering inventory and carrying costs across the supply chain, and also increases cash flow across trading partners. Allocating product supply at different price points based on market, channel, customer or immediacy of demand, also increases profitability. Information technologies provide more accurate forcasting tools, which guide companies to better production planning and eventually reduced inventory.

Lower transportation costs are achievable by the use of various supply chain optimization software tools, which creates transportation planning based on the company's and customers' constraints.

· **Improved customer service and enhanced market share**: By quoting accurate and reliable order promise dates, based on actual constraint optimization; customer satisfaction can be increased. IT solutions allow, for intelligent stratification of customers (based on profitability, volumes etc.), and ensure that higher priority customers obtain access to constrained material and capacity over lower priority customers. This is key to success in most businesses where 80% of the profits are contributed by 20% of customers.

All of the above benefits are achievable as long as the right solutions are used. Information Technologies can be very costly solutions so the right tools need to be identified for each company and business. Finally, information technologies can provide big advantages for the partners of a supply chain if the tools are wisely selected and implemented.

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Forrester Research
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APPENDICIES

Appendix 1: Functionality Comparison between Tier-1 Supply Chain Vendors

	i2 Technologies	Manugistics	SAP	J.D. Edwards
1. Supply Planning				
Built in statistical or other supply forecasting techniques.	i2 FIVE.TWO's Demand Planner provides 30+ different types of forecasting algorithms. These can be further configured through user defined parameters. Also, the user may configure unique algorithms within the product. The software can suggest best-fit algorithms as well.	Manugistics' NetWORKS Precision Pricing solution provides advanced methods and algorithms to determine optimal prices in order to maximize profit, market share, etc.	mySAP.com offers 20+ different forecasting algorithms that consider various model types like: constant, trend, seasonal, seasonal trend, automatic model selection, Croston, and simple linear regression. Depending on the forecast settings exponential smoothing, moving average, and model testing can be used to improve forecast results. Automatic outlier correction can be used if unstable historical data exists. Various forecast accuracy measurements (MAD, ET, MAPE, etc) are generated to verify the validity of the forecast.	APS Demand Planning module is a highly graphical, collaborative tool used to produce forecasts for the enterprise. Field employees as well as customers may easily be integrated into the forecasting process. Demand Planning takes a Bayesian approach to forecasting, which means that instead of just picking the best fit of 12 algorithms, it will take any weighted combination of any or all of those 12 algorithms which provides the best fit. This enables the algorithms to understand cycles, trends, seasonality, causal factors, and so forth, resulting in a much more accurate forecast. Only JD Edwards module not entirely developed by Numetrix, development done by Demantra. The newer Demand Consensus Module allows for the qualitative anayalsis of forecasts. The module was developed by a need for comapnies following the CPFR process, reconciles multiple data sources of forecast.
Ability to establish supply accuracies by customer, market, region, etc.	i2 FIVE.TWO's Demand Planner provides supply forecast accuracy measurement tools. Users may also create and configure reports within the tool itself.	Manugistics's NetWORKS Demand solution allows simultaneous tracking and understanding of demand along multiple dimensions including sales channels, geographies, and product hierarchies.	Forecast accuracy can be generated based on criteria selected in interactive demand planning. Therefore, a forecast can be generated and evaluated by any of the characteristics that exist in APO. Reviewing forecasting accuracy is commonly performed at the customer, market and region level.	Forecast accuracy is calculated at any or all levels of the hierarchy.
2. Demand Planning				
Built in statistical or other demand forecasting techniques.	i2 FIVE.TWO's Demand Planner provides 30+ different types of algorithms. These can be further configured through user defined parameters. Also, the user may configure unique algorithms within the product. The software can suggest best-fit algorithms as well.	Manugistics' NetWORKS Demand solution provides multiple forecasting algorithms in conjunction with advanced causal mode fit techniques, and can determine algorithms that best suit the optimization problem. Manugistics' NetWORKS Fulfillment solution utilizes algorithms that optimize inventory and replenishment planning while respecting multiple time horizons.	mySAP.com offers 20+ different forecasting strategies that consider various model types like: constant, trend, seasonal, seasonal trend, automatic model selection, Croston, and simple linear regression. Depending on the forecast settings exponential smoothing, moving average, and model testing can be used to improve forecast results. Automatic outlier correction can be used if unstable historical data exists. Various forecast accuracy measurements (MAD, ET, MAPE, etc) are generated to verify the validity of the forecast.	APS Demand Planning module is a highly graphical, collaborative tool used to produce forecasts for the enterprise. Field employees as well as customers may be easily integrated into the forecasting process. APS Demand Planning takes a Bayesian approach to forecasting, which means that instead of just picking the best fit of 12 algorithms, it will take any weighted combination of any or all of those 12 algorithms which provides the best fit. This enables the algorithms to understand cycles, trends, seasonality, causal factors, and so forth, resulting in a much more accurate forecast.
Ability to establish demand accuracies by customer, market, region, etc.	i2 FIVE.TWO's Demand Planner provides demand forecast accuracy measurement tools. Users may also create and configure reports within the tool itself.	Manugistics's NetWORKS Demand solution allows simultaneous tracking and understanding of demand along multiple dimensions including sales channels, geographies, and product hierarchies.	Forecast accuracy can be generated based on criteria selected in interactive demand planning. Therefore, a forecast can be generated and evaluated by any of the characteristics that exist in APO. Reviewing forecasting accuracy is commonly performed at the customer, market and region level.	Forecast accuracy is calculated at any or all levels of the hierarchy.

Ability to incorporate and correlate fruit demand with external variables.	i2 FIVE.TWO Demand Planner supports causal modeling such as weather, strikes, promotions, etc. to help apply the impact to future time buckets.	Manugistics' products offer multi-dimensional forecast planning, allowing up to 200 user-defined demand dimensions.	mySAP.com offers Causal Analysis and uses multiple linear regression to determine the significance of independent variables against a common dependent components. Various statistics (R squared, T-test, Durbin-h, etc.) are created to measure the fit of the data. The accuracy of the statistics will determine whether there is correlation between the different variables. Once a statistical forecast has been created, events can be introduced to adjust the values.	Demand Planning can define causal factors, which are known external influences that influence demand, to be incorporated into the forecast. Weather is an example of a causal factor, as is price. The software will automatically determine if the causal factor is relevant. Events and promotions can also be modeled so that it can predict those as impacts on demand as well. If you plan to repeat an event, DP will recognize the additional demand that will generated. As you run the same promotions over time the system will update the accuracy of the projected incremental volume or 'lift'.
3. Supply Chain Planning				
Ability to model constraints in equipment, assets, resources, containers, etc. which are visible to all users regardless of location, time zone, etc.	i2's Supply Chain Planner allows the modeling of constraints such as: assets, people, machines, tools, resources, etc. The constraints are considered when supply chain plans are being generated. The constraints can possess many defining attributes such as location, queue times, speed, physical capacities, etc. Also, multiple modes of transportation may be defined with attributes such as length of time, distance, etc. i2 FIVE.TWO generates an optimized demand/supply match rationalizing tradeoffs between the defined supply chain constraints.	Manugistics' NetWORKS Production Planning solution is a constraint-based planning tool that quickly identifies the operation's constraints and provides planners with tools to manage supply chain planning. Manugistics' Supply Chain Management solutions allow collaboration with partners, customers, and multiple users in real-time.	mySAP.com SCM allows various constraints to be modeled depending on the planning method. During optimization the system will generate a cost for production, storage, storage expansion, stock deficits, transportation, various capacities (handling, transportation, and production), delay, and shortfall. Based on cost equivalence all of the aspects of the supply chain will planned to create the least cost solution. During Capable-To-Match planning priorities will be placed on customers, locations, deliveries, transportation lanes, products, etc.	PDP, Production Demand Planner, utilizes defined constraints in the supply chain, to ensure a feasible plan is generated. Constraints such as the costs of all the resources being used in the supply chain, including supply costs, storage costs, manufacturing costs, and distribution costs are used.
Ability to solve / optimize plans based on 's business rules (i.e. minimize costs versus maximizing revenue).	i2 FIVE.TWO's Supply Chain Planner allows the user to define the parameters under which the model should be solved. Parameters such as cost must be defined in order to solve utilizing the least cost model. Other solving options include the ability to maximize customer service, maximize assest utilization, minimize work in process, maximize revenue, etc.	Manugistics' NetWORKS Attrubute-Based Planning solution allows consideration of unique attributes of physical resources, business rules, and independencies. Manugistics' NetWORKS production provides optimization based on user defined rules.	The optimizer uses linear programming to consider all relevant factors simultaneously as one problem. Several objects consisting of transportation, production, storage, and handling costs are used to compare alternative plans and provide the best feasible solution based on penalty costs defined in the system. The result of the optimization run is the most feasible solution that satisfies all constraints. However, the result might be that due date constraints are violated or safety stocks are not filled. The optimization ultimately resolves trade-offs to develop the best fit plan.	The balancing of cost versus profit is achieved through varying the penalties or benefits associated with different activities across the supply chain. This capability allows flexibility when following organizations specific business rules.

