



Dynamic Supply Chain - Planning and Inventory Management

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ABSTRACT

Inventory Planning and Optimization (Inventory Management) is a competitive advantage for an organization's ability to deliver the right product to the right place at the right time for the right price. The companies with superior planning and execution systems will support the market demand. As per Forrester Research, "the flow of goods should closely match with the demand conditions, by this companies will be able to trim inventories, improve customer satisfaction, and avoid nasty surprises". Companies have faced and are increasingly facing challenges in their efforts to manage the entire supply chain, the study aims at inventory planning and optimization method in manufacturing industries. In this study we would try to establish a co-relation between planning and inventory control methods, and being socially responsible for meeting the customer demand thus bringing stability in the buyer's market.

KEYWORDS

Introduction

Supply chain management addresses the management of materials and information across the entire chain from suppliers to producers, distributors, retailers, and customers. Traditionally, each company performs purchasing, production and marketing activities independently, hence it was difficult to make an optimal plan for the whole chain. In recent years, it has been realized that actions taken by one member of the chain can influence all others in the chain (T.J. Peters 1982 Riddell 2002). More and more companies have gradually recognized that each of them serves as part of a supply chain against other supply chains in terms of competition, rather than as a single firm against other individual firms. Since 1990, as the information technology has continuously developed, it is possible to coordinate all organizations and all functions involved in the whole chain. Consequently, supply chain management has been increasingly receiving attention from both academic researchers and practitioners.

Research on supply chain management has been mainly focused on three major issues.

1. Behavior of information flow through the supply chain.
2. Inventory management of entire supply chain.
3. Planning and operations management of the supply chain

In this paper planning and inventory management will be discussed. There is a Chinese proverb saying, "if you want to defeat an army, frustrate the chief first." In the past few decades, scholars have given ample attention on the impact of inventory on Supply Chain Management (SCM). As per the recent research analysis, inventory cost account to 30% of the total capital cost, successful inventory management is often the momentous symbol of competition victory of a well-run organization.

Effective planning and inventory management is the core of supply chain management excellence i.e managing multiple types of inventories, not only in finished goods but raw

materials, work-in progress, partner inventories and more. Yet our understanding of inventory management practices in many respects still has a long way to go. In the last one decade the direct link between inventory management effectiveness and corporate cash flow generation has been well understood.

Consultant Gerry Marsh, who works with some of the world's largest companies, has shown that firms which are able to use the supply chain to generate more cash flow than competitors will usually have higher stock price and multiples even if earnings per share and growth rates are similar between the companies.

Inventory levels in most of the companies have stayed flat due to some factors such as recession and more out-sourced supply chains. Most of the companies did cut inventories due to recession as a matter of survival. Now companies are again facing supply chain network complexity issues.

Some of the supply chain network pressures are as below

- Increased global scope and reach.
- Increased virtualization and resulting loss of visibility and control.
- Challenges faced from multi-channel market strategies.
- Shrinkage of product lifecycles.

As a result, companies realize that effective managing inventories a node or level at a time is no longer good enough. The problems and challenges must be tackled more holistically, considering strategies and tools that can tame the growing network inventory beast in a way that brings those inventory levels down while maintaining or even improving customer service levels.

Background

Supply chain planning is a process that predicts future market demand by logical forecasting and combines inventories

available on-hand with supply capabilities and constraints to develop a plan that would meet the gap. It considers the complete supply chain, from raw material procurement to the distribution of finished products to customers with targets of increasing customer sales value, improving supply chain performance and cost efficiency. As per (Stadler 2005) Supply chain planning is a hierarchical process that includes several phases and levels. The planning processes in companies are in multiple phases which are complex and fragmented. These steps in the process may cause delays because decisions may take place independently, at different time intervals, and with varying planning horizons. Typically, the planning process is a mixture of automated and manual processes. Companies have departments dedicated to carrying out end-to-end supply chain planning. Instead still companies rely on forecasters, procurement planners and production planners. The lack of integrated planning processes is a serious shortcoming, which leads to many supply chain inefficiencies like

1. High safety stocks,
2. Managing seasonal demand patterns
3. Insufficient demand forecasting,
4. Long planning horizons, and
5. The inability to capture supply constraints in-terms of capacity or materials availability

There can be stock-outs and supply constraints due to material availability & production capacity which would result in dissatisfied customers, hence it is essential to ensure that demand and supply ratio matches to keep excessive inventory under control which may be caused by unpredictable demand variation and forecasting error.

