# INVENTORY AND PRODUCTION MANAGEMENT IN SUPPLY CHAINS

**Anandasrinivasan Deviprabha**
**Dr. Yagnamurthy Raja**

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# CHAPTER 1

# SALES AND OPERATIONS PLANNING: DEMAND IN A SUPPLY CHAIN

Ms. Anandasrinivasan Deviprabha, Assistant Professor
Masters In Business Administration, Presidency University, Bangalore, India
Email Id: deviprabha@presidencyuniversity.in

**ABSTRACT:**

In order to effectively satisfy customer demand, anticipating and regulating the flow of goods, services, and information is a crucial function in supply chain planning. In order to achieve operational excellence and customer happiness, supply and demand planning in a supply chain is crucial. This chapter gives a general understanding of this idea. Planning for supply and demand tries to match product production and acquisition with expected consumer demand. In order to guarantee that goods and services are available at the appropriate time and in the appropriate quantity, it entails projecting future demand patterns, reviewing previous data, and working with suppliers and distributors.

**KEYWORDS:**

Demand Management, Green Thumb, Operation Planning, Predictable Variability, Supply Demand.

## INTRODUCTION

Demand change that can be predicted is referred to as predictable variability. Products that experience this kind of demand fluctuation cause a variety of issues in the supply chain, from high levels of stock outs during periods of peak demand to high levels of excess inventory during periods of low demand. These issues make the supply chain less responsive and raise its expenses. When used on items with predictable variability, supply and demand management through sales and operations planning can dramatically boost performance. A company's objective when faced with known variability is to react in a way that optimizes profitability by balancing supply and demand. Planning for sales and operations seeks to effectively combine two major approaches to manage known variability:

1. Control supply utilizing inventories, subcontracting, capacity, and backlogs.
2. Control demand by implementing temporary price reductions and promotions.

Because supply and demand are better coordinated when these technologies are used, the supply chain is able to boost profitability. Let's take a look at the garden equipment manufacturer Red Tomato Tools from Chapter 8 to highlight some of the challenges at hand. Gardening equipment is in seasonal demand, with spring being the busiest season for sales. To maximize profits, Red Tomato must determine how it will satisfy demand. Red Tomato must have sufficient manufacturing capacity, according to one method, to meet demand from production at any time. With this strategy, Red Tomato benefits from reduced inventory expenses since no inventory is kept on hand from one period to the next [1]. The expensive capacity's biggest drawback is that it sits largely unused during most months, when demand is lower. Building up inventory during the off-season to maintain consistent production all year round is another strategy for satisfying demand. The benefit of this strategy is that Red Tomato can get by with a less expensive, lower capacity factory. This method is costly, though, due to high inventory carrying expenses.

A third strategy is for Red Tomato to collaborate with its supply chain retail partners to run a price campaign prior to the spring months, during times of low demand. The promotion spreads out demand more equally throughout the year and lessens the seasonal surge by moving some of the spring demand ahead into a slack period. Supplying to such a demand pattern is less expensive. Red Tomato must choose which alternative, using its S&OP method, maximizes its profitability. Supply and demand management tasks are frequently broken down into separate functions by businesses. Sales often controls supply while operations controls demand. This problem also affects supply chains at a higher level, when manufacturers manage supply and retailers manage demand separately. When supply and demand management decisions are made independently, it reduces supply chain earnings. To coordinate these choices and increase profitability, supply chain partners must collaborate across organizations. This cooperation is made easier by the S&OP process. By talking further about Red Tomato, we demonstrate the importance of this collaboration. We first concentrate on steps a supply chain can take to boost profitability by controlling supply.

**Managing Supplies**

1. A business can alter its product supply by managing both of the following variables:
2. Capacity for production.
3. The goal is to maximize profit, which, for the sake of our discussion, is the difference between the sales income and the entire cost of the material, capacity, and inventory.

In order to control supply, businesses typically combine varying capacity and inventory. We outline some specific methods for controlling capacity and inventory with the aim of maximizing earnings in the sections that follow.

**Capacity Management**

In order to manage capacity to meet predictable variability, businesses combine the following strategies:

**Workforce Time Flexibility:** In this strategy, a company makes use of the workforce's flexible work schedules to manage capacity and better fulfil demand. Plants frequently do not run continuously and are left idle for parts of the day or week. As a result, the amount of time the plant can run on reserve is measured in hours. For instance, since many plants do not operate three shifts, the current workers may put in extra time at demand-peaking periods to increase output. The overtime is adjusted to account for changes in demand. With the help of this system, the plant's output can better meet client demand [2]. A company can arrange the workforce so that the available capacity more closely matches demand if demand varies by day of the week or week of the month and the workforce is flexible. Utilizing a part-time workforce in these circumstances enables the company to employ more employees during busy times, further increasing capacity flexibility. Banks and telemarketing companies frequently use part-time employees to better match supply and demand.

**Employing Seasonal Workers:** In this strategy, a company hires temporary workers during the busiest times of the year to expand capacity and keep up with demand. The tourism sector frequently employs seasonal labor. There is a base of full-time workers, and additional ones are only hired during the busiest times of the year. Toyota frequently employs seasonal workers in Japan to better balance supply and demand. However, if the labor market is tight, this strategy may be difficult to maintain.

**Use of Subcontracting:** In this strategy, a company subcontracts peak production so that internal production remains steady and can be done affordably. The corporation is able to construct a relatively rigid but inexpensive facility where production rates are kept largely constant apart from changes due to the use of overtime thanks to the subcontractor handling the peaks. Peaks are contracted out to more adaptable facilities. The availability of somewhat

flexible subcontractor capacity is important here. By combining the variations in demand among various manufacturers, the subcontractor may frequently provide flexibility at a lower cost. In order for the flexible subcontractor capacity to be viable, it must be able to accommodate both volume fluctuating demand from a manufacturer and variety flexibility demand from a number of manufacturers. For instance, most power companies lack the ability to provide all of the electricity needed by their consumers during peak hours. Instead, they rely on their ability to buy electricity from suppliers and subcontractors who have extra supply. As a result, the power providers are able to keep their costs low and their supply steady.

**Building both specialized and flexible facilities simultaneously:** In this strategy, a company constructs both types of facilities. A generally constant production of items is efficiently produced over time by specialized facilities. Flexible facilities may manufacture a wide range of volumes and goods, but at a greater cost per unit. A manufacturer of PC components, for instance, might have flexible facilities that can produce all types of circuit boards in addition to specialized facilities for each type of circuit board. The flexible facility absorbs fluctuations so that each specialized facility can produce at a roughly constant rate.

**Including flexibility in the production processes while designing products:** In this strategy, a company has flexible manufacturing lines with easily adjustable output rates. Then, production is adjusted to meet the demand. For various product families, Hino Trucks in Japan has a number of production lines. The layout of the production lines makes it possible to alter the production rate by altering the number of workers on a given line. Moving the workforce from one line to another can change the capacity on each line as long as the fluctuation in demand across different product lines is complementary when one goes up, the other tends to go down. Naturally, this calls for a staff that is multiskilled and flexible enough to transition from one line to another.

If the manufacturing equipment is adaptable and simple to switch from producing one product to another, production flexibility can also be achieved. This strategy works best when the total demand for all of the items is stable. Many companies that manufacture seasonal products attempt to take advantage of this strategy by carrying a portfolio of goods with peak demand seasons spread throughout the year. A well-known illustration is a company that makes lawn mowers but also produces snow blowers to keep year-round demand stable at its facility. Strategy consulting firms are an example from the services sector. Businesses combine the following strategies for managing inventories to account for predictable variability:

Making use of components that are shared by several products. With this strategy, a company creates standard parts that may be used to several products. Despite the fact that each product exhibits predictable variations, the overall demand for these components is comparatively steady. Although demand for lawn mowers and snow blowers varies throughout the year, the utilization of a single engine for both provides for rather steady engine demand. As a result, it is simple for the supply chain's component-producing segment to match supply and demand, and there is less need to stock up on parts. Similar to this, in a consulting firm, a large portion of the same consultants create growth strategies when they are in demand and cost-reduction ideas when those are in demand.

Stock up on high-demand or predictable-demand products: The prior strategy is impractical when the majority of the products a company produces have the same peak demand period. Because there is little to be learnt about the market for these products by waiting, it is ideal for the company to construct them during the off-season when demand is more predictable. The production of items with higher levels of uncertainty should begin earlier in the selling season, when demand is more predictable. Consider a company that creates winter coats for

both the Boston Fire and Police Departments and the general public. The demand for the Boston Police and Fire jackets may be produced during the off-season and kept on hand until the coming winter because it is more predictable. However, because fashion trends can change quickly, it is possible that the demand for the retail jacket will be better understood closer to the time when it is offered. As a result, the producer should make the retail jackets close to the peak season when demand may be more easily predicted. With the aid of this tactic, the supply chain can better synchronize supply and demand [3]. Following that, we look at steps a supply chain can take to increase profitability by controlling demand.

**Manage Demand**

Supply chains can affect demand by adjusting prices and utilizing other promotional tactics. Retailers frequently decide on promotions without considering the effects on the rest of the supply chain. In this section, we'll demonstrate how supply chain participants can work together to make pricing and overall planning demand and supply management decisions that will maximize the profitability of the supply chain. Let's go back to the maker of gardening tools, Red Tomato Tools. A significant retail chain called Green Thumb Gardens has an exclusive agreement to sell all goods produced by Red Tomato Tools. As gardeners get ready to start planting in the spring, the demand for gardening tools surges in the months of March and April. Both businesses should aim to maximize supply chain profitability during planning because the result gives them more money to split.

Red Tomato and Green Thumb must find a way to work together in order for profit maximization to occur. It is also crucial that they work out how to divide the supply chain profits. The secret to a successful collaboration is deciding how these benefits will be distributed to various players in the supply chain. Red Tomato and Green Thumb are looking into the impact of when shop promotions run on sales. Are they in a stronger position if they provide the price promotion during a time when demand is at its highest or lowest? The peak season is when sales are at their highest, thus the vice president of sales at Green Thumb prefers promotions. The vice president of manufacturing at Red Tomato, however, opposes the idea since it would raise manufacturing expenses. She believes that a promotion during a time of low demand is preferable since it balances supply and reduces production expenses. The two can work together and choose the best trade-offs thanks to S&OP.

**The Default Case**

We begin by thinking about the basic case that was previously covered. The suggested retail price per tool is $40. To keep track of all inventories, Green Thumb receives constructed tools from Red Tomato. One thousand tools make up Green Thumb's initial inventory in January. At the beginning of January, Red Tomato's manufacturing facility in Mexico employed 80 people. Each month has a total of 20 working days, and Red Tomato employees are paid the equivalent of $4 per hour. Each employee puts in eight hours of regular labor and the remaining hours are overtime. Since the Red Tomato operation comprises entirely of manual assembly, the production operation's capacity is primarily dictated by the total number of labor hours put in i.e., it is not constrained by machine capacity. No worker puts in more than 10 hours of extra time each month. Subcontracting, inventories, and stock outs are all unrestricted. All backlogs are filled from the production of the following month. Each month, inventory expenses are based on the ending inventory. The timing of a promotion is influenced by four main factors:

Demand-related effects of the promotion; inventory holding costs; the cost of adjusting the level of capacity; and product margins Both organizations' management teams are trying to determine whether a particular factor favors providing a promotion during times of strong demand or low demand. They begin by taking into account how demand is impacted by

promotions. When a promotion is made available, demand for that time period typically increases. The three variables listed below combine to cause this rise in demand:

1. Market expansion the product is consumed more frequently by both new and existing customers. For instance, when Toyota announces a Camry price reduction, it may entice customers who were contemplating buying a less expensive model. As a result, the promotion expands the market for family sedans as a whole and boosts Toyota's sales.
2. Stealing market share. Customers switch from the company's product to one made by a rival.
3. Customers who might have bought a Honda Accord can now buy a Camry when Toyota offers a discount. As a result, the campaign boosts Toyota sales while maintaining the same size of the family sedan market as a whole.
4. Forward buying is when customers bring present-day purchases ahead of future ones. Customers who would have bought a Camry in a few months may be drawn in by a promotion. Long-term sales growth for Toyota is not achieved by forward purchase, and the size of the family sedan market is likewise maintained [4].

**Lacing In Practice Sales and Operations Planning**

Organize planning together among supply chain companies. A supply chain's entire organization must be focused on maximizing profitability in order to properly manage predictable variability. This is something that most supply chain participants might agree on. In practice, however, it can be challenging for the entire supply chain to reach consensus on how to increase profitability. Even getting diverse functions inside an organization to collaborate on plans has proven difficult for businesses. Incentives are important in this. Within a company, incentives for sales are frequently based on income, but incentives for operations are frequently based on cost. Different businesses within a supply chain are evaluated based on their own profitability, not necessarily the profitability of the entire supply chain. It is evident from the prior instances that a supply chain would yield less than ideal earnings if companies are not focused on cooperating. Joint teams should be formed to facilitate collaboration. The incentives of the participants in a supply chain must match.

High-level support is required inside an organization since this coordination frequently calls for groups to deviate from their standard operating practices. Even if this relationship is challenging, the benefits are substantial. The idea of cooperative forecasting, planning, and replenishment is covered in more detail. When making strategic judgments, take into consideration predictable variability. A company's operations are greatly impacted by predictable variability. A company must always consider this impact when making strategic decisions. However, when strategic decisions are formed, such as what kind of items to sell, whether or not to create additional facilities, and what kind of pricing structure a company should have, predictable variability is not always taken into account. Predictable variability has a significant impact on profitability, as this chapter has shown, and can therefore influence whether strategic actions are successful or unsuccessful.

Create S&OP to comprehend and control the demand usage drivers. The S&OP team should aim to comprehend the consumer's actual usage patterns so that it can respond appropriately. S&OP should aim to control demand and supply in a way that increases supply chain surplus. The S&OP team needs to have adequate demand visibility throughout the supply chain in order for this strategy to be successful. Ensure that plans are modified by the S&OP process if reality or forecasts change. Early warning alarms must be incorporated into the S&OP process. A shift in supply or demand conditions could cause the reality to diverge from the plan. In this case, it is crucial that the planners notify the supply chain of the outdated plan and provide a fresh one that takes these modifications into consideration [5]. The output of

the S&OP process should be amended as projections or marketing strategies are modified, even if there are no immediate alarms.