Problem notification and key performance indicator analysis capabilities.	i2 FIVE.TWO's Supply Chain Planner, similar to i2's other products, contains a problem analysis and drill-down tool within the interface. This analysis tool allows the user to drill-down and uncover root causes to issues in the supply chain.	The Manugistics' suite contains a problem analysis and drill down tool within the interface. This analysis tool allows the user to drill-down and uncover root causes to issues in the supply chain.	mySAP.com SCM offers a few methods to monitor alerts or problems throughout the supply chain. The Alert Monitor is a tool used by planners to monitor the state of a plan and if errors occur in the ATP (Available-to-Promise) or SNP (Supply Network Planner) run. The Plan Monitor evaluates the current status of a plan for a given time period and assigns scores to the results. Planners can evaluate and compare the results of various planning and transactional simulation versions in different time frames. The quality of a production plan can be verified before releasing it for execution. Finally, mySAP.com SCM offers the Supply Chain Cockpit which is one of the APO planning applications, and consists of a graphical instrument panel for managing and controlling the supply chain.	Advanced Planning includes a real-time alert notification capability. Users that are subscribed to different types of alerts are notified when a problem exists. When the problem is resolved the alert messages are retracted. One additional feature of the alerts, is that they can be 'tuned' for sensitivity. If there is an alert that exists for inventory below safety stock, you can set the safety stock alert to only send when the inventory falls 30% below the safety stock requirement. This feature allows alerts to be more focused and real.
4. Scenario Analysis / Optimization				
Ability to automatically generate multiple optimal supply chain plans based on specific business rules while having the ability to evaluate these "what-if" scenarios based on specific requirements (i.e. customer service, revenue, costs, asset utilization).	i2 FIVE.TWO supports "what-if" analysis across all of their products. This capability is NOT avaiable standalone but is imbedded within the product offering. i2's products provide the ability to generate, analyze, and save multiple planning scenarios while incorporating specific business rules and parameters.	Manugistics's NetWORKS Attrubute-Based Planning solution allows consideration of unique attributes of physical resources, business rules as wells as their independencies.	mySAP.com SCM has the ability to store several versions that can be customized to capture different data, different view points, and contain different access control.	All APS modules have complete simulation capabilities. PDP utilizes defined constraints in the supply chain, to ensure a feasible plan. Constraints such as the costs of all the resources being used in the supply chain, including supply costs, storage costs, manufacturing costs, and distribution costs are used.
5. Event Management / Advanced Alerts				
Ability to create specific logic within the application based on pre-defined business rules which can handle minor incidents without human intervention.	Event Management / Advanced Alerts are avaiable within i2's planning tools. This functionality provides the users with alerts that can be configured to user preferances and tolerances.	Manugistics' software supports user-defined logic for a single task/activity, as well as user-defined default workflow logic for a given process, activity or object. Manugistics also supports automatic application activity response to events/data.	With mySAP.com SCM Demand Planning, promotions or other special events can be planned separately from the rest of the forecast. Promotion Planning is used to record either one-time events or repeated events. specific logic can be created with a macro and applied to demand planning at any point in the process.	PDP has real time alerts for managing supply chain events that impact cost, customer service, or resource utilization. PDP stays in tune in a real-time format regarding orders entered, inventory position, resource utilization. Notification can also be sent to suppliers or customer via external alerts. Planners or other appropriate individuals can determine how to go about solving the issues. Users may manually solve situations or change previous plans.
Ability to pre-define work flows and associate user roles with responsibilities.	i2 FIVE.TWO supports user-specific workflows.	Manugistics' solutions support user-defined activities required for processing business data, and use-defined triggering rules for when and how processes are initiated. Manugistics also supports user-identification of roles that performs each certain type of work.	SAP is delivered with pre-defined workflow templates and end-user roles for many business processes. These templates can be used out of the box. Workflow templates can also be copied and modified to specifically meet customer requirements.	The ability to setup and define user responsibilities that enable work flows is included as mentioned above.

6. Transportation Management				
Built in route optimization techniques based on matching orders and the truck fleet, schedules, requested delivery dates, lead times, etc.	i2 FIVE.TWO Transportation Planner solution supports this requirement.	Manugistics' products utilize transportation route optimization techniques. Manugistics' NetWORKS Transport application allows route optimization with many sub-shipments from origin to destination, and allows both leg optimization and entire multi-leg optimization.	Transportation planning enables transportation planners to optimize the use of available capacity on trucks, trains, ships, and airplanes, with the dual objective of planning loading capacity more efficiently and reducing costs.	The APS Vehicle Loading (VL) module is really part of PDP, and cannot be sold without PDP. VL builds loads to make optimal use of vehicles (both in terms of weight and cube), minimizing the number required, while respecting product/product, product/vehicle and vehicle/location constraints. VL also ties into the manufacturing/inventory availability schedules.
Built in statistical analysis tools to evaluate logistics performance, capacity utilization, etc.	i2 FIVE.TWO Transportation Planner solution supports the desired reporting requirments.	Manugistics' products support algorithms that consolidate multiple shipments from multiple pickup locations, multple shipments from a single source for multiple deliveries, and outbound and inbound shipments, backhauls, transshipments and customer returns.	There are standard delivered monitoring systems to review logistics performance, capacity, utilization, etc.	JD Edwards provides key perfomance indicators for transportation through it's business intelligence product. Some work may need to be done to define the KPI to fit 's standards.
Ability to model volume, weight, and packaging constraints.	i2 FIVE.TWO Transportation Planner solution supports this requirement.	Manugistics' products support transporation schedules which include number of pallets, container dimensions, weight, and freight class.	Load balancing and minimizing transporation cost is maintained in Vehicle Scheduling.	Vehicle Loading from JD Edwards includes these capabilities.
Ability to handle and / or model vessel rotation cycles and schedules.	i2 FIVE.TWO Transportation Planner solution supports this requirement.	Yes. See above.	The ability to model vessels and container schedules and rotations is possible with the Transportation Planning solution.	Some capability exists to model the vessels, containers, and the schedules for the vessels.
Ability to handle and / or model container rotation cycles and schedules.	i2 FIVE.TWO Transportation Planner solution supports this requirement.	Yes. See above.	The ability to model vessels and container schedules and rotations is possible with the Transportation Planning solution.	Some capability exists to model the vessels, containers, and the schedules for the vessels.
Ability to model / manage container constraints (i.e. ripening capabilities within containers).	i2 FIVE.TWO Transportation Planner solution supports this requirement.	Yes. See above.	Yes. See above.	VL can model the contraints of containers and the attributres of SKUs. This combination allows for attribute based loading.
7. E-Procurement				
Requisitioning and purchase order processing for non-direct materials.	i2 FIVE.TWO Procurement solution supports this requirement.	Through a partnership with Clarus, Manugistics provides an E-Procurement solution that allows for indirect material procurement and settlement solutions.	SAP's mySAP.com SRM (Supplier Relationship Management-replaces Enterprise Buyer) product allows for on-line creation of requisitions, requests for quote and purchase orders for both indirect and direct goods.	Fore robust indirect order processing, JD Edwards partners with Ariba®® to provide this functionality.
Purchase order processing and supplier acknowledgement for direct materials.	i2 FIVE.TWO Procurement solution supports this requirement.	See above.	SAP's mySAP.com SRM (Supplier Relationship Management) product allows for on-line creation of requisitions, requests for quote and purchase orders for both indirect and direct goods. Functionality to accommodate acknowledgements is also available.	JD Edwards includes in the ERP application, the requirements for Requisition, PO's, workflow approvals, budget checking, etc. for direct materials. In addition, the Advanced Planning systems will make significant vendor and quantity recommendations based on cost optimization.