The main objective of the materials/ planning is explained as per the fig 1 below

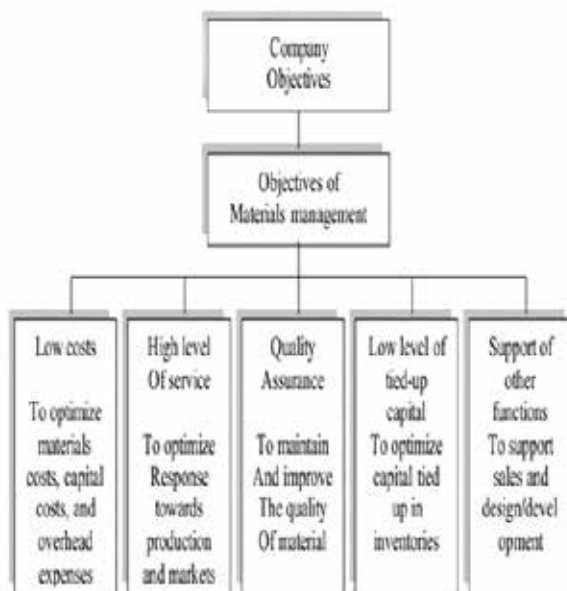


Fig - 1 - Planning / materials objective

The planning function exists due to three primary reasons.

1. Resource allocation
2. On-time delivery
3. Changes in Market demand

Resources are limited which in turn influence the need for effective utilization of capabilities, funds and resources.

Lead times can be lengthy in production or purchasing, hence it is important to ensure that customer is served on time as per the committed lead time. Manufacturing companies choose to allocate capacity between products if several products are sharing the same resources. And also decisions allocation of resources when customers demand exceeds supply availability.

Planning is needed to manage the uncertainty that exists in all supply chains. Uncertainties that exists relates to rapid changes in the market.

As per Vitasek 2003, planning complexity grows when it has to manage short product lifecycles and growing demand for shorter lead times.

This paper starts with a literature review that investigates different approaches of managing uncertainty and ways to provide flexibility in supply chains. The analysis will be on the framework of flexibility of resources and planning integration based on the cases. The aim is to study their planning processes and find situational factors that explain the planning approach used. Will also try to explore the connectivity between customer demand flexibility and supply chain planning. The focus is on mid-term operative planning, which looks for the most efficient way to fulfil demand over a medium-term planning horizon.

Objective of the study

Understanding the supply chain management concept from the perspective of suppliers and in particular to small and medium enterprises (SMEs) is crucial to this study of dynamic and integrated SCM. The supply opportunity analysis technique (SOAT) moves away from a reactive to a proactive mode by taking (determining) the suppliers perspective. Supply chain is a combination of processes, functions, activities, relationships and pathways along which products, services, information and financial transactions move in and between companies. The supply chain consist of suppliers, manufacturing centers, warehouses, distribution and sales offices. Complexities in the supply chain makes the development and managing a challenging task. A sustainable supply chain is one that measures profit and loss in social and environmental dimensions (Carter and Rogers 2008; Linton, Klassen, and Jayaraman 2007)

Supply Chain Planning

As stated earlier, supply chain management refers to integrated planning process. Integrated supply chain process is categorized into three major areas.

Functional integration of purchasing, manufacturing, logistics and warehousing activities.

Spatial integration across geographically dispersed vendors and markets.

Inter-temporal integration of these activities over strategic, tactical and operational planning horizons.

As per Jeremy Shapiro 2000 Inter-temporal integration is also called as hierarchical planning, it requires consistency and coherence among overlapping supply chain decisions at various levels of planning. Although it is not yet widely appreciated, inter-temporal integration is critical to the firm's sustained competitive advantage. Another aspect of inter-temporal planning is the need to optimize a product's supply chain over its life cycle through the stages of design, introduction, growth, maturity and retirement.