**Summary of Learning Objectives, Section**

In the face of predictable variability, manage supplies to enhance chain synchronization. Companies must manage their capacity through the use of labor flexibility, subcontracting, dual facilities, and product flexibility in order to manage supply with the purpose of maximizing profit. Businesses must also use inventory to control supply, focusing on common components and creating and storing products with predictable demand in advance. These approaches give a business the tools to manage supply efficiently when used with aggregate planning. Control demand to enhance supply chain synchronization in the face of known fluctuation. Companies must utilise price and promotion decisions in conjunction with supply planning to manage demand in order to maximize profit. The timing of promotions can significantly affect demand. Consequently, shaping demand through pricing can aid in synchronizing the supply chain.

When a supply chain is subject to expected variability, use sales and operations planning to maximize profitability. Supply chains must coordinate the management of both supply and demand in order to handle predictable variability in a way that maximizes profits. To choose pricing and promotion strategies and aggregate plans that maximize supply chain profit, this calls for coordinated planning throughout all phases of the supply chain. A planning technique called demand management is used to predict, organize, and control consumer demand for goods and services. This can happen both at macro levels in the economy and at micro levels within specific companies. At the macroeconomic level, for instance, a government may control interest rates to manage financial demand. To lessen demand during peak hours, a cellular service provider may offer free night and weekend use at the micro level.

For businesses that manufacture products and provide services, demand management includes a defined set of procedures, tools, and suggested conduct. Demand management outcomes are a reflection of policies and programmers to impact demand as well as competition and options available to users and consumers. Consumer electronics and products firms frequently take the lead in the application of demand management practices to their demand chains [6], [7]. In order to increase the predictability of outcomes, effective demand management employs the closed loop idea, in which input from the outcomes of the demand plans is given back into the planning process. Systems dynamics is reflected in several practices. Volatility is now understood to be a serious problem, with emphasis being placed on demand variations from projections and plans.

**Macroeconomics in Economics**

Demand management in macroeconomics is the art or science of regulating aggregate demand to prevent a recession. Keynesian economics served as an inspiration for demand management at the macroeconomic level, which uses discretionary policy and has components that are now accepted as part of the economic mainstream. The basic notion is for the government to alter important economic decisions like consumption, investment, the trade balance, and public sector borrowing through the employment of instruments like interest rates, taxes, and public spending, resulting in a evening out of the business cycle. From the 1950s to the 1970s, demand management was frequently used and initially successful. The supply shock brought on by the 1973 oil crisis is thought to have been the catalyst for the stagflation that occurred in the 1970s. Demand management is theoretically criticized for relying on a long-run Phillips Curve for which there is no supporting data and for producing dynamic inconsistency, which makes it potentially unreliable. Today, most governments focus their demand management efforts on resolving immediate crises and rely

on measures like fiscal policy guidelines and autonomous central banks to minimize long-term economic disruption.

**Resources and the Environment**

Demand management refers to measures to reduce consumer demand for items that are harmful to the environment or that are environmentally sensitive, such as energy and water, in natural resource management and environmental policy more generally. The phrase is used to describe the demand forecasting, planning, and order fulfilment processes in manufacturing companies. Demand management is being taken more seriously in the environmental context to decrease the economy's consumption of limited resources for which market pricing does not accurately represent genuine costs. Municipal water metering and petrol carbon levies are two examples.

**Social Economics**

Economics' focus on demand management is on the best distribution of resources to influence societal welfare. The viewpoint and methods of microeconomics are used in welfare economics, but they can be combined to draw conclusions about macroeconomics. Welfare economics looks for the state that would produce the highest overall degree of social welfare because many optimal states may exist in an economy with respect to the distribution of resources [8]. Although economists contend that redistributing earnings in the market could result in higher overall social welfare, some people oppose the idea since it goes against the principles of pure capitalism. Because welfare economics uses microeconomics techniques, demand planning is a part of the process, particularly when money is redistributed to programmers that benefit society, like roads, services, income support, and agricultural support programmers, through government taxes, fees, and royalties.

**As a Commercial Process, Demand Management**

Demand management is a procedure that can be used alone or as part of integrated business planning or sales and operations planning. The most effective demand management goes much beyond simply creating a forecast based on historical data and adding market or customer knowledge, which is frequently left up to the supply chain organization to interpret. Two crucial arguments are made by Philip Kotler:

1. The marketing organization is in charge of managing demand according to his definition, sales is a subset of marketing
2. The forecast of demand is the outcome of deliberate marketing actions. In addition to increasing demand, those planned activities should also, and perhaps more importantly, influence demand in order to advance a company's goals [9].

## CONCLUSION

Supply chain planning is a critical step that enables businesses to streamline operations, cut costs, and effectively satisfy client needs. Organizations can achieve operational excellence and gain a competitive edge by precisely estimating demand, coordinating manufacturing and procurement processes, and encouraging collaboration with supply chain partners. Numerous advantages result from effective supply and demand planning, including increased customer satisfaction, decreased stock outs, minimized surplus inventory, and optimized inventory levels. It raises customer happiness by increasing operational effectiveness, cutting expenses, and ensuring prompt order fulfilment. Demand volatility, supply chain disruptions, and shifting market dynamics are obstacles that supply and demand planners must overcome. To overcome these obstacles and adjust to changing market conditions, businesses must use strategies like demand segmentation, collaborative forecasting, and agile production techniques.

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# CHAPTER 2

# A BRIEF INTRODUCTION TO COORDINATION IN A SUPPLY CHAIN

Dr. Narayana Srikanthreddy, Assistant Professor
Department of Management, Presidency University, Bangalore, India
Email Id: srikanthreddyn@presidencyuniversity.in

**ABSTRACT:**

In order to achieve optimal performance and match consumer expectations, coordination in a supply chain entail synchronizing the actions, procedures, and connections across various organizations in the network of the supply chain. This summary gives a general overview of the idea of supply chain coordination and emphasizes its importance in promoting efficiency and effectiveness. The operations of suppliers, manufacturers, distributors, retailers, and other parties involved in the flow of goods, services, and information must be integrated and coordinated as part of a supply chain. It tries to improve overall supply chain efficiency by streamlining operations, cutting redundancies, lowering expenses, and minimizing costs.

**KEYWORDS:**

Chain Coordination, Chain Stages, Information Distortion, Lead Time, Supply.

## INTRODUCTION

If every level of the chain takes actions that are coordinated and raise the overall supply chain surplus, supply chain coordination improves. Coordination of the supply chain calls for information sharing and consideration of the effects of one stage's activities on subsequent stages. The supply chain's many stages may have competing aims, or information may move between them slowly and inaccurately, leading to a lack of coordination. If each stage of a supply chain is owned by a different party, the goals of the various phases may conflict. Each level strives to maximize its own earnings as a result, which frequently results in decisions that lower overall supply chain profitability. Supply chains today are made up of stages with various owners. For instance, Ford Motor Company works with thousands of suppliers, ranging from Motorola to Goodyear, and each of these suppliers in turn works with several suppliers. As information goes through the supply chain, it is skewed because complete information is not provided between phases. The fact that supply chains today create a wide range of items magnifies this misconception. Ford creates a variety of models, each with a range of options. Ford finds it challenging to organize information sharing with thousands of suppliers and dealers due to the expanded variety. To achieve coordination in supply chains despite varied ownership and growing product variety is today's key problem [1].

The bullwhip effect, which occurs when order variations get worse as they go up the supply chain from retailers to wholesalers to manufacturers to suppliers, is one result of a lack of supply chain coordination. This impact is illustrated. The supply chain's knowledge on demand is distorted by the bullwhip effect, with each stage's estimate of demand being different. The bullwhip effect has been noticed in the supply chain for Pampers diapers by Procter & Gamble the business discovered that P&G's orders for raw materials to its suppliers changed dramatically over time. When retail store sales were examined further down the chain, the changes, while existent, were minor. At the end of the supply chain, when diapers were being used by babies, it is reasonable to infer that this rate was constant. Despite constant end-user demand, orders for raw materials fluctuated greatly, driving up costs and making it challenging to balance supply and demand. Additionally, HP discovered that as

they proceeded up the supply chain from resellers to the printer division to the integrated circuit division, the order variability greatly rose.

While there was considerable variation in product demand, there was significantly more variation in orders placed with the integrated circuit division. As a result, HP found it more expensive and difficult to complete orders on schedule. Studies of the supermarket and garment industries have revealed a related phenomenon: As we move from retail to manufacturing upstream in the supply chain, the variability in orders grows. Pasta manufacturer Barilla in Italy noticed that while weekly sales at the distribution center representing orders placed by supermarkets fluctuated by a factor of less than three over the course of the year, weekly orders placed by the local distribution center fluctuated by up to a factor of 70.3 As a result, Barilla had to deal with demand that was far more unpredictable than consumer demand. As a result, there were more inventory, fewer products were available, and lower earnings. A longer period of time has seen a similar pattern in a number of businesses that are highly susceptible to boom and bust cycles. The manufacture of memory chips for personal computers is a good illustration. There were at least two cycles between 1985 and 1998 in which memory chip costs varied by a factor of three or more. Either severe shortages or capacity surpluses were to blame for these pricing variations. Panic buying and over ordering that was followed by a sharp decline in demand contributed to the shortages. We discuss how a lack of coordination affects supply chain performance in the section that follows.

**How A Lack of Coordination Affects Performance**

If each stage of the supply chain optimizes only its individual goals without taking the overall chain's effects into account, the chain as a whole lack’s coordination. As a result, overall supply chain earnings fall short of what may be attained by coordination. In an effort to best meet its local goal, each level of the supply chain performs activities that ultimately degrade the efficiency of the overall chain. Additionally, if there is knowledge asymmetry within the supply chain, there will be a lack of coordination. Think about the bullwhip effect P&G discovered in the supply chain for diapers [2]. The bullwhip effect causes orders P&G receives from its wholesalers to be far more erratic than nappy demand at stores. We go over the effects of a disjointed supply chain on key performance metrics in the nappy supply chain.

**Production Cost**

The supply chain's production costs go higher as a result of the absence of coordination. The bullwhip effect forces P&G and its suppliers to fill a stream of orders that is significantly more unpredictable than client demand. P&G has two options for dealing with the increased variability: either develop excess capacity or keep surplus inventory; both options raise the cost of production per unit manufactured. Inventory Cost the supply chain's inventory costs go up as a result of the lack of coordination. P&G has to maintain a larger level of inventory than would be necessary if the supply chain was coordinated in order to manage the increased demand fluctuation. The supply chain's inventory expenses consequently go higher. High inventory levels also increase the need for storage space, which raises the associated costs.

**Lead Time for Replenishment**

In the supply chain, a lack of coordination lengthens the lead times for replenishment. The bullwhip impact increases variability, which makes scheduling at P&G and supplier plants considerably more challenging than it is when demand is flat. There are instances where the inventory and capacity on hand are unable to fill the incoming orders. Higher lead times for replenishing are the outcome.

## DISCUSSION

Any factor that increases information latency, distortion, or variability within the supply chain or local optimization by various supply chain stages is a barrier to coordination. Managers in a supply chain can take appropriate steps to help establish coordination if they are able to pinpoint the major roadblocks. We categories the main barriers into the following five groups:

### Motivating Barriers

Obstacles to information processing include: operational, pricing, operational, and behavioral. Encouragement Barriers Incentive hurdles happen when incentives given to various supply chain participants or stages result in actions that raise unpredictability and lower overall supply chain profits. Decisions that do not maximize entire supply chain surplus are the outcome of incentives that solely consider local effects of an activity. For instance, if a transportation manager's pay at a company is based on the average unit cost of transportation, the manager is more inclined to make decisions that reduce transportation costs, even if they result in higher inventory costs or decreased customer service. Any supply chain participant would naturally act to maximize the performance metrics by which they are assessed. For instance, management at a company like Kmart decide everything regarding inventory and purchases in order to maximize Kmart earnings rather than overall supply chain profitability. Ordering practices that don't maximize supply chain profits result from purchasing decisions that are based on maximizing profits at a single step of the supply chain.

### Insurance for Sales Forces

Poorly designed sales force incentives are a major hindrance to supply chain coordination. In many businesses, sales force incentives are determined by how much the sales force sells over the course of a month- or quarter-long evaluation period. Instead of the amount supplied to final consumers sell-through, a manufacturer often measures the amount sold to distributors or retailers sell-in. It is frequently argued that using sell-in as a measure of performance is appropriate because the manufacturer's sales staff has little control over sell-through. For instance, during a four- to six-week promotion period, Barilla provided incentives to its sales team based on the volume sold to distributors [3], [4]. Even though distributors weren't selling as much pasta to retailers at the end of the assessment period, the Barilla sales team encouraged distributors to acquire more pasta to maximize their bonuses. To increase sales at the end of the term, the sales staff offered discounts under their supervision. As a result, there was more variation in the order pattern, with a spike in orders at the end of the assessment period and few orders at the start of the subsequent evaluation period.

Order volumes from distributors to Barilla varied from one week to the next by a ratio of up to 70. Due to the tendency of the sales force to push products closer to the end of the incentive period, an incentive programmer for the sales force based on sell-in results in order variability being greater than customer demand fluctuation. As orders migrate up the supply chain to manufacturers and suppliers, demand increases. Information is distorted as it passes up the supply chain in supply networks where orders are the primary means of communication between different stages. Each stage sees the fulfilment of orders placed by its downstream partners as its primary function within the supply chain. Each step creates a forecast based on the stream of orders it receives and perceives this as its demand. In such a case, a modest shift in customer demand that manifests as orders from customers causes it to grow as it moves up the supply chain. Think about the effects of a retailer experiencing an arbitrary rise in client demand.