Use of pre-aggregated data while decreasing spend through private network coordination and exchanges, public auctions, etc. (i.e. using Freemarkets for indirect materials).	i2 FIVE.TWO Procurement solution supports this requirement.	Manugistics' software supports integration with other order management, purchasing, planning, warehousing, and transportation systems. It also supports productized interfaces for specific vendor systems.	mySAP.com SRM is open and can integrate with non-SAP applications (ERP, PLM, CRM, SCM). mySAP SRM provides on-ramps to digital markets out of the box.	Data from ERP or legacy systems can be leveraged to generate quote requests, requisitions, PO's, etc. with a variety of markets and exchanges.
8. Additional Requirements				
Application contains built in integration tools and functionality.	i2's FIVE.TWO Platform supports requirement with built in EAI (enterprise application integration) capabilities.	Manugistics' software supports EDI application interfaces between specific functions and translation software, desktop application integration, and an interface with data tables and spreadsheets.	SAP offers its Business Connector (middleware) product built on webMethods technology, to allow for integration to various other software applications. In addition, SAP provides pre-defined BAPI's (Business Application Protocol Integration) to ease integration to/from SAP.	JD Edwards Advanced Planning applications are already integrated to the core ERP system. In addition, JD Edwards offers a robust EAI capability with Xpi.
Application can perform and run on an AS 400 Platform.	Not supported.	Not supported.	mySAP.com SCM applications perform on the following platforms and databases: Windows2000, NT, Sun Solaris, IBM AIX, Compaq Tru64 UNIX, HP-UX/ Databases: SQL Server, DB2, Informix, Oracle.	All applications can run under NT or Windows 2000. Several of the applications are available on UNIX platforms, Sun, IBM, and HP including the AS 400.
Ability to view, create, and / or output reports.	i2's suite allows the user to view and output a standard set of pre-defined reports. Users may create and configure reports within the tool.	Manugistics' products have the ability to view, create and output reports.	SAP allows the user to view and output numerous standard pre-defined reports, as well as provides users with multiple tools to create custom reports.	The modules allow the user to view and output a standard set of pre-defined reports. The underlying data for the reports can also be generated into output files for use with other applications. Customization is possible, but would require additional coding requirements to generate the desired reports.
Multi-lingual capability, allowing users to access a common application, but provide a user interface in the individual's native language.	i2 's suite provides multi-lingual capabilities.	Manugistics' products have multi-lingual capability.	SAP has multi-lingual capabilities.	English-only for Documentation, Manuals and Online Help. Currently, the GUI is available in French, Spanish and German; however, customers can alter screens of all Advanced Planning modules to adapt to other languages.
Application responsiveness and scalability	i2 FIVE.TWO SCM solution is scaleable and responsive.	Responsiveness is good. Processing is done in batch mode. Proven scalability.	Responsiveness is good with proven scalability.	Responsiveness is good with proven scalability.
Useability / user friendly application	i2 has partnered with Frog Design to help them redesign the FIVE.TWO user interface. This new UI provides the same look-and-feel, which improves usability, makes it easier to learn multiple products.	User-friendly and similar look and feel across the entire suite.	User-friendly interfaces.	User-friendly interfaces.
Number of installations	i2 has over 1500 customers and 9000+ implementations.	Manugistics has over 1100 customers.	SAP has over 10 million users, 36,000 installations, 1,000 partners, and 21 industry solutions.	JD Edwards product has a significant install base and has a proven track record. Over 300 installed locations.