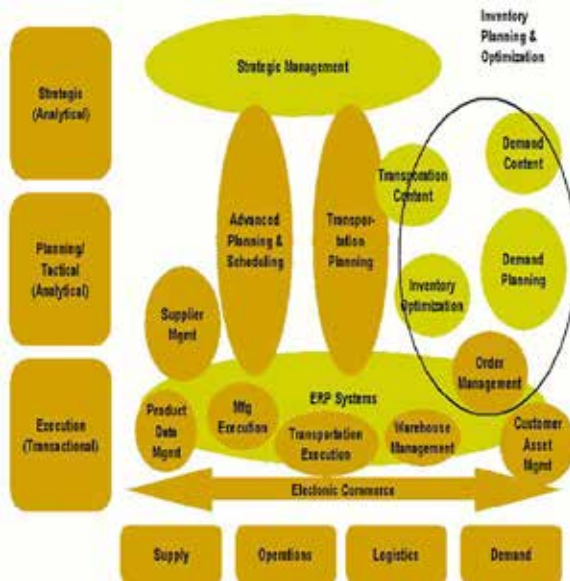


Fig: 2 – Integrated supply chain management planning framework - Jeremy Shapiro 2000

Strategic planning involves resource acquisition decisions to be taken over long-term planning horizons. Tactical planning involves resource allocation decisions over medium-term planning horizons, and Operational planning involves decisions affecting the short-term execution of the company’s business.

For example, analysis of capital investment decisions in manufacturing equipment during the growth phase of a new product should take into account marketing decisions affecting product sales and gross revenues that may provide future returns sufficient to justify the investments. Improved integration of activities across multiple companies sharing components of a supply chain is a concern of increasing interest and importance. Such integration is obviously relevant to the efficient operation of two companies.

Moreover, enhanced integration implies greater sharing of confidential information about costs and capacities, as well as integrative management of business processes. Developments in integrated supply chain planning have been both facilitated and required by advances in IT.

Lead-time Probability Curve

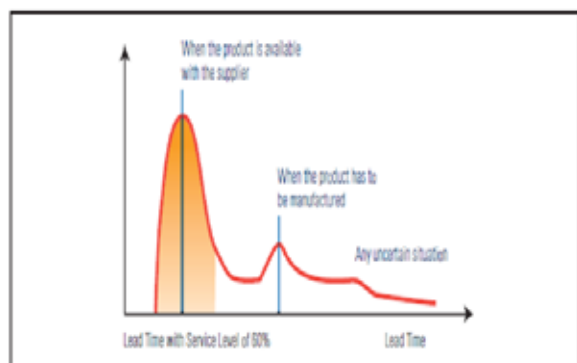


Fig: 3 – Lead time with respect to service level (cognizant 20-20 insights | December 2011)

Inventory managers have incorporated demand-side variations, since the assumption has been that lead time is always known and determinable. But supply-side variations expressed in terms of variation in lead time also need to be taken into account.

As per cognizant 20-20 insights research, lead time does not follow a normal curve distribution. A probability curve for lead time variation is depicted in Figure-3. Usually the time taken to transport material is the same unless unforeseen circumstances arise. Therefore, in the distribution curve shown in Figure 3 the first crest represents the lead time when the product is available with the supplier and only transportation is required. There may be situations when the product is not available with the supplier. In that case the product has to be manufactured by the supplier, which results in a greater lead time, as represented by the second crest. Depending on the service level that a company wants to achieve, a corresponding lead time in the curve above is chosen and used (safety stock = $Z^* \cdot \sqrt{(l/t)}$) to calculate the reorder point and safety stock of material planning.

Supply Chain Flexibility

The planning approaches to create flexibility is shown in Table 1, and this is grouped according to the flexibility of resources. These approaches can be further characterized into inventory, capacity and timely buffer based strategies. And mapping supply and delivery risk is also buffered in supply chains.

Table 1. Approaches to provide flexibility in supply chains.

	Solution	Description	References
Buffer-based strategies	Inventory buffer	To upkeep inventory to meet forecast demand, which varies acc. to time and quantity	Vollman et al., 1997; Vonderembse and White, 1988
	Capacity buffer	To upkeep additional capacity (slack) in the form of production capacity or workforce; must be defined in terms of how easy capacity change should be	Galbraith, 1977; Vonderembse and White, 1988
	Time buffer	Long delivery time to allow production or assembly to order, used for products with a large number of possible configurations. Slack time included in scheduled time.	Vollman et al., 1997; Galbraith, 1977
Managing supply risks	Addressing supplier processes	Contracting, cooperation, guaranteeing access to scarce raw materials; using multiple supplying sources; devising or negotiating the environment	Zsidisin and Ellram, 2003; Galbraith, 1977

Co-relating Supply chain planning with Demand flexibility – (Table from The effects of delivery speed on supply chain planning-Riikka Kaipia)