The store can consider a portion of this sporadic increase to be a growth pattern. Because the retailer anticipates growth to continue in the future and orders to account for future projected growth, this interpretation will drive the retailer to order more than the observed increase in demand. Thus, the rise in orders made with the wholesaler is greater than the rise in demand that has been shown at the retailer. One-time increases make up a portion of the increase. However, the wholesaler is unable to properly comprehend the order increase. The wholesaler only notices an increase in order size and deduces a growth tendency. Since the retailer increased the order size to accommodate for future growth, the wholesaler's predicted growth trend will be higher than the retailer's predicted growth trend. As a result, the distributor will give the manufacturer a larger order. The order size increases as the supply chain is moved up farther. Assume now that random increases in demand are followed by random decreases in demand. The retailer will now predict a deteriorating trend and lower order size using the same forecasting logic as before. Moving up the supply chain will also result in an increase in this reduction [4].

**Misshaping of Information**

The information distortion is made worse by a lack of information sharing along the supply chain. A planned promotion may drive a merchant like Wal-Mart to boost the size of a specific order. The manufacturer can take the larger order as a long-term boost in demand and place orders with suppliers if it is unaware of the planned offer. As a result, the manufacturer and suppliers have a lot of inventory once Wal-Mart ends its sale. Manufacturer orders will be fewer than before as future Wal-Mart orders resume to their regular levels due to the excess inventory. Thus, there is a significant variation in manufacturer orders as a result of the retailer and manufacturer not sharing information.

**Buying In Big Lots**

The unpredictability of orders is amplified across the supply chain when a firm places orders in lot sizes that are significantly greater than those in which demand originates. Due of the high fixed costs involved in placing, receiving, and transporting orders, businesses are able to place big orders. If the seller gives quantity discounts based on lot size, large lots could also happen. depicts the order stream and demand for a company that submits orders every five weeks. Notice how much more unpredictable the order stream is than the demand stream. The order stream has four weeks without orders followed by a large order that equals five weeks of demand since orders are batched and placed every five weeks. An order stream for a manufacturer supplying many retailers that batch their orders is far more unpredictable than the demand the merchant’s encounter. The impact is increased if the producer sends orders to suppliers in batches [5]. In many cases, there are particular focal-point times when the majority of the orders arrive, such as the first or last week of a month. The effects of batching are further exacerbated by this concentration of orders.

**Replenishment Lead Times are Large:**

If there are large lead times between phases for replenishing, information distortion is exacerbated. Think about a scenario where a retailer mistook an erratic rise in demand for a rising trend. When placing the purchase, the retailer will factor in the expected growth over the next two weeks if the lead time is two weeks. In contrast, if the shop has a two-month lead time, it will include in the anticipated increase throughout that time, which will be significantly larger. The same holds true when a sudden drop in demand is perceived as a downward trend.

**Shortage Gaming and Rationing**

Information distortion is amplified by rationing plans that distribute limited production in accordance to retailer requests. This may happen if there is a shortage of a product that is in

high demand. Manufacturers devise a number of strategies in such circumstances to distribute the limited product supply across different distributors or merchants. One popular method of rationing is to distribute the product's supply in accordance with orders received. Each store will receive 75% of its order under this rationing plan if the supply is equal to or more than the total number of orders. Retailers attempt to increase the size of their orders to increase the amount of supply sent to them as a result of this rationing plan. A retailer who needs 75 units places an order for 100 in the hopes of receiving. This rationing plan will ultimately artificially increase goods orders. Additionally, a merchant who places an order based on what it anticipates selling will receive less and lose sales, whereas a retailer who places an inflated order will benefit. The manufacturer will interpret an increase in orders as an increase in demand even if consumer demand remains unchanged if it is utilizing orders to estimate future demand. The manufacturer may react by increasing capacity so that it can fulfil all orders. Orders increase in response to the rationing plan, but once enough capacity is available, they return to regular levels. The manufacturer is now left with an excess of inventory and available space. Therefore, these boom-and-bust cycles usually alternate. The electronics industry frequently experiences periods of component shortages followed by component surpluses, and this occurrence is rather typical there. The manufacture of memory chips in particular went through a few of these cycles in the 1990s [6].

**Behavioral Barriers**

Behavioral barriers are issues with learning within organizations that skew the information. These issues are frequently connected to the supply chain's organizational structure and interstate communication. The following list of behavioral barriers applies to some:

1. Each level of the supply chain sees the effects of its activities only locally and is unable to understand how they affect subsequent stages.
2. Instead of attempting to determine the underlying causes, various supply chain stages respond to the current local circumstances.
3. According to local study, various supply chain stages place the responsibility for the variations on one another, leading to the supply chain's latter stages becoming rivals rather than allies.
4. Because the most important effects of the activities any one stage perform happen elsewhere, no level of the supply chain learns from its actions over time. As a result, a stage's actions end up creating the identical issues that the stage then places the blame for.
5. When partners in the supply chain lack trust, they become opportunistic, which lowers the performance of the chain as a whole. Significant effort is also significantly wasted as a result of the lack of trust. More importantly, because it is not trusted, information that is available at various phases is either not shared or is ignored.

**Manage Mental Elements for Coordination**

After identifying the impediments to coordination, we now concentrate on the steps a manager may take to assist in removing them and achieving supply chain coordination. The managerial practices listed below reduce information distortion while raising overall supply chain profits: Building strategic partnerships and trust; enhancing information visibility and accuracy; enhancing operational performance designing pricing strategies to stabilize orders

**Goal and Incentive Alignment**

By coordinating goals and incentives so that everyone involved in supply chain operations seeks to maximize overall supply chain profits, managers can enhance coordination within the supply chain. Aligning objectives throughout the supply chain every step of the supply chain must concentrate on the supply chain surplus, or the overall amount of the pie, rather

than simply its own portion, in order to be coordinated. Every supply chain loses money if such a strategy is not used. Examples from demonstrate how the overall supply chain surplus decreases when each level only considers increasing its own profits. Before actions and incentives throughout the supply chain are in line with this goal, a focus on the supply chain excess is unlikely to materialize.

For instance, it is crucial for strong stages within the supply chain to understand that shifting all risk to the weakest stage ultimately harms their own earnings, as was covered [7]. Developing procedures that enable the formation of a win-win situation in which the supply chain surplus rises together with the profits for all supply chain stages is essential to coordination. Incentivizing across functions Assuring that the objective any function uses to evaluate a decision is aligned with the firm's overarching objective is one essential to coordinated decisions inside a firm. Profitability, not overall costs or, worse yet, simply local expenses, should be the criterion used to evaluate all facility, transportation, and inventory decisions. Instances where a transportation manager makes choices that reduce transportation expenses but raise overall supply chain costs are avoided as a result.

**The Cost of Coordination**

If a manufacturer has significant fixed costs associated with each lot, the company can employ lot size-based quantity discounts to achieve coordination for commodity products. A manager can employ two-part tariffs and volume discounts to help accomplish coordination for goods for which a firm has market power. Given the unpredictability surrounding demand, producers can encourage retailers to offer levels of product availability that maximize overall supply chain profits by using buyback, revenue-sharing, and quantity flexibility contracts 15 for a complete discussion. In the publishing sector, buyback agreements have been employed to boost overall supply chain earnings. Contracts with quantity flexibility have increased supply chain profits for Benetton.

**Sell-In to Sell-Through Change in Sales Force Incentives:**

The bullwhip effect is diminished by any adjustment that lessens the motivation for a salesman to push a product to the retailer. Instead of selling in to the retailer, managers should tie sales team incentives to sell-through by the retailer. This measure takes away any incentive salespeople may have to promote forward buying. Eliminating forward purchases helps to stabilize the order stream. The incentive to market a product is further diminished if sales force incentives are determined by sales over a rolling time period. This lessens forward buying and the resulting order variation. Increasing the Clarity and Accuracy of Information By increasing the visibility and accuracy of the information available to various supply chain stages, managers can achieve coordination.

**Sharing Data at The Point of Sales:**

The bullwhip effect can be lessened by sharing point-of-sale data with other supply chain participants. The fact that each stage of the supply chain uses orders to predict future demand is a major factor in information distortion. Forecasts at various phases also vary because orders received at various stages differ. Actually, the final customer's requirement is the only one that the supply chain must meet. Retailers can estimate future demand based on client demand if they share POS data with other supply chain stages. Since all stages now react to the same shift in customer demand, sharing POS data helps reduce information distortion. Keep in mind that providing aggregate POS data alone is enough to reduce information distortion. Detail POS data is not required to be shared [8], [9]. The sharing of such data is made easier by the use of suitable information systems. Wal-Mart has frequently given its suppliers access to its point-of-sale data. Through the Internet, Dell communicates demand information and current component inventory positions with many of its suppliers, preventing

unneeded changes in supply and order placement. Many stores have shared demand data after being persuaded by P&G. P&G then distributes the information to its vendors, enhancing supply chain coordination.

**Collaborative Forecasting and Planning**

If perfect coordination needs to be achieved, several supply chain stages must foresee and plan collaboratively once point-of-sale data have been shared. Sharing of POS data does not guarantee coordination in the absence of cooperative planning. A retailer may have noticed high demand in January as a result of a campaign it ran. Even if both forecasts use historical POS data, the retailer's projection will be different from the manufacturer's forecast if no promotion is scheduled for the upcoming January. To establish synchronization, the manufacturer must be aware of the retailer's promotion strategies. The important thing is to make sure that every link in the supply chain is using the same prediction. The Voluntary Interindustry Commerce Standards Association has established a Collaborative Planning, Forecasting, and Replenishment committee to identify best practices and design principles for collaborative planning and forecasting in order to facilitate this type of coordination in the supply chain environment. Later in the chapter, these practices are described in more detail.

**Designing Single-Stage Replenishment Control**

Information distortion can be reduced by creating a supply chain where replenishment choices are made at a single step for the entire chain. The fact that each level of the supply chain uses orders from the preceding stage as its historical demand is one of the main causes of information distortion, as we previously noted. Each stage sees its function as fulfilling orders set by the stage above it. Since final client purchases are made at the store, it is where the important replenishment occurs. Multiple prediction problems are solved and supply chain coordination results when a single stage makes replenishment choices for the entire chain. A single point of control for replenishment is offered by a number of industry practices, including vendor-managed inventory and continuous replenishment programmers, both of which are discussed later in the chapter.

For each significant product category, Wal-Mart typically designates one of its suppliers as the leader to oversee store-level restocking. Suppliers now have access to sales information and a single decision-maker for replenishment. Enhancing Operational Performance By enhancing operational performance and creating suitable product rationing plans in the event of shortages, managers can assist reduce information distortion. Reducing the lead time for replenishment Managers can lessen demand uncertainty during the lead time by cutting the lead time for replenishment. A shorter lead time is especially advantageous for seasonal products since it enables repeated orders to be placed with a significant improvement in forecast accuracy. Therefore, a shorter replenishment lead time helps to reduce information distortion by lowering the underlying demand uncertainty.

At various points along the supply chain, managers can implement a range of strategies to help shorten lead times for replenishment. The lead time associated with placing an order and transferring information can be considerably reduced by ordering electronically, whether through an EDI system or online. Lead times can be significantly cut in manufacturing facilities by using cellular production and improved flexibility. Because of stabilized demand and better scheduling as a result, information distortion is reduced even further. This is especially true when a wide range of products are produced by manufacturing [10]. Advance ship notices ASN can be utilised to shorten lead times and ease receiving-related work. Cross-docking can be used to shorten the lead time needed to move a product across supply chain stages. Many of these techniques have been applied by Wal-Mart to drastically cut lead times in their supply chain.

## CONCLUSION

An essential element that enables businesses to effectively satisfy consumer needs and optimism operations is coordination in the supply chain. Organizations can achieve operational excellence, customer happiness, and a competitive edge in the market by coordinating activities, sharing information, and encouraging collaboration among supply chain partners. Numerous advantages result from efficient supply chain coordination, including higher levels of customer satisfaction, lower costs, improved supply chain responsiveness, and greater profitability. It enables businesses to achieve operational efficiency by streamlining procedures, optimizing inventory levels, and responding rapidly to changes in client demand.

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# CHAPTER 3

# MANAGING ECONOMIES OF SCALE IN A SUPPLY CHAIN: CYCLE INVENTORY

Mr. Kunal Saxena, Assistant Professor
Department of Management, Presidency University, Bangalore, India
Email Id: drkunal@presidencyuniversity.in

**ABSTRACT:**

One of the most important factors in maintaining effective operations and maximizing profitability is managing economies of scale in a supply chain. Economies of scale are the financial benefits that result from higher production volumes and lower unit costs. In order to efficiently manage economies of scale in their supply chains, organizations use a variety of tactics and techniques, which are explored in this chapter. A few important factors to take into account are streamlining supplier networks, automating operations where possible, and improving production processes. In order to achieve economies of scale, coordination and collaboration among supply chain partners are also crucial.

**KEYWORDS:**

Cycle Inventory, Economies Scale, Holding Cost, Managing Economies, Ordering Cost.

## INTRODUCTION

The amount that a supply chain stage either generates or purchases at a time is referred to as a lot or batch size. Think about a computer shop that sells four printers on average each day. The store manager, however, consistently placed orders with the manufacturer for 80 printers. In this instance, 80 printers make up the lot or batch size. It typically takes 20 days for the store to sell out of a lot of four printers, based on daily sales, before making a replenishment lot order. The manager of the computer store buys printers in lots that are larger than the daily sales of the business. Cycle inventory, which results from production or acquisitions of lots larger than those required by the client, is the average amount of inventory in a supply chain. Thus, cycle inventory at the Jean-Mart store extends the typical time that jeans spend in the supply chain by five days. The gap between the times a product is manufactured and when it is sold is longer the higher the cycle inventory. As significant time lags make a company sensitive to changes in market demand, a smaller level of cycle inventory is always preferred. Additionally, a lower cycle inventory reduces a company's need for working capital.