Appendix 2: SAP ScreenShots

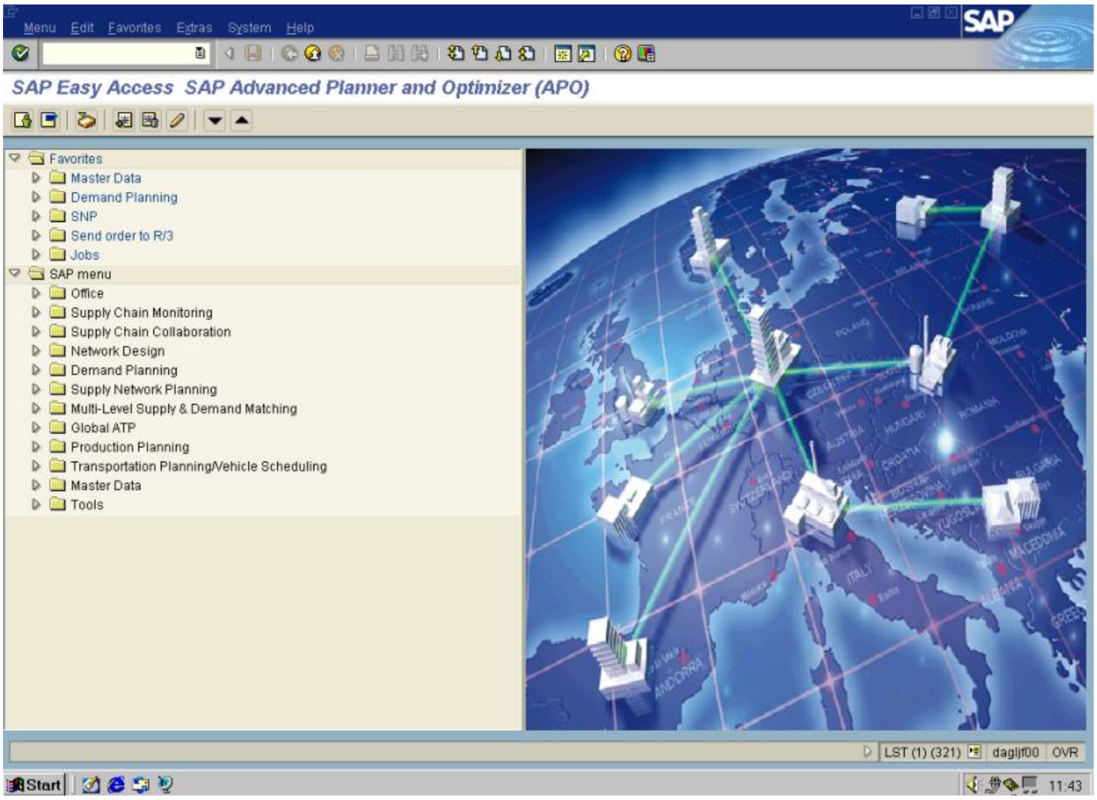


Figure 6.6: SAP Advanced Planner and Optimizer (APO) Initial screen

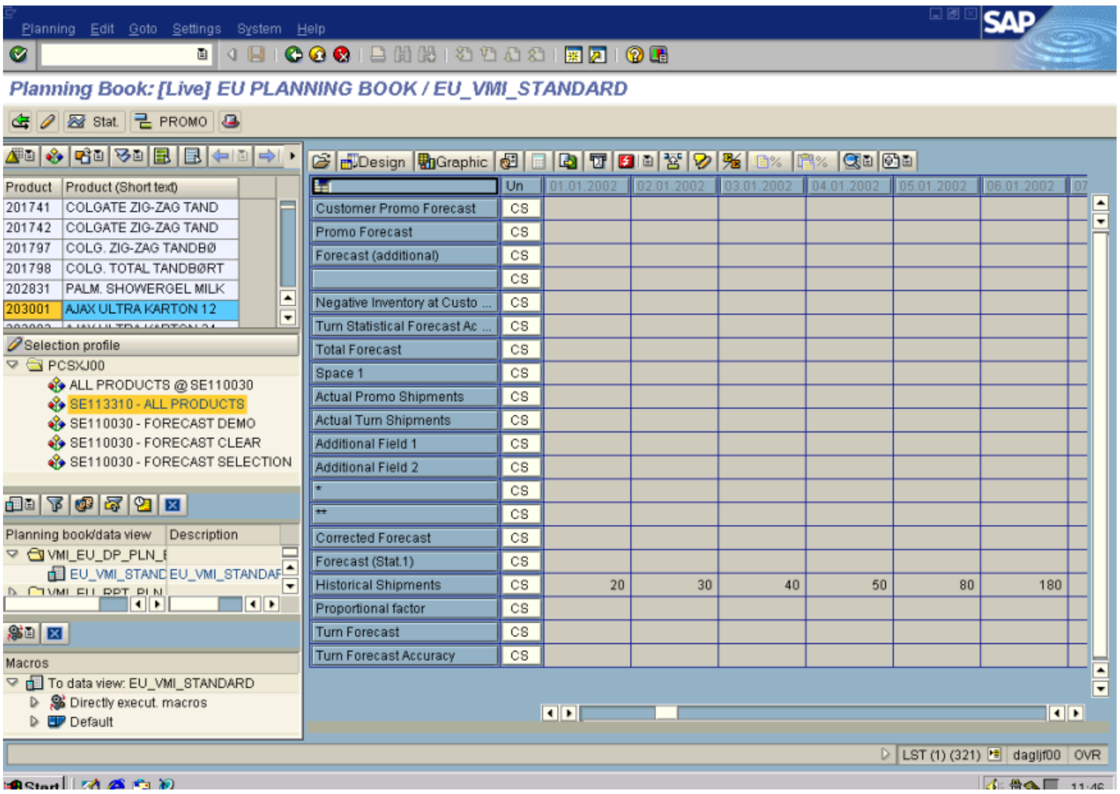


Figure 6.7: DP – Customer Sales Data / Historical Shipments