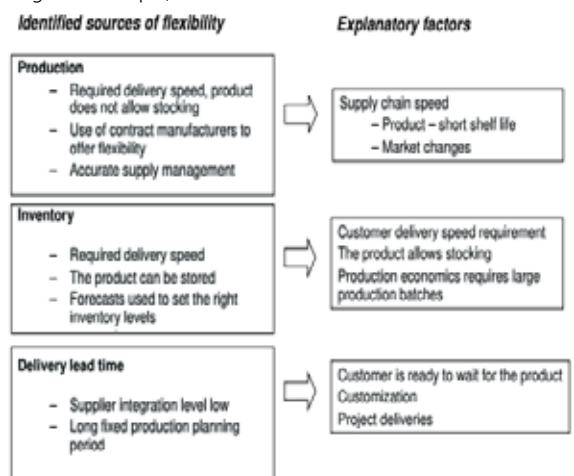


Fig – 4 co-relating planning and customer delivery

The above three methods of offering flexibility is positioned based on production, inventory and delivery lead times in supply chain. The identified resources of flexibility in production, inventory and delivery lead times are treated differently from the supply chain point of view with respect to their location at different parts of supply chain.

Production is the main source of flexibility in case of companies which are forced to respond to demand from production as the product does not allow stocking and the customers requires fast deliveries. Hence companies rely on an efficient forecasting process for sourcing of materials.

Inventory can be used to offer flexibility. Customer requires fast delivery but the product can be stocked and hence forecasts are crucial. Production can happen in batches to optimise the costs

Delivery lead times are the principal source of flexibility. Procurement is based on firm orders. Hence project orders are taken with exact delivery time. Usually order back log forms a large part of delivery.

Hence companies use inventory to provide flexibility which is located at middle level of integration. And in companies where delivery time is flexible, the planning process seems to be operated at lesser levels.

Types of Planning Process.

Companies can be identified based on their planning approaches.

1. Forecast based planning
2. Order based planning

These are differentiated on the basis of product characteristics, speedy delivery, flexibility and supplier management. Companies that belong to Group 1 deliver standard products at a high speed to customers. Companies that belong to Group 2 is focused on firm order based planning, whose delivery lead time varies to customer requirement.

	Group 1 <i>Forecast-focused planning</i>	Group 2 <i>Order-focused planning</i>
Delivery time to customers	4 h – 7 days	2 wks – 6 months
Product change rate	4-20 %	0-3 %
Product type	Standard	Customized
Source of flexibility	Production, inventory	Delivery time
Balancing demand and supply	In production plan or in a separate balancing process	In defining customer delivery time
The most important plan	Demand forecast or sales plan	Production plan
The most important information source	Historical sales data, demand when available	Orders, order backlog

Role of Inventory Management in Supply Chain



Figure – 5 Schematic diagram of Inventory in supply chain

Why Inventory Control?

Inventory is needed to ensure that the business has the right goods on hand to avoid stock-outs, Businesses demand on lean resources, working capital h is one of the major asset that is tied up to inventory. Many of the instances show that working capital is tied up with wrong kind of inventory. Inventory typically represents 45% to 90% of all expenses for any business.

Inventory control systems range from eyeball systems (visual management) to reserve stock systems (two-bin) and to perpetual computer-run systems. Average industry figures serve as a guide for comparison. Too large an inventory may not be justified because the turnover does not warrant the investment. On the other hand, too small an inventory may minimize sales and profits as customers go somewhere else to buy what they want which is immediately available. Minimum inventories are to be maintained based on reordering time which become an important aspect of purchase activity.

Inventory Control

Inventory control involves the procurement, storage and disposition of materials. There are three kinds of inventory that are of concern to all managers:

- Raw materials,
- In-process or semi-finished goods,
- Finished goods.

If a manager effectively controls these three types of inventory, working capital can be released that may be tied up in unnecessary inventory

The reasons for inventory control are as below:

Helps balance the stock as to value, model and price line in proportion to demand or sales trends.

Help plan the fast selling products as well as move slow selling products.

Helps to secure the best rate of stock turnover for each item.

Helps reduce expenses and markdowns.

Helps maintain a business reputation for always having new products in wanted models and correct prices.

Helps better production control.

Helps against obsolescence, deterioration and/or theft.

Controlling Inventory

Controlling inventory does not have to be an onerous or complex proposition. It is a process and thoughtful management of inventory.