Toyota, for instance, maintains a cycle inventory between the factory and the majority of suppliers that only includes a few hours of manufacturing. Toyota never has excess inventory because of this, and as a result, it needs less working capital than its rivals. Additionally, Toyota devotes hardly any room to inventory in the production. It is crucial to comprehend why supply chain stages generate or buy in large lots and how lot size reduction affects supply chain efficiency before we advise steps a manager may take to minimize cycle inventory. Cycle inventory is kept in order to benefit from economies of scale and lower costs along a supply chain [1]. We first identify supply chain costs that are influenced by lot size in order to comprehend how the supply chain achieves these economies of scale. An important expense in choosing the appropriate lot size is the average cost per unit purchased. If doing so lowers the price paid per unit purchased, the buyer may enlarge the lot size.

The store manager at Jean-Mart orders in lots of at least 500 pairs of jeans to receive the cheaper pricing, for instance, if the jeans manufacturer charges $20 per pair for orders less 500 pairs and $18 per pair for bigger orders. The material cost, designated by the letter C, is

the cost paid per unit. It is priced in dollars per unit. In many real-world scenarios, economies of scale may be seen in the material cost, and growing the lot size reduces the material cost. All expenses that are incurred each time an order is made but do not change based on the quantity of the order are included in the fixed ordering cost. An order placement may have a fixed administrative fee, a trucking fee for delivery, and a labor fee for pickup. No matter how many pairs of jeans are sent, Jean-Mart must pay $400 for the truck.

A lot size of 100 pairs of jeans results in a transportation cost of $4 per pair, whereas a lot size of 1,000 pairs leads in a transportation cost of $0.40 per pair, assuming that the truck can accommodate up to 2,000 pairs of jeans. The store manager can decrease transportation costs per unit by expanding the lot size given the fixed cost of transportation every batch. S sometimes referred to as a setup cost stands for the fixed ordering cost per lot or batch and is expressed in dollars per lot [2]. Economies of scale are also demonstrated by the ordering cost, and growing the lot size lowers the fixed ordering cost per item bought. The expense of keeping a single unit in inventory for a predetermined amount of time, often one year, is known as the holding cost. It is made up of the capital cost, the cost of keeping inventory physically stored, and the cost associated with the product ageing out of use. The holding cost, H, is expressed in terms of dollars per unit each year. It can also be acquired as a portion, h, of the product's unit cost. The holding cost H is determined by given a unit cost of C.

Average cost per unit purchased, $C/unit Holding cost per unit per year, $H/unit/year, plus fixed ordering cost per lot, $S/lot, equals. In a later section of the course, we go over practical methods for estimating the various expenditures. However, we presume that they are already known for the sake of this discussion. Cycle inventory's main purpose is to enable various points in a supply chain to buy goods in lots with minimum material, ordering, and holding costs. A management will cut the lot size and cycle inventory if the holding cost is the only factor taken into account. On the other hand, economies of scale in ordering and purchasing encourage a management to raise the lot size and cycle inventory. When choosing the lot size, a management must choose the trade-off that minimizes the total cost. Stock-Holding Cost a product's holding cost is calculated as a percentage of its total cost and is made up of the primary elements listed below: Cost of capital: For goods that don't age quickly, this is the main contributor to holding costs. The best course of action is to assess the weighted-average cost of capital, 1 which account for both the cost of the firm's debt and the required return on equity.

**D Amount of Debt E Amount of Equity**

The firm's beta and the risk-free rate of return, which is typically in the mid-single digits. Because inventory computations are done pretax, the pretax WACC is ideal for a company that can grow its business using money freed up by reducing inventories. A firm's annual report and any equity research report on the company will typically provide the majority. The borrowing rate is derived from tables that show the interest rates charged for bonds issued by companies with similar credit ratings. The return on U.S. Treasuries is known as the risk-free rate, while the return on the market is known as the market risk premium. In the absence of access to a company's financial structure, data from publicly traded firms in the same sector and with comparable sizes can provide a reliable approximation. Cost of obsolescence the obsolescence cost calculates the pace at which the market value or quality of the stored goods declines, decreasing its value [3]–[5].

Depending on the goods, this cost can vary greatly, from thousands of percent to practically nothing. Products that spoil quickly have high rates of obsolescence. If they have brief life cycles, even nonperishables can experience high rates of obsolescence. A product with a six-month life cycle has a 200 percent effective obsolescence cost. On the other end of the range

are goods that take a very long time to expire or spoil, such crude oil. A low obsolescence rate may be used for certain products. Cost of handling: Only additional receiving and storage costs that change with the amount of product received should be included in the handling cost [6]. The order cost should account for quantity-independent handling expenses that change depending on the volume of orders. If the quantity fluctuates within a range, the quantity-dependent handling cost frequently remains constant.

The extra handling cost added to the holding cost is zero if the quantity is within this range e.g., the volume of inventory a crew of four persons can empty in a given amount of time. An extra handling cost is added to the holding cost if the quantity handled necessitates the use of more personnel.

**Occupancy expense:** Occupancy expenses reflect incremental changes in space costs brought on by shifting cycle inventories. We have the direct occupancy cost if the firm is being charged based on the actual number of units kept in storage. Businesses frequently lease or buy a set quantity of space. The incremental occupation cost is zero as long as a little change in cycle inventory does not alter the needed amount of space. Occupancy expenses frequently take the shape of a step function, with a sharp rise in price when capacity is reached and additional space is required.

**Additional costs:** Other relatively tiny costs are covered by the last element of holding cost. Theft, security, damage, taxes, and increased insurance premiums are among these expenses. It is crucial to evaluate the incremental change in these expenses due to changing cycle inventory once more.

**Economies of Scale to Exploit Fixed Costs**

Consider a scenario that frequently occurs in daily life the purchase of groceries and other household goods to better comprehend the trade-offs mentioned in this section. These can be bought at a convenience store close by or at a Sam's Club, a big warehouse club that sells consumer products but is typically much farther away. The time it takes to travel to either place is the fixed cost of shopping. The nearby convenience store has a substantially lower fixed cost. The neighborhood convenience store, however, has more expensive prices. We often adjust our choice of lot size after taking the fixed cost into account. We visit the neighborhood convenience store when we only require a modest amount because the benefit of a low fixed cost offsets the expense of the convenience store's higher prices. However, when we need to buy a lot, we go to Sam's Club because the reduced pricing for the bigger amount more than make up for the higher fixed costs. This section focuses on the scenario where a set cost is incurred each time an order is placed for placing, receiving, and conveying the order. In order to reduce the overall cost of meeting demand, a buying manager must choose the right cost trade-offs while choosing the lot size. We begin by thinking about the selection of a particular product's lot size.

**Scale Economies to Use Quantity Discounts**

Now let's look at price plans that motivate customers to buy in bulk. The pricing schedule frequently exhibits economies of scale in business-to-business transactions, with prices falling as lot size rises. If the pricing schedule provides reductions based on the quantity requested in a single lot, the discount is lot size-based. If a discount is volume-based, it is based on the total amount purchased during a specified time period, not the number of deals purchased during that time. The tendency of lot size-based quantity discounts to increase lot size and cycle inventory in a supply chain will be demonstrated in this section [7]. The following are two frequently used lot size-based discount schemes:

Multi-block tariffs or marginal unit quantity discounts we must respond to the following two fundamental inquiries before we can analyze how such quantity discounts affect the supply

chain: What is the best purchase choice for a buyer looking to maximize earnings given a pricing schedule with quantity discounts? How does this choice impact cycle inventories, flow rates, and lot sizes in the supply chain? Under what circumstances ought to a provider provide volume discounts? What price plans should a provider use if they want to make the most money possible? The best course of action for a retailer the buyer when presented with either of the two-lot size-based discount plans supplied by a manufacture the supplier is the subject of our initial research. The retailer's goal is to choose lot sizes that will reduce the overall annual expenses of materials, orders, and holding. The best lot size is then determined for all unit quantity discounts.

**Assistance in Organizing to Rise Total Supply Chain Profits**

If the choices made by the retailer and supplier maximize the overall profits of the supply chain, the supply chain is said to be coordinated. In actuality, each link in a supply chain may have a different owner, who will work to increase that link's own earnings. For instance, each step in a supply chain is likely to decide on lot size with the aim of reducing its own overall costs. Because decisions that maximize retailer profits do not always maximize supply chain profits, the outcome of this independent decision-making might be a lack of coordination in a supply chain. In this section, we go through how a manufacturer can make good use of quantity discounts to make sure that the entire supply chain profits are maximized, even if the store is only looking out for its own interests.

Quantity reductions for common goods. According to economists, a competitive market exists for basic commodities like milk, driving prices down to their marginal costs. In this scenario, the firm's goal is to reduce expenses in order to boost profits. The market determines the price. Take the previously mentioned online shop DO as an example. It may be claimed that it offers a commodity item for sale. Each order placed by the retailer results in expenses for the manufacturer and DO in this supply chain. As it builds up inventory to meet the order, the manufacturer incurs holding costs and fixed costs associated to order setup and fulfilment (SM). Similar to this, DO has holding costs for the inventory it holds while an order is being slowly sold, as well as fixed expenses for each order it puts. The store bases its lot-sizing decisions only on the costs it encounters, even if both parties pay costs as a result of DO's lot-sizing choice. Because of this, decisions about lot size are made that are locally optimal but do not maximize supply chain excess. Ageing Supply Chain Economies of Scale:

**Quick Savings**

Manufacturers employ trade promotions to provide retailers with a lower price and a duration during which the discount is valid. For instance, a maker of canned soup might provide a 10% price reduction for shipments made between December 15 and January 25. Retailers receive a 10 percent discount on all purchases made during the designated time frame. In some instances, the manufacturer may demand specific steps from the retailer in order for them to be eligible for the trade promotion, such as displays, advertising, marketing, and so on. In the consumer-packaged goods sector, trade promotions are extremely prevalent, with manufacturers advertising various items at various times of the year. Trade promotions are intended to persuade merchants to take actions that aid the manufacturer in achieving its goals. From the standpoint of the manufacturer, a trade promotion has the following main objectives:

1. Encourage merchants to promote sales by offering price reductions, displays, or advertising.
2. Transfer inventory from the producer to the shopper and the store.
3. .Protect a brand against rivalry.

Although these might be the manufacturer's goals, it's not always obvious that trade promotions lead to their fulfilment. In this section, we'll look into how trade promotions affect retailers' actions and the efficiency of the entire supply chain. The key to comprehending this effect is to concentrate on how a store responds to a manufacturer's trade promotion. The following choices are available to the retailer in response to a trade promotion:

1. Pass on part or all of the promotion to consumers to increase sales.
2. Pass on very little of the offer to customers but encourage them to make more purchases during the promotion to take advantage of the momentary price decrease.

The first step lowers the product's price for the final consumer, encouraging more purchases and consequently more sales throughout the entire supply chain. The second step increases the amount of inventory held by the store but does not result in more purchases by the client. The supply chain's cycle inventory and flow time therefore rise. When a store makes a purchase during a promotion in anticipation of future sales, this is known as a forward buy [7]. An advance purchase lowers the retailer's future cost of goods for merchandise that will be sold after the promotion has ended. Although an advance buy is frequently the retailer's proper response to a price promotion, it typically results in increased demand fluctuation, which increases inventory and flow times across the supply chain and can reduce supply chain earnings. Understanding a retailer's ideal response to a trade promotion is our goal in this section. We pinpoint the elements influencing the retailer's forward buy and calculate its size. Additionally, we pinpoint variables that affect how much of a promotion a merchant passes on to the customer.

**Managing the Inventory of Multichine Cycles**

Each stage of a multichine supply chain may have a large number of players. There is an excessive amount of cycle inventory and high expenses as a result of the supply chain's lack of coordination in lot sizing decisions. A multichine system's objective is to reduce overall costs by coordinating orders along the whole supply chain. Take into account a straightforward multichine arrangement where one producer supplies one shop. Assume that production happens instantly, allowing the firm to generate a large quantity as necessary. The manufacturer could create a new lot of size Q shortly after shipping a lot of size Q to the store if the two steps are not coordinated. Depicts the inventory at the two stages in this situation. In this instance, the manufacturer has an inventory of roughly Q and the retailer has an inventory of Q/2. If the manufacturer schedules its production so that it is ready just in time to be sent to the store, overall supply chain inventory can be reduced. In this instance, the retailer has an average inventory of Q/2 whereas the producer has no inventory.

Supply chain can reduce total cycle inventory from roughly 3Q/2 to Q/2 by synchronizing production and replenishment. Ordering strategies where the lot size at each stage is an integer multiple of the lot size at its immediate client have been demonstrated to be pretty near to optimal for a simple multichine supply chain with only one actor at each step. When lot sizes are integer multiples, order coordination between stages enables some deliveries to be cross-docked to the following stage.

The ratio of the fixed ordering cost S to the holding cost H at each stage determines the degree of cross-docking. The ideal percentage of cross-docked product increases as the ratio between the two stages gets closer. In a multichine setup with a single producer supplying a single shop, Munson, Hu, and Rosenblatt's 2003 study offers the ideal order numbers. It's critical to distinguish between retailers with high demand and those with low demand if one party distributor in a supply chain supplies many parties' retailers at the subsequent stage of the supply chain [8].

**Application Format**

Application for Supply Chain Economies of Scale Management I'm writing to say how much I want the Position Title job at Company Name, which was posted on Source. I am confident that I can considerably help your organization's supply chain by managing economies of scale thanks to my in-depth knowledge and expertise in supply chain management. I have number of years of real-world experience in supply chain management in addition to a good academic background in related discipline. I've developed deep insights into the difficulties of supply chain operations from my past employment, and I've effectively applied tactics to maximize economies of scale.

Process Optimization By correctly identifying and streamlining the production processes, I was able to cut down on waste and increase overall effectiveness. I've continuously increased productivity and cut costs by putting lean principles and continuous improvement efforts into practice. Technological Advancements I have a track record of successfully utilizing cutting-edge technologies and automation solutions to increase supply chain efficiency. I have improved inventory management, demand forecasting, and supplier performance by putting strong enterprise resource planning ERP systems and data analytics platforms in place. Rationalization of Supplier Networks I have been effective in negotiating advantageous contracts, combining purchasing power, and rationalizing supplier networks. I have reduced costs, enhanced quality control, and reduced supply chain risks by carefully choosing suppliers and cultivating long-term relationships.