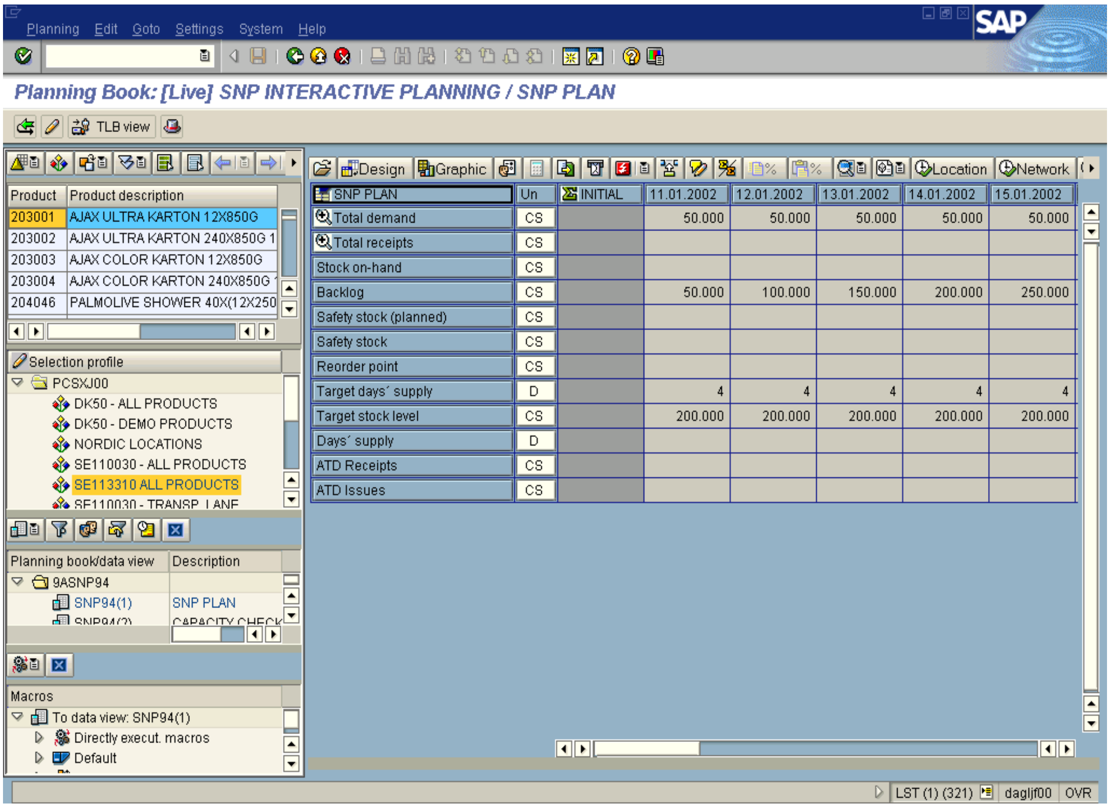


Figure 6.8: DP – Statistical Forecast

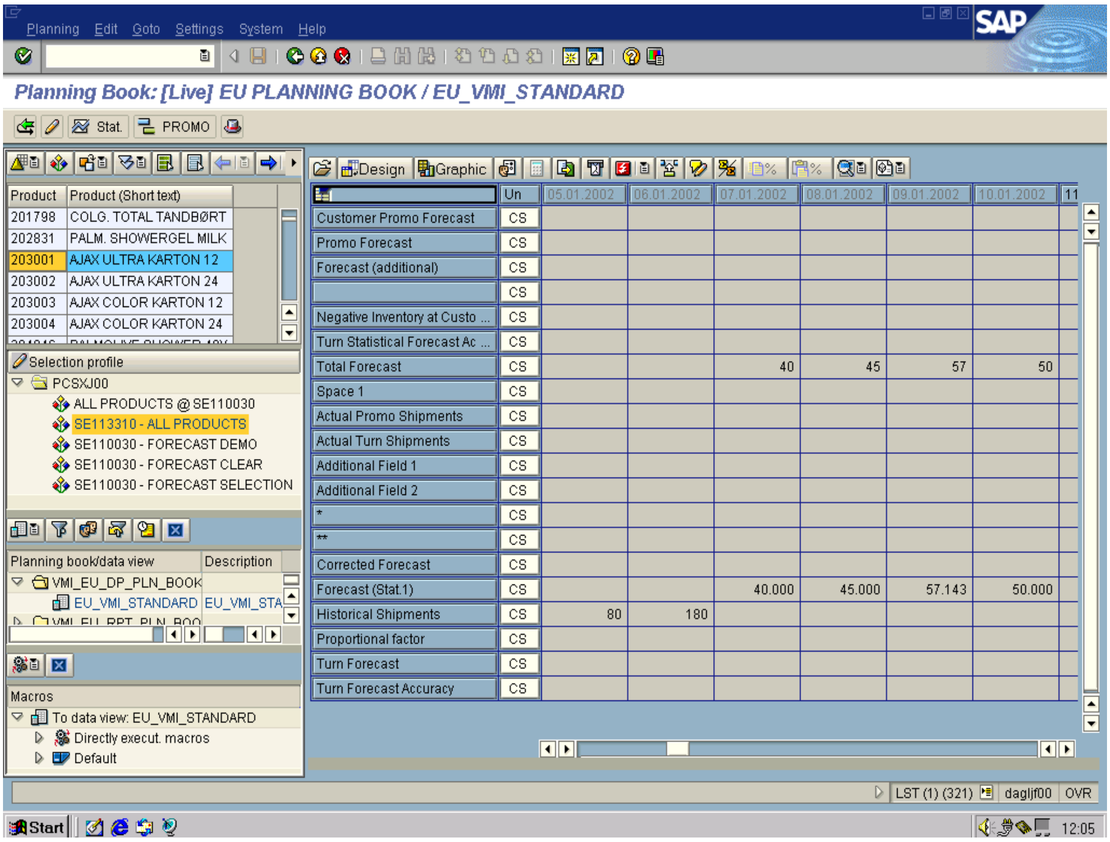
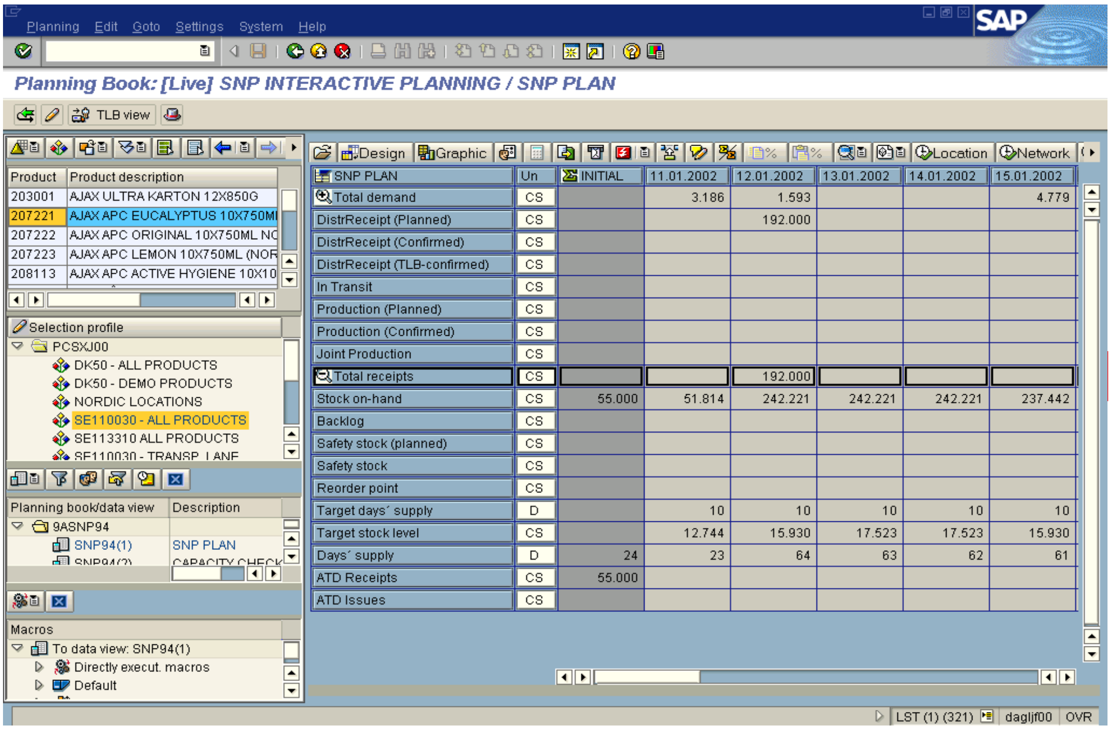
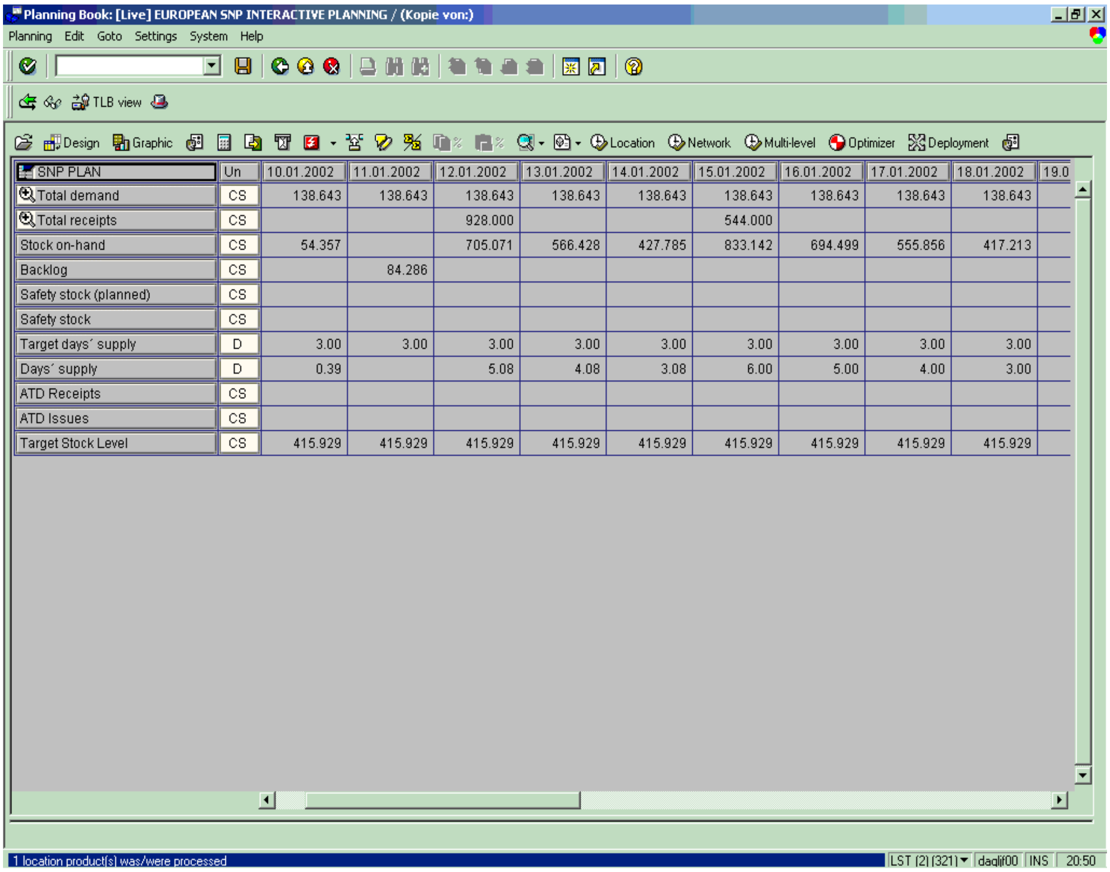