A five step process could be designed that would help any business bring this potential problem under control through a systematically approach and also help the business to make the most efficient use of the resources. However some of the final decisions, may be the result of good judgment, and not the product of a mechanical set of formulas.

STEP 1: Inventory Planning

Inventory control requires inventory planning. Inventory refers to more than the goods that are on hand like finish products, work in progress and raw material in manufacturing facility. It also represents goods that must be in transit. An ideal inventory control would be arranging for the arrival of new goods at the same moment the last item has been sold or used. The economic order quantity, or base orders, depends upon the amount of cash (or credit) available to invest in inventories, the number of units that qualify for a quantity discount

from the manufacturer, and the amount of time goods spend in shipment.

STEP 2: Establish order cycles

If demand can be predicted for the product on a regular basis, regular ordering quantities can be setup that would take into consideration the most economic relationships among the costs of preparing an order, the aggregate shipping costs, and the economic order cost as per the below fig 6. It is possible to program regular ordering levels so that stock-outs will be avoided and costs will be minimized, also replacements would be scheduled to arrive in regular intervals. In these cases all efforts should be spent developing a system tailored to meet these requirement. It is useful to focus on items whose costs justify such control, recognizing that in some cases control efforts may cost more the items worth. It is also necessary to include low return items that are critical to the overall sales effort.

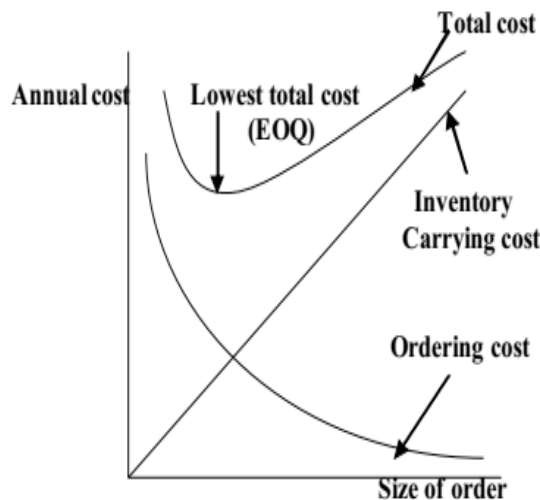


Fig – 6 - Represents the co-relation between Working capital v/s inventories

If the business experiences seasonal cycles, strategically recognize these demands that will be placed on suppliers in these periods. Seasonable implications must be built into the planning process in order to support an effective inventory management system. There will be seasonal implications of inventory control as well, both positive and negative

The EOQ units can be calculated using the formula

$$EOQ = \sqrt{2AC/DV}$$

A = the ordering cost per order

D = annual demand or usage of product (number of units)

C = annual inventory carrying cost (as a percentage of product cost)

V = average cost of one unit of inventory

STEP 3: Balance Inventory Levels

Efficient or inefficient management of inventory by any firm is a major factor between healthy profits and operating at a loss. They are both market-related and budget-related issues that must be dealt with in the terms of arriving an ideal inventory balance:

- Is the inventory correct for the market being served?
- Does the inventory have the proper turnover?
- What is the ideal inventory for a typical business of this sort?

An inventory that is not compatible with the firm’s market will lose profitable sales. Customers who cannot find the items they desire in one store or from one supplier are forced to go to a competitor. Repeated experiences of this type will motivate customers to become regular customers of competitors.



Fig – 7 represents parameters for calculating safety stock

STEP 4: Review Stocks

Stocks sitting on the shelf as obsolete inventory are simply dead capital. Keeping inventory up to date and devoid of obsolete material is another critical aspect of good inventory control and also keeping working capital in control. Technologically obsolete items should normally be removed from inventory at any cost. Stocks are monitored by stock turn over ratios. The stock turnover ratio is the rate at which the average inventory is replaced or turned over through a pre-defined standard operating period, typically one year. Stock turns or turnover, is the number of times the “average” inventory of a given product is sold annually. It helps to determine what the inventory level should be to support the predicted sales. Inventory turnover is computed by dividing the volume of goods sold by the average inventory. An efficient and effective tool to benchmark the business. Too frequent inventory turns can be as great as a potential problem as too few turns. Too frequent inventory turns may indicate the business is trying to overwork a limited capital base, and may carry with it the attendant costs of stock-outs and lost customers. The impact of high and low safety stocks are explained in the below Table – 3.