Management To reduce holding costs and improve supply chain responsiveness, I have used inventory optimization strategies including just-in-time (JIT) and vendor-managed inventory VMI. To ensure effective inventory replenishment, I have also created safety stock procedures and used demand forecasting models. Additionally, I have excellent interpersonal and communication skills that help me work well with cross-functional teams and develop connections with stakeholders at all levels. I have faith in my abilities to inspire and lead teams while fostering an innovative and constant improvement culture. I am thrilled to have the chance to use my expertise and talents to help Company Name develop and succeed. I am convinced that I would be a significant contribution to your company given my knowledge of managing economies of scale in a supply chain and my enthusiasm for promoting operational excellence.

Scope

The following are some crucial components of managing economies of scale:

1. **Production and Operations:** Managing economies of scale requires streamlining production procedures to maximize output while keeping costs flat. This entails putting effective production practices into practice, making use of automation and technology, and consistently increasing operational efficiencies to reduce unit costs.
2. **Procurement and Supplier Management:** By streamlining their supplier networks and negotiating advantageous contracts with suppliers, businesses can obtain economies of scale. To do this, it is necessary to pool purchasing power, form strategic alliances, and take advantage of economies of scale by making large purchases or signing long-term contracts.
3. **Inventory Control:** Controlling inventory effectively is essential for managing economies of scale. Organizations can lower carry costs, avoid stock outs, and maximize order volumes by applying lean inventory practices. The effectiveness of the supply chain is increased by using effective demand forecasting and planning tools to match inventory levels with customer demand.
4. **Logistics and transportation:** By grouping goods, streamlining routes, and utilizing effective transportation methods, logistics and transportation can achieve economies of

scale. Organizations can lower transportation costs per unit, resulting in overall supply chain cost savings, by increasing load capacities and reducing empty kilometers.

5. **Information systems and technology:** Managing economies of scale requires effective use of information systems and technology. Enterprise resource planning (ERP) systems, data analytics tools, and sophisticated supply chain management software enable businesses to collect and analyses data, pinpoint areas for development, and make well-informed decisions that promote economies of scale.
6. **Collaboration and Partnerships:** Managing economies of scale requires close cooperation among supply chain partners, including suppliers, manufacturers, distributors, and retailers. Together, streamlining operations, reducing duplication, and using economies of scale are made possible by cultivating strong connections, encouraging open communication, and aligning goals and plans [9].

**Application**

Following are some significant examples of managing economies of scale:

**Cost Reduction:** Achieving cost reduction is one of the main applications of managing economies of scale. Organizations can minimize unit costs by spreading fixed costs over a larger output by increasing production volumes. Due to their lower costs, businesses are able to provide customers with competitive pricing, entice new clients, and increase profit margins.

**Enhanced Efficiency:** Supply chain optimization and streamlining are key components of managing economies of scale. Organizations can increase productivity and decrease waste by using effective production methods, automation, and resource allocation. As a result, the entire supply chain becomes more efficient, leading to shorter lead times, shorter cycle times, and greater resource utilization.

**Increased Purchasing Power:** By controlling economies of scale, businesses may bargain with suppliers for more favorable terms and conditions. Organizations can take advantage of their greater quantities to obtain favorable pricing, rebates, and other incentives through consolidated purchasing and long-term contracts. In addition to lowering procurement costs, this improves ties with suppliers and guarantees a steady supply of goods. Investing in technology and systems to improve supply chain operations is a common part of managing economies of scale [10]. Implementing sophisticated enterprise resource planning (ERP) systems, tools for demand forecasting, inventory management systems, and software for transportation optimization are a few examples of how to do this. Organizations can collect and analyses data, make data-driven choices, and enhance the effectiveness of their supply chains thanks to these technological tools [10].

**Market Expansion:** By managing economies of scale, businesses can broaden their customer base. With lower unit costs, businesses are better able to explore new markets, provide competitive pricing, and expand into undeveloped areas. Through increasing sales volumes, this application enables businesses to grow their customer base, expand their market share, and realize economies of scale.

**Risk Reduction:** Controlling economies of scale can also aid in reducing supply chain risks. Organizations can lessen their reliance on a single supplier, reducing the impact of disruptions or price changes, by diversifying suppliers and employing dual sourcing techniques. Furthermore, economies of scale allow businesses to keep higher amounts of safety stock, assuring company continuity in the case of unforeseen occurrences or supply chain disruptions.

**Environmental Impact and Sustainability:** Managing economies of scale effectively can lessen environmental impact and support sustainability initiatives. Organizations can lessen

their carbon footprint by streamlining production procedures and cutting waste. Additionally, combining modes of transportation and improving traffic patterns might result in lower fuel usage and emissions.

## CONCLUSION

Managing economies of scale in a supply chain is crucial for businesses looking to boost productivity, save costs, and gain a competitive edge. Companies can profit from higher production volume and lower unit costs by putting into practice initiatives like process optimization, technology developments, supplier rationalization, and efficient inventory management. Additionally, encouraging cooperation and coordination among supply chain participants improves how well economies of scale are managed overall. Businesses are better positioned to meet customer expectations, boost profitability, and maintain long-term growth in the ever-evolving business environment when they successfully manage economies of scale in their supply chains. Companies must priorities managing economies of scale and invest in doing so if they want to be competitive and succeed in the long run as supply networks continue to change.

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# CHAPTER 4

# MANAGING UNCERTAINTY IN A SUPPLY CHAIN: SAFETY INVENTORY

Mr. Anil Gowda, Associate Professor
Masters In Business Administration, Presidency University, Bangalore, India
Email Id: anilbgowda@presidencyuniversity.in

**ABSTRACT:**

In a changing business climate, meeting consumer needs and ensuring operational resilience both depend on managing uncertainty in the supply chain. The application of safety inventory as a tactic for reducing uncertainty in a supply chain is the main topic of this chapter. Safety inventory, commonly referred to as buffer stock, is the extra stock kept to lessen the effects of fluctuating demand, supply disruptions, or lead times. The chapter examines the major factors and trade-offs, such as the costs of carrying inventory vs the costs of stock outs, that go into calculating the ideal level of safety inventory. It examines a number of variables, including supply chain lead times, accuracy of demand forecasting, and desired service levels, that affect safety inventory decisions.

**KEYWORDS:**

Cost Accounting, Demand, Inventory Proportionality, Safety, Uncertainty.

## INTRODUCTION

Safety inventory is stock held to meet demand that is higher than what is anticipated for a particular time period. Because demand is unpredictable and a product shortage could occur if actual demand exceeds predicted demand, safety inventory is kept on hand. Take the upscale department store Bloomingdale's as an illustration. Gucci, an Italian company, supplies Bloomingdale's with their handbag line. The Bloomingdale's store manager places purchases in lots of 600 purses due to the high expense of shipping from Italy. At Bloomingdale's, there are typically 100 purse requests per week. In response to an order, Gucci delivers the handbags to Bloomingdale's in three weeks. The store manager at Bloomingdale's can make an order when there are precisely 300 purses left in stock if there is no demand uncertainty and exactly 100 purses are sold each week. Such a policy assures that the new lot arrives just as the final purse is being sold at the store in the absence of demand uncertainty.

The actual demand over the course of the three weeks could, however, be more or lower than the anticipated 300 purses due to demand fluctuations and projection inaccuracies. Some clients may not be able to purchase purses at Bloomingdale's if the store's actual demand is higher than 300, which could result in a loss of margin for the store. The store manager so decides to order Gucci even though there are 400 purses left in stock. With this arrangement, the store only runs out of purses if demand over the course of three weeks reaches 400, which increases customer access to products. The retailer will typically have 100 handbags left when the replenishment lot comes, assuming an average weekly demand of 100 purses. Safety inventory is the typical amount of inventory still present when the replenishment lot is delivered [1]. As a result, Bloomingdale's maintains a stock of 100 purses for security. The cycle inventory, which was the subject of the last chapter, is Q2 300 purses given a lot size of Q 600 purses.

On the one hand, increasing safety inventory levels boosts product availability and, consequently, the profit made from consumer purchases. On the other hand, increasing the

safety inventory level results in higher inventory holding expenses. This problem is especially important in sectors where demand is unstable and product life cycles are short. Excessive inventory can be beneficial in reducing demand fluctuation, but it can be detrimental if new items enter the market and the demand for the inventory-held item declines. The stock on hand then loses all value. Customers can now more easily search across stores for product availability in the current business climate. If a book is unavailable on Amazon, a customer can quickly discover if it is still available on Barnes & Noble [2]. Businesses are under pressure to improve product availability due to the simplicity of searching. Product diversity has expanded at the same time that personalization has increased. As a result, demand for certain products is unstable and challenging to predict, and marketplaces have grown more diversified. Firms are compelled to increase the degree of safety inventory they hold as a result of both the increasing variety and the rising need for availability.

In the majority of high-tech supply chains, a sizeable portion of the inventory is safety inventory because of the variety of products and high demand uncertainty. However, product life cycles have shortened as product variety has increased. A product that is hot today is therefore more likely to become obsolete tomorrow, increasing the expense to businesses of holding too much inventory. Finding solutions to reduce safety inventory levels while maintaining a high degree of product availability is thus essential for the operation of any supply chain. The experience of Nordstrom, Macy's, and Saks during the 2008–2009 recession highlights the significance of lower safety inventories. The fact that Nordstrom moved its inventory almost twice as quickly as its rivals allowed it to surpass the other two retailers. In 2008–2009, Nordstrom carried an average of two months' worth of goods, Macy's four months, and Saks four months. The ability of Nordstrom to offer customers a high degree of product availability while carrying low levels of y has been a key to its success.

**Selecting the Suitable Level of the Safety Inventory**

The following two elements define the proper degree of safety inventory:

1. The ambiguity surrounding supply and demand.
2. The intended level of product availability.

The necessary level of safety stockpiles rises when supply or demand becomes more unpredictable. Think about the smart phone sales at B&M Office Supplies. Demand for a new smart phone model is quite unclear, hence B&M carries a considerably larger amount of safety inventory in comparison to demand. Demand is easier to forecast as uncertainty decreases and the market's response to the new model becomes more apparent. When that happens, B&M can carry less safety inventory than is necessary given the demand. The required amount of safety inventory likewise rises as the desired degree of product availability does. For the new phone model, B&M must maintain a higher level of safety inventory if it wants to aim a higher level of product availability. We then go over a few ways to measure demand uncertainty.

**Counting the Uncertainty of Demand**

Demand contains a systematic component as well as a random component, as was covered in Chapter 7. Predicting the systematic component and estimating the random component are the two objectives of forecasting. The standard deviation of forecast error serves as a common approximation of the random component. We consider the following demand inputs Typical demand each period: Demand standard deviation prediction inaccuracy for each time for the time being, we will suppose that B&M's weekly demand for phones has a mean of D and a standard deviation of. Although forecast error and standard deviation of demand are not

always the same thing, we will regard them as such in this article. Calculations for safety inventory ought to be based on anticipated inaccuracy. The lead time is the period of time between placing and receiving an order [3]. L serves as a shorthand for the lead time in our discussion. L in the B&M example refers to the interval of time between the time B&M orders phones and the time they are delivered. In this instance, B&M is susceptible to the lead-time demand uncertainty. The demand for phones experienced during the lead period and the inventory B&M has when a replenishment order is placed determine whether B&M will be able to meet all demand from inventory. As a result, B&M must calculate the demand uncertainty over the lead time as a whole, not just during a particular period. Given the distribution of demand for each time, we now assess the demand distribution over L periods.

## DISCUSSION

Product availability represents a company's capacity to fulfil a client order from stock on hand. When a customer order is received but the product is out of stock, a stock out occurs. The availability of a product can be measured in a variety of ways. The following is a list of some of the critical steps. Product fill rate measures the percentage of product demand that is met by inventory. The likelihood that product demand is met from available inventory is known as fill rate. Instead, then focusing on time, fill rate should be calculated over predetermined levels of demand. Therefore, rather than measuring fill rate monthly, it is more appropriate to do so over every million units of demand. Assume B&M sells smart phones to 90% of its clients from inventory, with the other 10% going to a nearby rival since there isn't enough inventory. In this instance, B&M obtains a 90% fill rate.

The percentage of orders that are filled using inventory on hand is known as the order fill rate. Additionally, rather of gauging an order fill rate over a single order, do so over a certain number of orders. When there are many products in an order, only those products that can be supplied from the existing inventory are used to fill the order. A consumer can order a phone and a laptop together from B&M. Only when both the phone and the laptop are readily available in the store is the order filled from inventory. Due to the requirement that all products, be in stock before an order can be executed, order fill rates are frequently lower than product fill rates. The percentage of replenishment cycles that end with all customer demand being satisfied is known as the cycle service level CSL. The period of time between two subsequent replenishment deliveries is known as a replenishment cycle. The likelihood of not experiencing a stock out during a replenishing cycle is the CSL. Over a predetermined number of replenishment cycles, CSL should be assessed. When B&M orders replenishment lots of 600 phones, a replenishment cycle is the period of time between the arrivals of two such lots.

The store achieves a CSL of 60% if the manager at B&M manages inventory so that the store does not run out of inventory in 6 out of 10 replenishment cycles. Keep in mind that a CSL of 60% normally means that inventory is sufficient to meet consumer demand. In the 40% of cycles where a stock out does happen, the majority of customer demand is met from inventory. Only a small portion of the cycle's final stages, which arrive after B&M runs out of goods, are lost. The fill rate is therefore substantially higher than 60%. In a case with a single product, the difference between the product fill rate and order fill rate is typically not important. But when a business is selling a variety of goods, this distinction could matter a lot. For instance, if the majority of orders involve 10 or more products that need to be dispatched, the order won't be filled from stock if one of those products is out of stock. Even if the company in this instance has strong product fill rates, it may have a bad order fill rate. When clients place a high value on the fulfilment of the complete purchase at once, tracking order fill rates is crucial. We then go through two replenishment strategies that are frequently applied in real-world settings.