Figure 6.9: SNP – After Release to SNP



SNP PLAN	Un	INITIAL	11.01.2002	12.01.2002	13.01.2002	14.01.2002	15.01.2002
Total demand	CS		3.186	1.593			4.779
DistrReceipt (Planned)	CS			192.000			
DistrReceipt (Confirmed)	CS						
DistrReceipt (TLB-confirmed)	CS						
In Transit	CS						
Production (Planned)	CS						
Production (Confirmed)	CS						
Joint Production	CS						
Total receipts	CS			192.000			
Stock on-hand	CS	55.000	51.814	242.221	242.221	242.221	237.442
Backlog	CS						
Safety stock (planned)	CS						
Safety stock	CS						
Reorder point	CS						
Target days´ supply	D		10	10	10	10	10
Target stock level	CS		12.744	15.930	17.523	17.523	15.930
Days´ supply	D	24	23	64	63	62	61
ATD Receipts	CS	55.000					
ATD Issues	CS						

Figure 6.10: SNP – After Heuristics run 1



SNP PLAN	Un	10.01.2002	11.01.2002	12.01.2002	13.01.2002	14.01.2002	15.01.2002	16.01.2002	17.01.2002	18.01.2002	19.0
Total demand	CS	138.643	138.643	138.643	138.643	138.643	138.643	138.643	138.643	138.643	
Total receipts	CS			928.000			544.000				
Stock on-hand	CS	54.357		705.071	566.428	427.785	833.142	694.499	555.856	417.213	
Backlog	CS		84.286								
Safety stock (planned)	CS										
Safety stock	CS										
Target days´ supply	D	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	
Days´ supply	D	0.39		5.08	4.08	3.08	6.00	5.00	4.00	3.00	
ATD Receipts	CS										
ATD Issues	CS										
Target Stock Level	CS	415.929	415.929	415.929	415.929	415.929	415.929	415.929	415.929	415.929	