$$\text{Stock turn} = \frac{\text{cost of goods sold}}{\text{Avg. inventory at cost}}$$

$$\text{Inventory turns} = \frac{\text{sales}}{\text{Avg. inventory at sales value}}$$

	Manufacturers	Retailers
High Safety Stock	<ul style="list-style-type: none"> • High safety stock distorts true store demand thus category management and related efforts are less accurate and effective. • High costs of maintaining inventory • Excessive capital tied up in inventory. 	<ul style="list-style-type: none"> • Operational costs increase as management of excess stock is required. • High safety stock distorts true shopper demand thus decreases forecasting and ordering accuracy.
Low Safety Stock	<ul style="list-style-type: none"> • Low safety stock reduces the impact of promotions. • Leads to irregular ordering from retailers. • Loss of brand loyalty and brand equity. • Out-of-stock encourages competitors sales. 	<ul style="list-style-type: none"> • Increases possibility of stock outs. • Loss of revenue due to stock outs. • Decreased customer satisfaction. • Loss of share loyalty. • Competitor gains.

Table – 3 Impact of High and Low safety stocks

STEP 5: Follow-up and Control

Periodic reviews of the inventory to detect slow-moving or obsolete stock and to identify fast sellers are essential for proper inventory management. Taking regular and periodic inventories must be more than totaling the costs. However, it is the responsibility of key management to study the figures and review the items themselves in order to make correct decisions about the disposal, replacement, or discontinuance of different segments of the inventory base as indicated in the below fig – 8 of dynamic inventory management.

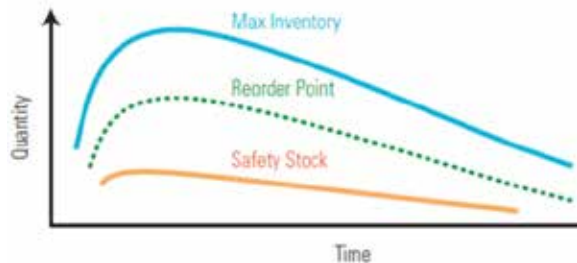


Fig – 8 Dynamic inventory management.

Just as an airline cannot make money with its airplanes on the ground, a firm cannot earn a profit in the absence of sales of goods. Finished goods inventory is usually the largest investment. It will earn profits in direct proportion to the effort and skill applied in its management. Inventory must be organized maintained and measured. Minimum stocks must be assured to prevent stock-outs or the lack of product. At the same time, they must be balanced against excessive inventory because of carrying costs.

Significance of Information flow in Supply Chain Inventory Management (SCIM)

Inventory management for supply chains could be effective only when the information flow from top to bottom of a supply chain is streamlined. Cachon & Fisher (2000) developed a value shared information model and performed a comparative study with the conventional data sharing strategies and ended up with the proposed model performing better, reducing inventory holding expenses. Strategic plans for the effective distribution of information are essential for supplying goods to the customer at the expected rate. Mutual sharing and analyzing of the information and standards between the supplier and customer at every stage of the supply chain is crucial and it also nurtures customer supplier relationships. Thus incorporating information flow standards in inventory management in a supply chain will definitely result in increased returns.

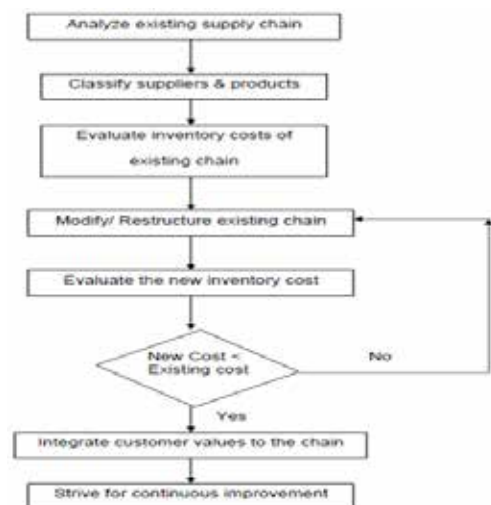


Fig – 9 Flow chart showing frame work of SCIM

Inventory Management in Discontinuous Supply Chains

Supply chains can be streamlined in such a way that they are continuous and follow the chain of activities at any given time. But there are certain cases where the chains appear to be in a broken or discontinuous due to lack of communication flow and other practical factors that limit them from following the supply chain policy. So in such cases it is extremely difficult to evaluate the inventory management strategies. Materials stored at various locations of a supply chain can have divergent effects on the cost and service levels of the chain (Lee & Belington, 1993). So managing inventories in such supply chains requires special focus and considerations at all levels.