### Resupply Procedures

The timing and quantity of reorders are determined by a replenishment policy. Along with the fill rate for and the cycle service level CSL, these choices also affect the cycle and safety inventories. The types of replenishment policies can vary. We limit emphasis to two categories:

**1. Ongoing Review:** Inventory is continuously monitored, and when it reaches the reorder point (ROP), an order for a lot size Q is placed. Take the store manager at B&M, for instance, who keeps tabs on the inventory of phones. When the available inventory falls lower ROP 400, she orders 600 phones. In this instance, the order's size remains constant from one order to the next. Due of the fluctuating demand, the interval between orders may change.

**2. Regular Review:** The status of the inventory is examined, and an order is placed to increase it to a predetermined threshold. As an illustration, think about buying films from B&M. The film inventory is not regularly monitored by the store management. Employees check the film inventory every Thursday, and the manager places orders large enough to cover both the available stock and the amount of the order, which equals 1,000 films. The interval between orders in this instance is fixed. Due to the changing demand, however, the size of each order can change [4].

## DISCUSSION

The items and materials a company keeps on hand with the intention of reselling, producing, or using them are referred to as inventory in American English or stock in British English. The main focus of inventory management is determining the location and shape of stocked commodities. It is necessary to go before the regular and scheduled course of manufacturing and stocking of materials at various places within a facility or at several sites of a supply network. By defining work in process or work in progress broadly as all work that is or has occurred prior to the completion of production, the concept of inventory, stock, or work in process or work in progress has been expanded from manufacturing systems to service businesses and projects. Inventory in the context of a manufacturing production system refers to all completed work, including raw materials, products that have been partially finished, completed products that have not yet been sold, and finished items that have left the manufacturing system. Inventory in the context of services refers to all work completed prior to sale, including information that has not yet been fully processed [5].

### Inventory Proportionality Principle

The objective of demand-driven inventory management is inventory proportionality. To ensure that all items run out at the same time, the primary optimal result is to have the same number of days' or hours', etc. worth of inventory on hand across all of them. There is no excess inventory in this scenario, which is inventory that would remain after the initial product runs out. The expense of acquiring it and the cost of keeping it could have been better applied elsewhere, to the product that recently ran out, making storing surplus inventory suboptimal. Inventory minimization is the secondary objective of inventory proportionality. A considerably more accurate and ideal result is anticipated by integrating precise demand forecasting with inventory management as opposed to only looking at historical averages. This method of incorporating demand forecasting into inventory management enables the prediction of the can fit point when per-product inventory storage is constrained.

### Applications

As opposed to keep full systems, where a retail customer would prefer to see full shelves of the product they are buying so as not to think they are buying something old, unwanted, or stale; and distinct from trigger point systems, where product is reordered when it hits a

certain level; inventory proportionality is most effective for inventories that are hidden from the consumer; just-in-time manufacturing. Motor fuel was one of the first retail applications of inventory proportionality in the United States. In most cases, subterranean storage tanks are used to store motor fuel such as petrol. The drivers don't know whether they are filling the tank from the top or bottom, nor do they need to care [6], [7]. Additionally, the capacity of these storage tanks has a limit and cannot be exceeded. And lastly, the product is pricey. The concept of inventory proportionality is employed to maintain a balance between the stocks of the various motor fuel grades, each of which is kept in a separate tank, and the sales of each grade. Excess inventory is essentially money sunk literally into the earth because the consumer cannot see it or value it. The amount of extra inventory kept in underground storage tanks is reduced by inventory proportionality. Petrol Soft Corporation initially created and executed this application for motor fuel for Chevron Products Company in 1990. These systems are now utilised by the majority of significant oil firms.

1. Taking inventory into account.
2. German ledger from the early 19th century, from a series on accounting.
3. Cost in the past perpetual purchasing power.
4. Large kinds.
5. Important ideas.
6. Certain accounts.
7. Accounting guidelines.
8. Financial records.
9. Bookkeeping.
10. Auditing.
11. Individuals and organizations.
12. Development.
13. Misconduct vet.

Each nation has its own inventory accounting regulations that correspond to its requirements for financial reporting. As an illustration, businesses in the US define inventory in accordance with their needs while still adhering to US Generally Accepted Accounting Practices (GAAP), the regulations established by the Financial Accounting Standards Board (FASB) (and others) and upheld by the Securities and Exchange Commission (SEC) and other federal and state agencies. Similar structures are frequently found in other nations; however, they use their own national institutions and accounting standards. It is on purpose that cost accounting operates internally to an organization and potentially with far greater flexibility, and that financial accounting utilizes standards that enable the public to compare firms' performance.

Following various instances and a discussion of inventory from a financial accounting viewpoint, inventory is discussed from a conventional and Theory of Constraints-based cost accounting perspective. Inventory internal costing and appraisal can be challenging. In the past, most businesses operated straightforward, one-process factories, but in the twenty-first century, such businesses are likely in the minority. Where 'one process' factories are present, the goods produced have a market, which creates a separate market value for the good. Many items in inventory that were once finished goods are now held as work in process (WIP) in multistage process organizations. Since there is no market for the partially finished product, the valuation must be made by management in order to be recorded in the books. Due to the allocation of overheads and the rather arbitrary valuation of WIP, certain unanticipated and unpleasant outcomes have occurred.

**Financial Management**

The balance sheet asset status of an organization's inventory can appear to be a mixed blessing because it holds up funds that could be used for other reasons and necessitates

additional costs for its upkeep. Depending on the regulations of the country in question governing the depreciation of inventory, as in the case of Thor Power Tool Company v. Commissioner, inventory may also result in considerable tax expenses. Because it can, in theory, be sold to generate cash, inventory is shown as a current asset on a company's balance sheet. In order to artificially inflate their apparent asset value and their perceived profitability, some businesses maintain greater inventories than their activities require. Inventory comes with fees for warehouse space, utilities, insurance to cover people to handle and safeguard it from fire and other calamities, obsolescence, shrinkage theft and errors, and other expenses in addition to the money committed by purchasing inventory.

These holding expenses, which range from a third to a half of the purchase price annually, quickly add up. Businesses with insufficient inventory cannot profit from huge consumer orders if they are unable to fulfil them. The competing goals of cost reduction and customer satisfaction frequently pit a company's finance and operational managers against its sales and marketing divisions [7], [8]. Because salespeople frequently receive commissions, unavailable goods may lower their potential personal revenue. By lowering manufacturing time to be close to or below customers' anticipated delivery time, this conflict can be minimized. The Lean production initiative, which will also drastically lower manufacturing costs see the Toyota Production System, will reduce working capital locked up in inventories.

**Inventory Accounting's Function**

The accountants can assist the public sector in changing in a very beneficial way that increases value for the taxpayer's investment by assisting the organization in making better decisions. By making sure that achievement is suitably recognized in both the formal and informal reward systems of the organization, it can also help to encourage progress and to ensure that reforms are sustainable and successful over time. It would be an understatement to suggest they have a significant role to play. The majority, if not all, of the organization's important business procedures are tied to finance. It ought to be in charge of the stewardship and accountability frameworks that guarantee the organization is carrying out its operations in a proper, moral manner. These foundations must be solidly established.

They serve as a litmus test by which public support for the institution is frequently gained or lost. Additionally, finance should offer information, analysis, and guidance to help the service managers of the organizations run efficiently. This is more than just the typical concern with budgets how much have we spent so far and how much do we still have to spend? It aims to improve the organization's understanding of its own performance. That entails drawing links and comprehending the linkages between the resources used, or the inputs, and the results and outputs they produce. Additionally, it entails recognizing and proactively managing hazards related to the organization and its operations. The cost of goods sold COGS, which occurs when a merchant purchases items from inventory, is deducted from the inventory account's value. When the cost has not changed across those that are in stock, this is straightforward; but, when it has, a consensus technique must be developed to assess it.

Accountants must select a strategy for commodity goods that are difficult to track separately based on the specifics of the sale. First in, first out FIFO and last in, first out LIFO are two often used techniques. According to FIFO, the first item that entered inventory counts as the first item sold. According to LIFO, the first item sold is the last item to enter the inventory. Whichever approach an accountant chooses can have a big impact on net income, book value, and taxation. Due to the consequences of inflation, a corporation often reports lower net income and lower book value when using LIFO accounting for inventory. Taxation is typically reduced as a result. UK GAAP and IAS have essentially outlawed LIFO inventory accounting due to its propensity to inflate inventory value. Section 472 of the Internal Revenue Code regulates the use of LIFO accounting in the US.

**Conventional Cost Accounting**

Accounting for standard costs in the main In order to compare the labor and materials actually used to manufacture a good with those that the same goods would have required under standard conditions, standard cost accounting utilizes ratios called efficiencies. Few issues exist as long as the actual and expected conditions are similar. Unfortunately, traditional cost accounting techniques were created over 100 years ago, at a time when labor accounted for the majority of manufacturing costs. Even though labor costs are typically only a very tiny portion of total costs, standard approaches still place a strong emphasis on labor efficiency. Standard cost accounting can harm supervisors, employees, and businesses in a number of ways.

For instance, a factory manager's performance review may suffer as a result of a policy choice to increase inventory. Production must be raised in order to increase inventory, which necessitates faster process speeds. When not if something goes wrong, the procedure requires more time and labor than is typical. Even if the manager has no control on the problem or the output requirement, they appear to be responsible for the excess. Businesses employ the same efficiency to downsize, right size, or otherwise cut their workforce during lean economic times. In certain situations, laid-off employees have even less control over surplus inventory and cost-saving measures than their bosses have. The need to replace traditional cost accounting has long been acknowledged by both financial and cost accountants. However, they have not yet identified a replacement [9].

**Cost Accounting Under Theory of Constraints**

The Theory of Constraints was created in part by Aliyah M. Goldratt to solve the issues with cost accounting in what he refers to as the cost world. He proposes a replacement known as throughput accounting, which treats labor as a fixed cost as opposed to a variable cost and substitutes throughput cash for goods sold to clients for output goods created that may sell or may increase inventory. He defines inventory as whatever an organization owns that it intends to sell, which includes not only the items in the categories listed here but also machinery, buildings, and many other items. Only the really variable costs, such as materials and components, which fluctuate directly with the amount produced, are recognized by throughput accounting. Stocks of finished items continue to be assets on the balance sheet, but labor-efficiency ratios are no longer used to assess managers and employees. Throughput accounting places emphasis on the linkages between throughput revenue or income and controlled operating expenses and changes in inventory, as opposed to an incentive to lower labor costs.

**Safety Inventory Effects of Desired Product Availability and Uncertainty**

The intended degree of product availability and uncertainty are the two main variables that have an impact on the necessary level of safety inventory. The effects of each factor on the safety inventory are now covered. The needed safety inventory rises as the intended product availability does since the supply chain now needs to be ready to handle unusually high demand or unusually low supply. Be aware that increasing the fill rate from 97.5 percent to 98.0 percent necessitates adding 116 units of safety inventory, whilst increasing the fill rate from 99.0 percent to 99.5 percent necessitates adding 268 units of safety inventory. As a result, as product availability increases, the marginal increase in safety inventory increases. This phenomenon emphasizes how crucial it is to choose appropriate product availability levels. A supply chain manager should be aware of the products that need to be available at all times and only keep high safety inventories for those products. It is improper to arbitrary choose a high level of product availability and demand it for all products. Any supply chain manager's objective is to decrease the amount of safety inventory necessary without

jeopardizing product availability. Two crucial managerial tools that might be employed to accomplish this goal are highlighted in the earlier discussion:

**1. Shorten the Supplier Lead Time**

If lead time is shortened by a factor of k, the quantity of safety stock that is needed is shortened by a factor of the only catch is that although reducing safety inventory happens at the shop, reducing supplier lead time necessitates significant effort from the supplier. As described in Chapter 10, it is crucial for the retailer to split part of the gains that emerge from this. Numerous merchants, including Wal-Mart and Seven-Eleven Japan, put a lot of pressure on their suppliers to shorten the lead time for replenishment. The entire business strategy of clothing retailer Zara is based on utilizing local flexible production to shorten lead times for replenishment. Each time, the advantage showed itself as a decrease in safety inventory while keeping the intended level of product availability.

**2. Lower the Demand's Underlying Uncertainty**

If is lowered by a factor of k, the necessary safety inventory is similarly lowered by a factor of k. better market knowledge and the application of more advanced forecasting techniques may be used to reduce. Seven-Eleven Japan gives its shop managers comprehensive information about previous demand, weather, and other variables that may affect demand. The store managers can reduce uncertainty in their estimates by using this market intelligence. To reduce the underlying forecast uncertainty in the majority of supply chains, however, it is essential to connect all supply chain forecasts to data on consumer demand. Due to autonomous planning and forecasting at each stage of the supply chain, a large portion of the demand unpredictability exists. This alters demand along the entire supply chain and raises uncertainty. Increased coordination, as outlined, can frequently greatly lower the demand uncertainty. Both Wal-Mart and Seven-Eleven Japan share demand information with their suppliers, reducing uncertainty and thus safety inventory within the supply chain. Zara plans its production and replenishment based on actual sales at its retail stores to ensure that no unnecessary uncertainties are introduced [10].

## CONCLUSION

Organizations must strategically use safety inventory to manage supply chain uncertainty in order to meet the challenges posed by demand swings, supplier disruptions, and lead time unpredictability.

Organizations can increase their resilience, boost customer satisfaction, and reduce the risks brought on by uncertainty by retaining an appropriate level of buffer stock. A comprehensive comparison of costs, such as the costs of carrying inventory vs the costs of stock outs and customer unhappiness, is necessary to determine the ideal quantity of safety inventory. The effectiveness of demand forecasts, supply chain lead times, and desired service levels are also important considerations when calculating the right number of safety inventory.

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# CHAPTER 5

# MEETING CONSUMER DEMANDS: ORGANIZATIONAL STRATEGIES IN SUPPLY CHAIN

Dr. Ramalingam Mageshkumar, Assistant Professor
Department of Management, Presidency University, Bangalore, India
Email Id: mageshkumar@presidencyuniversity.in

**ABSTRACT:**

In order to keep operations running smoothly and satisfy consumer requests, organizations must overcome the difficult problem of managing uncertainty in a supply chain. The application of safety inventory as a tactic for successfully controlling uncertainty in a supply chain is the main topic of this chapter. Safety inventory, often referred to as buffer stock, is excess inventory that is kept on hand to reduce the risks associated with varying demand, supply disruptions, and lead times. The chapter examines the essential factors, such as lead times, required service levels, and demand forecasting accuracy that go into calculating the ideal level of safety inventory.