Figure 6.11: SNP – After Heuristics run 2

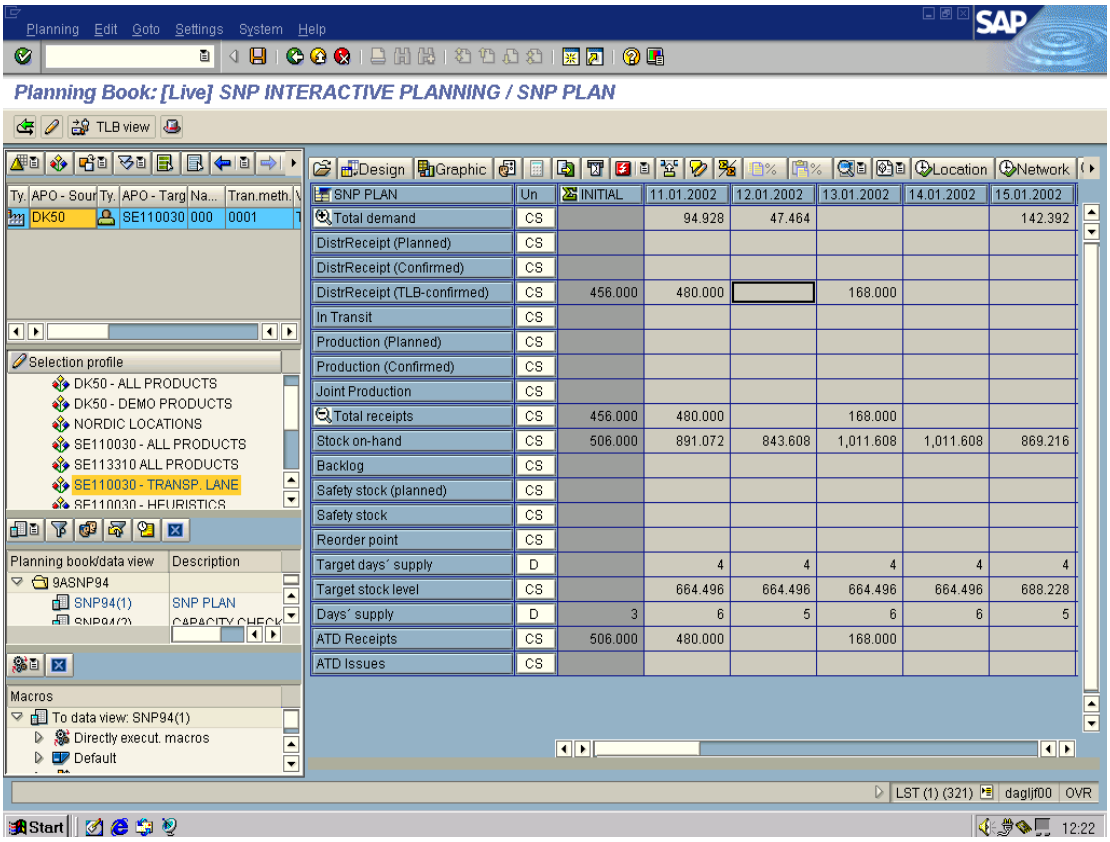


Figure 6.12: SNP – After TLB

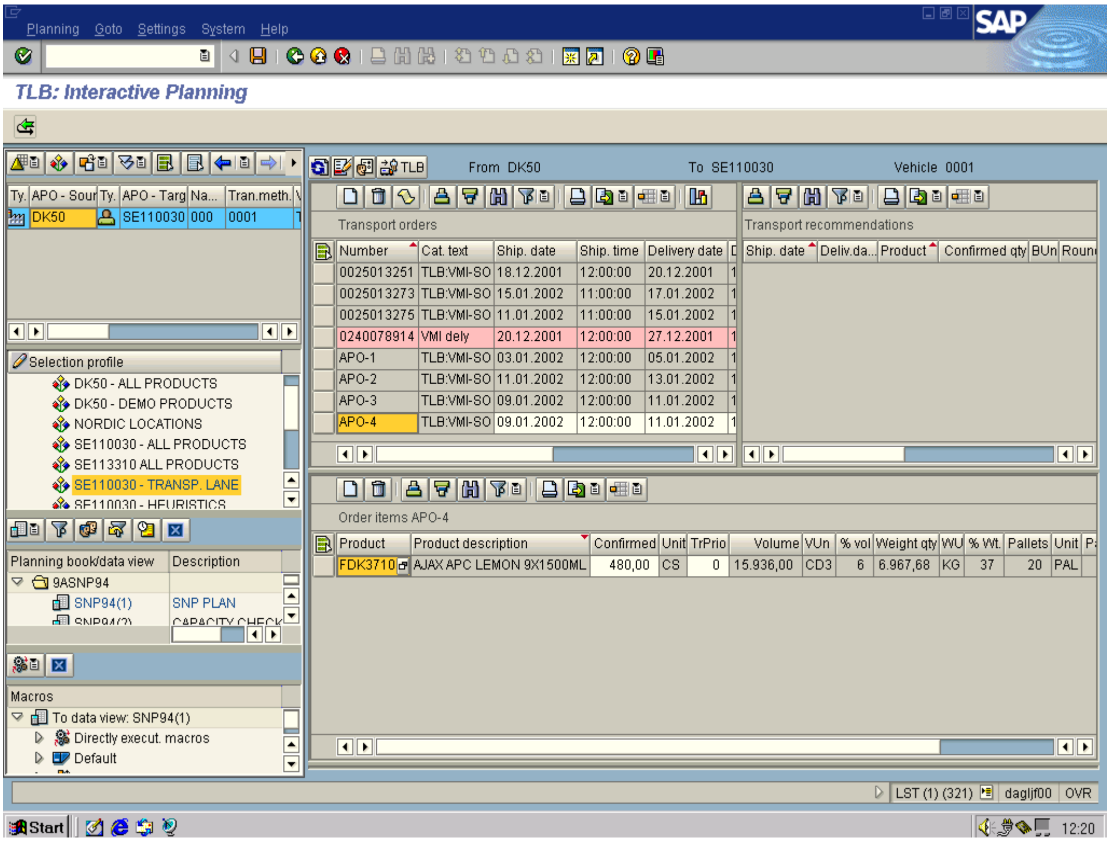


Figure 6.13: SNP – TLB view

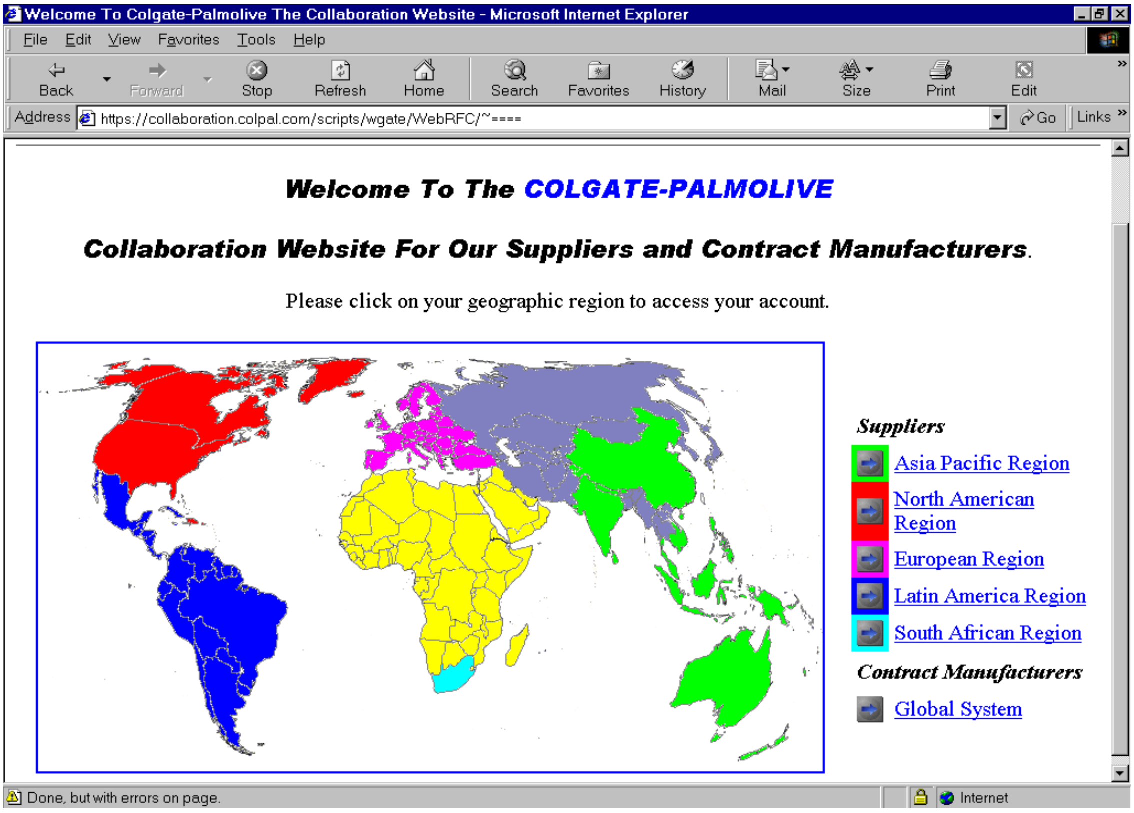


Figure 6.14: Colgate-Palmolive Collaboration Website for Suppliers (SMI Web site)

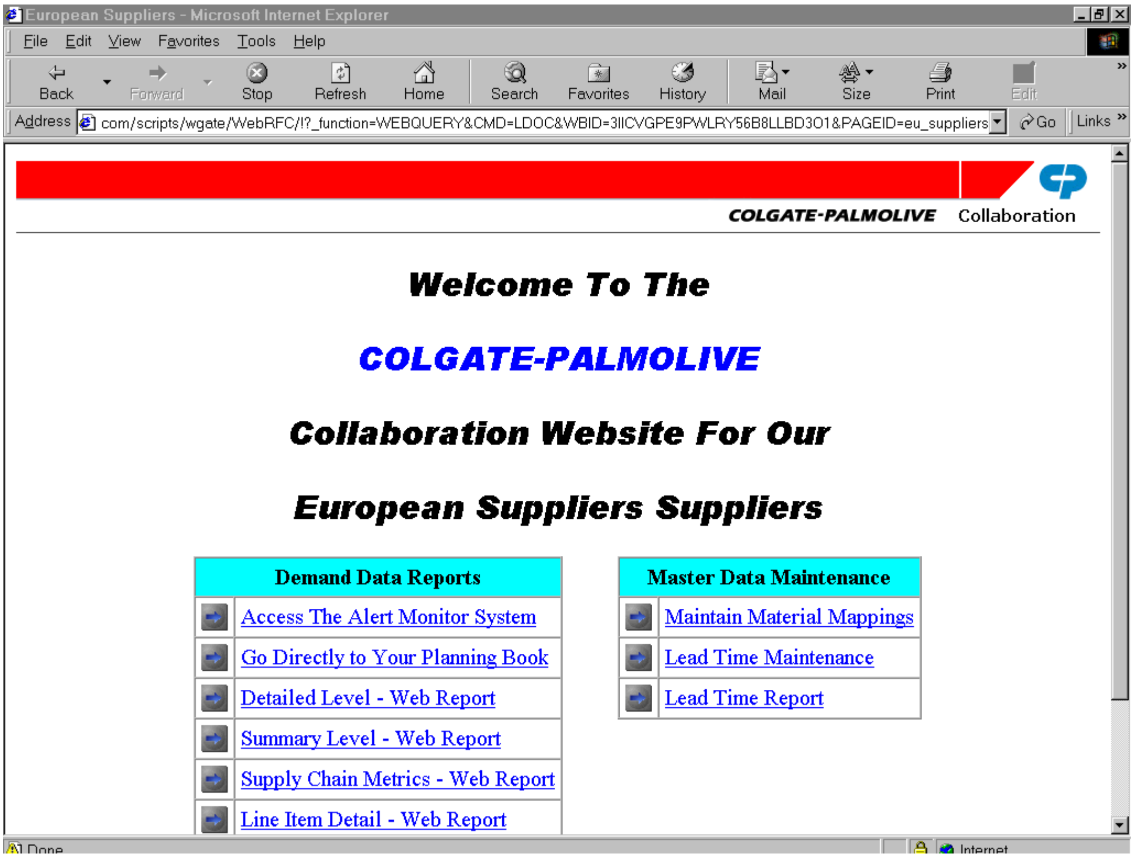
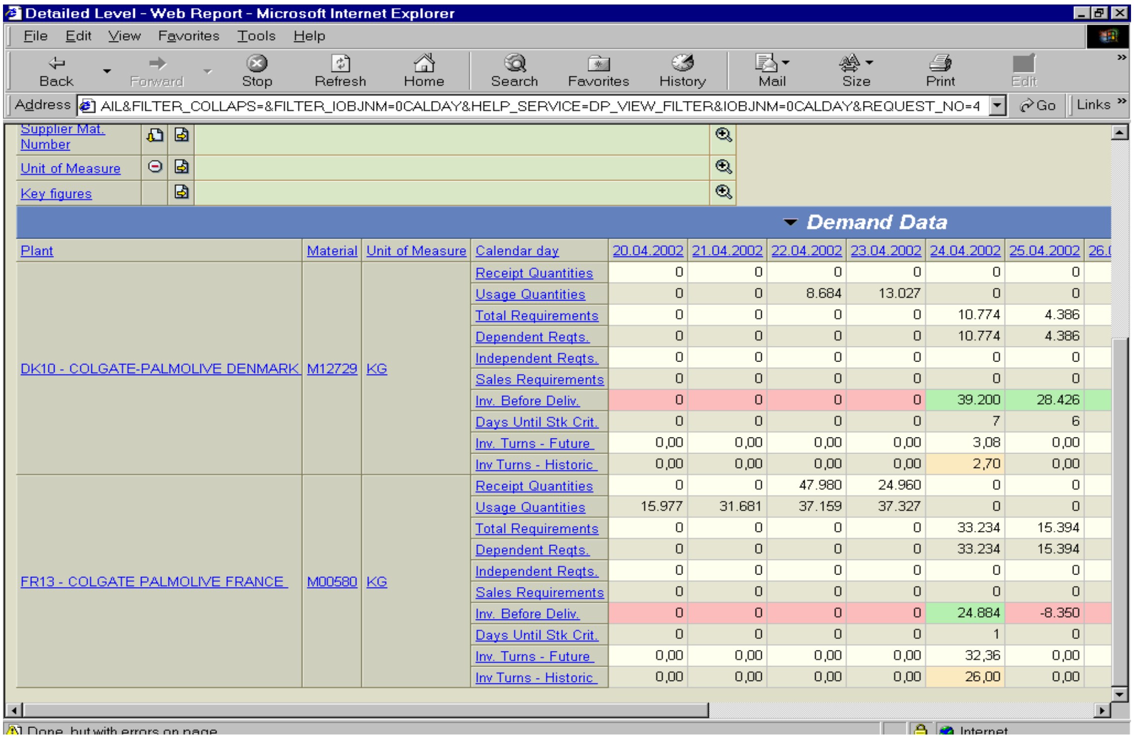