Characteristics of Planning and Inventory Optimization

Lead time forecasting – forecasts the most appropriate supplier lead time for any item or supplier and quantifies the variability of this lead time into measurable variance.

Service level analysis– information monitored includes demand history, demand variation, profit margins and lost sales.

Demand forecasting– includes seasonality and life cycles, promotional filters, demand spikes, trend analysis, item profit margins and other deterministic factors.

Order frequency– correct order frequency analysis can reduce inventory by 10 – 15%. The trade-off between economic break points and minimizing on-hand quantities results in a dynamic review period for re-ordering.

Replenishment– takes into account timing of the order, order point, potential overstock/under stock situations, promotional information, and production changes. Purchasing and inventory management established as profit center.

Network awareness– inventory planning is done taking into account the requirements of the entire supply chain network including suppliers and customers. This global view replaces the traditional sub-optimization byproduct and/or location.

Collaboration- new browser-based technology allows for planning through the participation of the entire supply chain community. This was previously not possible in the past, where systems were not open to integration. CPFR (Collaborative Planning for Replenishment) and VMI (Vendor-managed Inventory) are now becoming commonplace.

Measurement criteria of Planning and Inventory Optimization are as below:

Increased profitability by avoiding markdowns and obsolescence write offs.

Lowered working capital cost of holding excess stock through redistribution and better purchase order management.

Better cost management associated with space utilization.

Lower transportation costs through network planning.

Reducing excess stock by accurate forecasting of demand.

Increased customer service levels.

Increased Customer spending based on increased availability.

Improved product mix.

Reduction of Safety stock through better predictive techniques that decrease variability and uncertainty.

Reduction of lost sales through improved in-stock position.

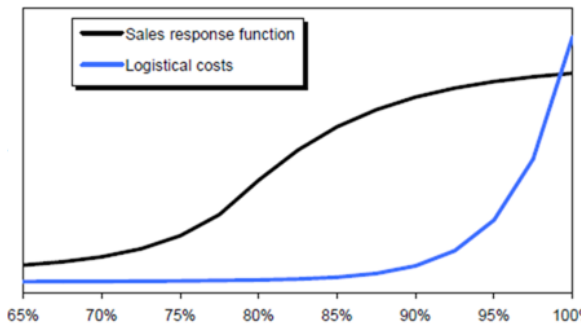
Reduction of slow moving items with rules that account for periodic review.

Reduced intervention of buyers and product managers on regular process instead focus their efforts improvement processes / projects.

Reduction of delivery lead times, with better business management.

Inventory Optimization Solution

Inventory Optimization solutions allow an organization to achieve a balance between the most efficient investment in inventory and highest customer service levels. Inventory very well maintained will provide a basis for replenishment. The below fig – 10 explains logistics cost with respect to customer service levels. Solutions should be established for the optimal mix between inventory investment and service levels for each inventory item at each location within an organization. These solutions are strategic and tactical, initial execution process tools that analyze all necessary information of past, present and future to build the ideal working inventory model.



Some of the advanced SCM functionality includes:

Material Acquisition Analysis & Planning

Demand Planning & Forecasting

Inventory Modeling

Automated Replenishment

Distribution and Re-Distribution

Collaborative Planning

Analysis Tools

Optimization balances supply to meet demand at the lowest possible cost (investment in inventory) by using least company resources, for a given service level for each item at each site within the entire supply chain. Optimization of inventory can result in an inventory reduction of 30%, while also reducing out-of stock situations and ensuring that the correct stock is available to satisfy demand. These are benefits that can't be realized by increasing sales."(Source: J.Healy, Profit from the inside out, isourceonline.com , 2002) Inventories typically comprise 40-50% of a manufacturing or distribution organization's capital investment. "Right-sizing" this investment, without compromising service levels, provides management with a beneficial way of increasing return and freeing needed capital for expansion and other strategic investments. Again this goes against conventional wisdom, which states that "Inventory reductions will not provide the same profitability increase as that of increasing sales". However, with gross margins under extreme pressure, the reduction of investment in "dead" stock is significant. It reduces the Cost-of-Goods by not purchasing that will not be sold. "While sales are obviously important, ongoing inventory optimization practices actually afford the single largest opportunity to have a direct impact on profitability.

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