**KEYWORDS:**

Barnes Noble, Coefficient Variation, Demand Uncertainty, Lead Time, Product Availability.

## INTRODUCTION

We have concentrated on scenarios where demand uncertainty manifests itself as a forecast inaccuracy in our discussion up to this point. Supply unpredictability also has a big impact in many real-world scenarios. The effects of the grounding of the MSC Napoli off the south coast of Britain in January 2007 serve as a good example of the effects of supply uncertainty. More than a thousand tons of nickel, a crucial component of stainless steel, were being transported on the container ship. This delay in getting nickel to market led to major shortages and increased the price of nickel by roughly 20% in the first few weeks of January 2007. At the time, there were 5,052 tons of nickel kept in warehouses around the world, and 1,000 tons represented almost 20% of that total. Numerous factors, such as production delays, transportation delays, and quality issues, contribute to supply unpredictability. When planning safety inventories, supply chains must take supply uncertainty into account. In this part, we take supply uncertainty into account by presuming that lead times are uncertain and we analyse how lead times affect safety inventories. Assume that the lead time for replenishment from the component supplier and the consumer demand for Dell PCs each period are properly distributed [1]–[3].

Given that Dell manages component inventory using a continuous review process, we take into account the safety inventory standards. If demand during the lead period exceeds the ROP, or the amount on hand when Dell places a replenishment order, Dell encounters a stock out of components. As a result, we must determine how the client demand is distributed during the lead time. Due to that in reality, practices at the supplier and the party receiving the order both contribute to supply lead time variability. Suppliers occasionally lack adequate planning tools that prevent them from setting up production schedules that can be carried out. Today's supply chain planning software packages feature effective production planning tools that let providers make realistic lead times promises. As a result, lead time variability is decreased. In other situations, the order-placing party's actions frequently result in an increase in lead time variability.

A distributor once sent orders to every supplier on the same day of the week. Because of this, every delivery was received on the same day of the week. It was impossible to record all of the supplies into inventory on the day they arrived due to the sudden increase in deliveries. As a result, it appeared that supply lead times were lengthy and unpredictable. The lead time and lead time variability were drastically decreased by simply spreading out the orders over the course of a week, allowing the distributor to decrease its safety inventory. We then go through how aggregation can assist the supply chain's safety inventory be reduced [4].

**The Influence of Aggregation on the Safety Inventory**

In reality, there are different levels of inventory aggregation in supply chains. For instance, Barnes & Noble sells books and music from retail locations with inventory spread out geographically around the nation. Amazon, in contrast, ships all of its music and books from a small number of locations. Seven-Eleven Small convenience stores are widely scattered throughout Japan. In comparison, supermarkets typically have a lot more space and fewer, less evenly spaced outlets. Tens of thousands of kiosks scattered throughout the United States are where Redox rents out its films. Netflix, on the other hand, consolidates its DVD inventory at fewer than 60 distribution facilities [5], [6].

**Centralization of Information**

Despite having tens of thousands of vending machines, Redox essentially aggregates its DVD inventories by using information centralization. Customers can use an internet system set up by the business to find nearby vending machines that have the DVD they're looking for in stock. Redox is now able to offer a significantly greater level of product availability than they could if customers had to rely solely on visiting vending machines to learn about availability. Since the majority of consumers purchase their DVDs from the vending machine nearest to their residence, information centralization benefits are generated. Customers are serviced from another vending machine in the event that the closest one is out of stock, increasing product availability without increasing stocks. Retailers like Gap successfully utilize information centralization.

Store personnel can utilize their information system to tell customers of the closest store that has the desired size or color in stock if a store does not have it in stock. The customer can then pick up the items in person or have it delivered to their home. Thus, even though the inventory is physically divided, Gap leverages information centralization to virtually aggregate it across all retail outlets. As a result, Gap can carry less safety inventory while still maintaining a high level of product availability. The information system in place at Wal-Mart enables shop managers to look for an overabundance of goods that might be popular items in their own stores. Wal-Mart offers transportation services that let store managers swap goods so they can get to locations where they are in high demand. With a responsive transportation infrastructure and information centralization, Wal-Mart is able to carry less safety inventory while still maintaining a high degree of product availability in this situation [7]–[9].

**Specialization**

The majority of supply chains provide clients a range of goods. A supply chain manager's major choice when carrying inventory across several sites is whether to stock all items at each location. It goes without saying that a warehouse or retail establishment located in a location where a product does not sell should not stock it. For instance, it makes little sense for a Sears's retail location in southern Florida to stock a large selection of snow boots. The decrease in safety inventory caused by aggregation is a crucial consideration that must be taken into account when making stocking selections. It is preferable to carry a product in one central location if aggregation significantly decreases the necessary safety inventory for the product. It may be preferable to carry a product in numerous decentralized locations if

aggregation just slightly reduces the necessary safety inventory for the product, as this will cut down on reaction time and transportation costs. The demand's coefficient of variation has a significant impact on the reduction in safety inventory brought on by aggregation. It is possible to accurately predict disaggregate demand for a product with a low coefficient of variation. The benefit of aggregation is therefore negligible. Forecasting the disaggregate demand for a product with a high coefficient of variation in demand can be challenging. In this instance, aggregation dramatically raises forecast accuracy, offering significant advantages. Example 12-10 serves as an example of this concept.

**Effect of Coefficient of Variation on Aggregate Value**

Assume that W.W. Grainger, a supplier of MRO goods, operates 1,600 shops across the country. Think about two products: commercial cleansers and powerful electric motors. While industrial cleaners are low-value commodities with high demand, large electric motors are high-value items with low demand. Each motor costs $500, while cleaning agents cost $30 per can. Each store's weekly demand for motors has a mean of 20 and a standard deviation of 40, and it is normally distributed. Each store's weekly demand for cleaner has a mean of 1,000 and a standard deviation of 100, and it is normally distributed. Each store's demand is unique, and both the cleaner and motor supply lead times are four weeks. The holding cost for W.W. Grainger is 25 percent. Analyze the impact on safety inventories for each of the two goods if they are only carried at a centralized DC instead of retail outlets.

## DISCUSSION

In contrast to things with strong demand, which are referred to as fast-moving items and often have a low coefficient of variation, items with low demand are referred to as slow-moving items and typically have a high coefficient of variation. For many supply chains, focusing the distribution network so that fast-moving items are stocked at decentralized locations near the customer and slow-moving items are stocked at a centralized location can significantly reduce the safety inventory carried without negatively impacting customer response times or increasing transportation costs. Then, the central location is trained to manage things that move slowly. Naturally, other criteria must also be taken into account when selecting how to distribute products throughout stocking locations. For instance, a product with a high coefficient of variation might still be kept in stores if the client considers it to be an emergency item. The item's price is another thing to take into account. The advantages of centralization are larger for high-value than for low-value items.

When developing their online approach, businesses with physical and mortar stores must keep the concept of specialization in mind. Think of a network of bookstores like Barnes & Noble, which has around 100,000 titles in each of its retail locations. Best-sellers with high demand and other books with significantly lesser demand make up the majority of the titles carried. Barnes & Noble can create an online strategy where the retail outlets stock their shelves primarily with best sellers. To enable clients to explore, they also have one or a maximum of two copies of each of the other titles. Electronic kiosks in the store that offer access to BarnesandNoble.com inventory allow customers to access all titles that are not physically present in the store. Customers may now access a wider selection of books from Barnes & Noble shops thanks to this method.

While buying high-volume titles in-store, customers order low-volume titles through Barnes & Noble's website. Barnes & Noble can gather all of the slow-moving items to be sold by the internet channel thanks to this specialization technique. All top sellers are distributed and kept nearby the buyer. Thus, the supply chain lowers inventory costs for slow-moving goods at the tradeoff of marginally increased transportation expenses. By keeping the fast-moving items in retail locations close to the client, the supply chain offers lower transportation costs and faster response times. Similar to this approach, Gap combines its online and offline

channels. Online orders can be placed at the retail locations using terminals. Fast-moving items are available in retail outlets, and customers can request slow-moving colors or sizes online. As a result, Gap can expand the selection of products available to customers while minimizing supply chain stocks. Another tactic used by Walmart.com is to sell slower-moving goods online.

**Two Circumstances Allow for Substitution**

**1. Manufacturer-Driven Substitution:** The choice to substitute is made by the manufacturer or supplier. A lower-value product that is not in stock is typically replaced by a higher-value product by the manufacturer. In the event that a 1 terabyte hard drive is out of stock, Dell, for instance, may substitute a 1.2 terabyte drive for the customer's order.

**2. Substitution driven by the Customer:** Customers choose the replacement. If a gallon of detergent isn't available, a consumer entering a Wal-Mart store could opt to purchase the half gallon amount instead. The half-gallon size is used in place of the gallon size by the consumer. In both situations, taking use of substitution enables the supply chain to meet demand with aggregate stockpiles, allowing it to lower safety inventories without compromising product availability. Generally, if two products or components are present, replacement can either be one-way only one product or component can replace the other or two-way either product or component can replace the other. In the context of manufacturer-driven substitute, we briefly discuss one-way substitution, and in the context of customer-driven substitution, we briefly explore two-way substitution.

One-way substitution driven by the manufacturer Think about a PC maker who sells directly to consumers and provides drives with capacities ranging from 100 to 300 gigabytes. Customers are charged based on the drive size they choose, with larger sizes costing more. Two options are available if a PC manufacturer runs out of 200-gigabyte drives after a client orders one: either delay or reject the order, or substitute a larger drive that is in stock let's say a 220-gigabyte drive and fulfil the customer order on schedule. Because the consumer experiences a delayed delivery in the first instance, a sale could have been missed or future sales could have been lost. The second scenario involves the manufacturer installing a more expensive component, which lowers the company's profit margin. The manufacturer's inventory decisions for specific drive sizes must take into account these elements as well as the fact that only larger drives can replace smaller drives.

By aggregating demand across components through substitution, the PC manufacturer can reduce the amount of safety inventory that is needed. Substitution becomes more valuable as demand becomes more uncertain. The PC producer should therefore think about substituting components with high demand uncertainty. The cost difference between the higher-value and lower-value component affects the intended level of substitution. The PC maker should aggregate the majority of the demand and carry the majority of its inventory in the form of the higher-value component if the cost disparity is extremely modest. The benefit of substitution reduces as the cost differential widens. The PC maker will find it more advantageous in this scenario to maintain inventories of each of the two components and reduce the quantity of substitution. The demand correlation between the items also affects the required level of replacement. When demand for two components is very positively connected, replacement is not very useful. The benefit of substitution increases as the demand for the two components becomes less positively connected or even negatively correlated.

**Two-Way Substitution Driven by the Customer**

Consider W.W. Grainger, which sells two motor brands with comparable performance traits: GE and SE. Generally, consumers are open to buying either brand, depending on the availability of the goods. Managers at W.W. Grainger won't promote customer substitution if

they don't acknowledge it. They will therefore need to hold large levels of safety inventory of each brand for a given level of product availability. Its management can combine the safety inventory across the two brands, increasing product availability, if they recognize and promote customer substitution. In terms of recognizing customer substitution, W.W. Grainger does a good job.

The consumer is promptly informed of the availability of all equivalent products that she may replace for when she phones or places an order online and the requested product is not in stock. Most buyers in this situation finally purchase a replacement product. By collaboratively maintaining the safety inventory of all substitutable products, W.W. Grainger takes advantage of this substitution. W.W. Grainger is able to deliver a high level of product availability with reduced levels of safety inventory by recognizing and taking advantage of customer substitution. In the retail sector, having a solid understanding of customer-driven substitution is crucial. When merchandising, it must be taken advantage of to ensure that alternative goods are positioned next to one another, allowing a buyer to purchase one if the other is out of stock. If a consumer wants a product that is out of stock, a shop through the online channel must show them available alternatives. Thus, the supply chain is able to increase product availability while lowering the amount of safety inventory that is needed.

**Commonality of Components**

A sizable portion of inventory is kept in the form of components in every supply chain. A single product, like a PC, can include hundreds of parts. Component inventories can readily grow to be very vast when a supply chain is generating a wide range of products. To take advantage of aggregation and lower component inventories, a supply chain approach that works well is the usage of similar components in a number of products. Dell offers consumers tens of thousands of PC combinations. Designing unique components that are matched to the performance of a specific configuration is an extreme possibility for Dell. For each unique finished product, Dell would employ different memory, hard drives, modems, and other components. The alternative is to design products so that various component arrangements result in various final products. Without shared components, the demand uncertainty for any component is the same as the demand uncertainty for the finished good it is utilised in.

Because each finished product has a large number of components, demand uncertainty will be considerable, leading to high levels of safety inventory. The demand for each component when goods with shared components are designed is an accumulation of the demand for all the final products of which the component is a part. Demand for components is therefore more predictable than demand for any one final product. The supply chain's component stocks are reduced as a result of this reality. This concept had a major influence in the PC industry's development and has now begun to have a significant impact on the vehicle sector. Component commonality is essential to lowering supply chain inventories while maintaining product availability as product variation rises.

**Postponement**

The capacity of a supply chain to postpone product customization or differentiation until just before the product is sold. The objective is to move product differentiation as near to the pull phase of the supply chain as possible while maintaining similar components for the majority of the push phase. For instance, today's retail stores mix the last batch of paint after the customer has chosen the color she wants. As a result, only when demand is assured is paint variation produced. Paint merchants may keep much fewer safety inventories than in the past when mixing was done at the paint manufacturer thanks to postponement and component commonality. When scheduling production in the past, the factory manager had to predict paint demand by color. Because mixing has been deferred until after customer need has been

established, a production manager today simply needs to forecast the demand for aggregate paint. Because of this, each retail location mostly stocks aggregate inventory in the form of basic paint that is customized to the right shade in response to client demand. The procedure used by Benetton to create colored knit clothing is a prime example of delay. The original method required that the thread be dyed before being woven into clothes. Up to six months were needed for the complete process.