Figure 6.15: SMI Functionalities Provided to Suppliers on the WEB



Plant	Material	Unit of Measure	Calendar day	20.04.2002	21.04.2002	22.04.2002	23.04.2002	24.04.2002	25.04.2002
DK10 - COLGATE-PALMOLIVE DENMARK	M12729	KG	Receipt Quantities	0	0	0	0	0	0
			Usage Quantities	0	0	8.684	13.027	0	0
			Total Requirements	0	0	0	0	10.774	4.386
			Dependent Reqts.	0	0	0	0	10.774	4.386
			Independent Reqts.	0	0	0	0	0	0
			Sales Requirements	0	0	0	0	0	0
			Inv. Before Deliv.	0	0	0	0	39.200	28.426
			Days Until Stk Crit.	0	0	0	0	7	6
			Inv. Turns - Future	0,00	0,00	0,00	0,00	3,08	0,00
			Inv Turns - Historic	0,00	0,00	0,00	0,00	2,70	0,00
FR13 - COLGATE PALMOLIVE FRANCE	M00580	KG	Receipt Quantities	0	0	47.980	24.960	0	0
			Usage Quantities	15.977	31.681	37.159	37.327	0	0
			Total Requirements	0	0	0	0	33.234	15.394
			Dependent Reqts.	0	0	0	0	33.234	15.394
			Independent Reqts.	0	0	0	0	0	0
			Sales Requirements	0	0	0	0	0	0
			Inv. Before Deliv.	0	0	0	0	24.884	-8.350
			Days Until Stk Crit.	0	0	0	0	1	0
			Inv. Turns - Future	0,00	0,00	0,00	0,00	32,36	0,00
			Inv Turns - Historic	0,00	0,00	0,00	0,00	26,00	0,00

Figure 6.16: Detailed Demand Data (Colgate's Demand Data for a specific Vendor in Different Locations of Colgate)

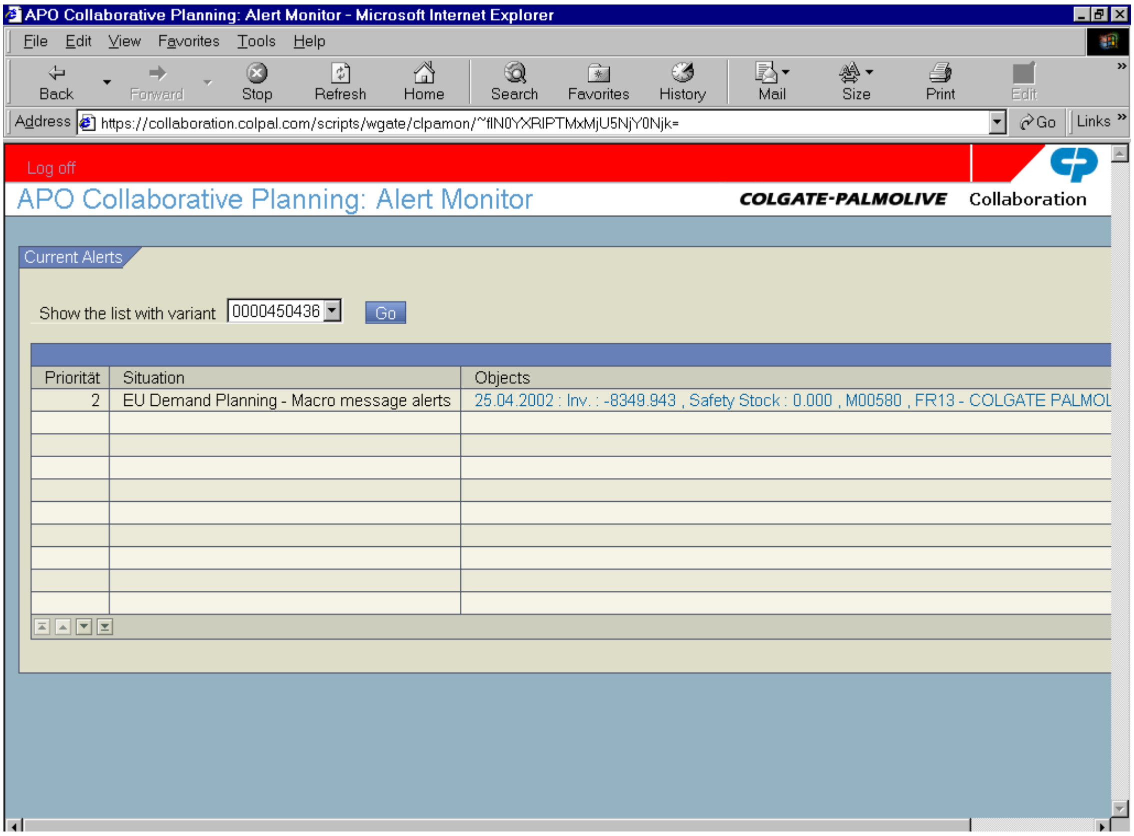


Figure 6.17: Alerts Monitor (Generated for The supplier for materials in danger of stock-out)

ABOUT THE AUTHOR

Ebru Coskun was born in 1976, IZMIR. She graduated from American Collegiate Institute (Izmir) in 1994 and she attended Istanbul Technical University, Engineering Management programme in the same year. Having graduated from university in 1998 she started her business life in an Information Technologies company known as Vestel Consulting which belongs to one of the leading durable goods manufacturer Vestel Group. After 1,5 years of SAP consultancy experience she joined Boyner Holding as a business analyst in the information technologies group, responsible from implementation of SAP Retail solution to Boyner Group Companies. Currently, she is working as a supply chain business analyst in the information technologies group of Colgate Palmolive based in Dublin and she is responsible for the supporting Colgate business in Europe and implementing the supply chain initiatives associated with the information technologies.