Due to the fact that the final garment's color was set as soon as the thread was dyed, the demand for specific colors had to be predicted far in advance up to six months. In order to dye knitted clothing, the correct color, Benetton created a manufacturing technique. Now, before dying, grieve thread the name for unstained thread can be bought, knitted, and used to make clothing. The clothing gets dyed significantly earlier in the selling season. In actuality, some of the dying is completed after the beginning of the selling season, when demand is well recognized. In this instance, Benetton has delayed the knit clothing's color personalization. When buying thread, only the total demand across all colors needs to be anticipated. There is a significant benefit to this aggregation since it occurs well in advance, when estimates are least likely to be right. The forecast's degree of uncertainty declines as Benetton gets closer to the selling season. Demand is highly accurate at the time Benetton dyes the knit clothing.

**Multichine Supply Chain Safety Inventory Management**

We've presummit in our discussion up to this point that each link in the supply chain has a clear demand and supply distribution that it uses to determine the appropriate safety inventory levels. For multichine supply chains, this is not always the case in reality. Think about a straightforward multichine supply chain where a supplier supplies a retailer, who then sells to the end user. In order to set safety inventory levels, the store needs to understand both supply and demand uncertainties. But how much safety inventory the supplier choose to carry has an impact on supply uncertainty. The supply lead time is low if a retailer order comes in at a time when the supplier has enough stock. In contrast, the retailer's lead time for replenishment lengthens if the supplier is out of stock when the retailer places the order. Thus, the retailer can store less safety inventory if the supplier raises the level of safety inventory it maintains. This suggests that there should be a relationship between the degrees of safety inventory at each stage of a multichine supply chain.

Echelon inventory refers to all stock that is located between a stage and the last customer. The only inventory that counts as echelon at a retailer is that which is already there or is on its way. However, Echelon inventory at a distributor comprises stock at both the distributor and every store the distributor serves. Reorder points and order-up-to levels in a multichine environment should always be based on echelon inventory rather than local inventory. As a result, a distributor should base its safety inventory decisions on the amount of safety inventory that all of the stores that it supplies carry. The distributor needs to carry less safety inventory the more safety inventory retailers hold. To ensure regular replacement at the retailers, the distributor must raise its safety inventory as merchants reduce the amount of safety inventory they carry. When every stage of a supply chain tries to control its echelon inventory, the question of how the inventory is distributed throughout the different stages becomes crucial.

In a supply chain, carrying inventory upstream enables greater aggregation and hence lowers the amount of inventory needed. However, carrying inventory upstream raises the likelihood that the end client would have to wait since the product is not accessible at a stage close to him or her. Therefore, a choice must be made on the quantity of safety inventory transported at various points throughout a multichine supply chain. To take advantage of the advantages of aggregation, it is preferable to carry more safety inventory upstream, distant from the

ultimate consumer, if inventory costs a lot to keep and customers are ready to put up with a delay. It is preferable to carry more safety inventory downstream, closer to the end consumer, if inventory is affordable to hold and customers are time-sensitive.

**It's Participation in Inventories Management**

The two most important contributions of IT systems, aside from the fundamentals of formalizing inventory replenishment processes for thousands of SKUs, can be increased inventory visibility and improved supply chain coordination. The advantages of better inventory visibility are very well illustrated by the American department store chain Nordstrom. Although previously separating its online inventory and its store inventories, the corporation has always been quite good at controlling its inventories IT systems played a significant role in this. The business began incorporating shop inventories onto its website in September 2009. Inventory is now accessible to customers wherever it was previously. Nordstrom may now accommodate them by using store inventory if they want home delivery. However, Nordstrom gives clients the option to reserve the item for pickup if they would rather pick it up personally. The improved online customer service and more foot traffic to shops are both made possible by Nordstrom's increased inventory visibility.

Wal-Mart also implemented a comparable product in 2010 called Pick up Today, which enables customers to place orders online and pick them up at a location a few hours later. When the order is prepared, customers are informed usually via text message. Redox uses inventory visibility at each of its kiosks to direct clients to the one that has the required DVD in stock and is the closest. In each case, the company is able to improve product availability to customers without adding to stockpiles because to the increased insight given by IT systems.

Locating in-store or in-warehouse goods is another situation where better visibility may have a big impact. It frequently happens that a business or warehouse has merchandise on hand, but it's located in the wrong spot. Despite having inventories, the end outcome is a reduction in the availability of the goods. Effective RFID systems may be able to solve this problem. While there hasn't been much success with RFID systems at the item level in retail establishments although there has been some success with high-value clothing, there has been success in areas like the storage of aircraft spare parts. The improvement of supply chain integration has been significantly aided by IT systems. Based on the visibility of available inventories and sales at Wal-Mart, Procter and Gamble and Wal-Mart agreed that P&G could replace nappy inventory at Wal-Mart. The two businesses were able to improve service while lowering inventories because to this coordination.

With increased visibility of inventory and sales, the programmer evolved over time into collaborative planning, forecasting, and replenishment described in further detail, which enables better coordination of planning and replenishment across numerous supply chain partners. Although IT serves as the backbone of each of these initiatives, it is crucial to recognize that success calls for significant organizational adjustments and leadership commitment, as covered in Chapter 10. Successful business operations require good IT systems, but that alone won't guarantee it. It's critical to understand that in each of the aforementioned scenarios, the value of the IT system is closely correlated with the accuracy of the inventory data. Inaccurate inventory data results in poor decisions and, in the worst-case scenario, could breed mistrust among supply chain participants trying to coordinate the decisions and actions. A retailer's inventory records were found to be erroneous in roughly 65 percent of cases, according to a study by Decorations and Raman. In other words, for 65% of the records examined, the inventory in-hand did not correspond to the inventory displayed in the IT system. The value offered by an IT system will be constrained in the absence of inventory records that are reasonably accurate.

**Practical Estimation and Management of Safety Inventory**

Take into account the uneven demand throughout the supply chain. A manufacturer or distributor typically places orders in huge lots rather than one unit at a time. As a result, the demand seen at various points throughout the supply chain is frequently erratic. Lumpiness increases demand's cyclicality. For instance, lumpiness may cause inventory to fall well below the ROP when utilizing a continuous review strategy before a replenishment order is placed. Inventory will typically fall below the ROP by half the typical order amount. By doubling the safety inventory recommended by the preceding models' average order size, the lumpiness can be explained in practice.

If demand is seasonal, modify your inventory regulations. In reality, demand is frequently seasonal, with the mean and standard deviation changing according to the season. As a result, during the low-demand season, a given reorder point or order-up-to level may correlate to 10 days of demand while just 2 days of demand are present during the peak demand period. The peak season will undoubtedly see stock outs if the lead time is one week. It is inappropriate to choose an average demand and standard deviation across the year to assess fixed reorder points and order-up-to levels when seasonality is present. To account for seasonal variations in demand, the mean and standard deviation of demand must be modified. Over the course of the year, corresponding adjustments must be made to the safety inventories, order-up-to levels, and reorder points. Adjustments for variations in variability are typically less important than adjustments for changes in the mean demand over the course of the year.

Test inventory policies using simulation. The simulation should use a demand pattern that truly reflects actual demand, including any lumpiness as well as seasonality, since demand is most likely not normally distributed and may be seasonal, it is a good idea to test and adjust inventory policies using a computer simulation before they are implemented. To achieve the intended service levels, the inventory rules derived from the models outlined in the chapter can then be tested and updated as necessary. When compared to dealing with these issues after the inventory policy is in place, finding flaws in a simulation can save a lot of time and money. Begin with a test run. Even a simulation cannot catch every issue that can occur while implementing an inventory policy. It is frequently a good idea to begin implementation with a pilot programmer of products that are representative of the complete set of products in inventory after an inventory policy has been chosen and tested using simulation.

Many of the issues in the actual inventory policies as well as in the process of applying the policies can be resolved by beginning with a pilot. Time and money can be saved by resolving these issues prior to the policy being applied to all products. Observe service levels. Once an inventory policy has been put in place, it is crucial to track and keep an eye on how it is performing. Monitoring is important since it enables a supply chain to spot when a policy isn't performing as intended and make changes before the performance of the supply chain is adversely impacted.

Monitoring entails keeping an eye on both the inventory levels and any potential stock outs. Stock outs have historically been poorly recorded by businesses, in part because they are challenging to monitor and in part because it is believed that stock outs only effect the consumer and not the business. Pay attention to lowering safety inventories. Given that safety inventory frequently makes up a major portion of the total inventory in a supply chain, it would be profitable to minimize safety inventory without compromising product availability. Given the short product life cycles in the high-tech sector, this is particularly crucial. Several managerial methods that can help reduce safety inventories without compromising availability were covered in this chapter. Managers of supply chains must consistently concentrate on leveraging these levers to cut back on safety inventory.

## CONCLUSION

Organizations must effectively use safety inventory to manage supply chain uncertainty in order to reduce risks and preserve operational stability. Organizations can overcome the difficulties caused by demand swings, supplier disruptions, and lead time uncertainty by maintaining a sufficient level of buffer stock. In order to maintain the ideal level of safety inventory, it is important to carefully weigh the carrying costs of maintaining inventory against the possible consequences of stock outs, such as customer resentment and lost revenue. The effectiveness of demand forecasts, lead times, and desired service levels are all important considerations when selecting the right number of safety inventory.

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# CHAPTER 6

# A BRIEF OVERVIEW: OPTIMAL LEVEL OF PRODUCT AVAILABILITY

Ms. Pramoda Hegde, Assistant Professor
Masters In Business Administration, Presidency University, Bangalore, India
Email Id: pramodah@presidencyuniversity.in

**ABSTRACT:**

In order to satisfy consumer demand while reducing costs and maximizing profitability, organizations must make a crucial choice about the ideal amount of product availability. The process of choosing the ideal degree of product availability and the variables affecting this choice are the main topics of this chapter. In order to balance inventory investment and customer pleasure, the chapter examines the trade-offs between carrying costs and stock out costs. It highlights the important factors to take into account, including client preferences, lead times, demand unpredictability, and service level agreements.

**KEYWORDS:**

Amount Product, Customizing, Degree Product, Ideal, Time.

## INTRODUCTION

The cycle service level or fill rate, which are measurements for the percentage of customer demand satisfied from available inventory, are used to gauge the degree of product availability. One of the key indicators of how responsive a supply chain is the level of product availability, often known as customer service level. A supply chain might leverage a high level of product accessibility to enhance its responsiveness and draw clients, hence boosting revenue. High product availability, however, necessitates big inventories, which drive up supply chain costs. A supply chain must therefore strike a balance between the availability level and the cost of inventories. The level of product availability that maximizes supply chain profitability is the ideal level. Because of the sharp fall in demand that affected manufacturers and retailers in the fourth quarter of 2008, U.S. stocks soared by $6.2 billion.

Due to the excess inventory of raw materials that certain firms had accumulated in anticipation of price hikes, such as steel and plastics, the situation was accentuated for them. Retailers were also severely impacted; some, like Saks Fifth Avenue, slashed prices by 70% to increase demand throughout the holiday season. Several stores filed for bankruptcy during this time due to surplus inventories and a decline in demand, including Steve and Barry and Circuit City. The failure of Nintendo to meet the surging global demand for their Wii video game machine, on the other hand, cost the company an estimated $1.3 billion in lost sales over the 2007 holiday season. These illustrations demonstrate how product availability levels that are either too high or too low have a substantial influence on supply chain profits [1]. Depending on where a specific corporation thinks it can maximize earnings, the ideal degree of availability may be high or low.

To succeed as a department store chain, Nordstrom has concentrated on offering a high degree of product availability and has benefited from its reputation for responsiveness. Although there are fewer products available in budget stores, Nordstrom's prices are higher. Because a shutdown is quite expensive and results in many days of production loss, power plants make sure that they almost never run out of fuel. In order to eliminate any chance of running out of fuel, several power plants attempt to maintain a few months' worth of supply. In contrast, most supermarkets only keep a few days' worth of inventory on hand, and out-of-

stock situations do happen occasionally. If the store of choice is out of stock, a client can readily shop at another location thanks to the Internet. Online retailers are under pressure to raise their degree of availability as a result of the market competition. Meanwhile, fierce pricing competition has driven down prices online. With extra inventory, online companies struggle to turn a profit. Thus, the secret to success online is to offer the best possible amount of product availability. In the aforementioned cases, businesses offer various degrees of product accessibility. Every supply chain management must use variables that affect the ideal availability of products to target that ideal level and find administrative levers that boost supply chain surplus. The next step is to determine the variables that influence the ideal level of product availability.

**Elements Impacting the Ideal Level of Product Availability**

Consider L.L. Bean, a sizable mail-order retailer of clothing, to gain an understanding of the variables that affect the ideal degree of product availability. Ski jackets are one of the things L.L. Bean offers for sale. Ski coats are available for purchase from November through February. Currently, L.L. Bean's buyer buys the entirety of the season's worth of ski coats from the producer before the start of the selling season. In order to maintain a high level of product availability, several jackets must be bought. A high level of product availability could be able to meet all demand, but it also might leave L.L [2]. Bean with a lot of unsold jackets at the end of the season, costing the company money. On the other hand, a low degree of product availability is probably going to leave few coats unsold. It's conceivable, though, that L.L. Bean will have to turn away consumers who want to purchase jackets because they are out of stock. In this case, L.L. Bean loses potential revenue due to a decrease in consumer base. When deciding on the amount of product availability, the buyer at L.L.

Bean must weigh the loss from having too many unsold jackets in the event that the number of jackets purchased is greater than the demand and the lost profit from turning away clients in the event that the number of jackets ordered is less than the demand. The loss a company experiences for each unit that remains unsold at the conclusion of the selling season is represented by the symbol Co, or the cost of overstocking. The margin a business loses for each sale it loses because it has no inventory on hand is indicated by the symbol Cu, which stands for the cost of understocking. If a consumer doesn't come back, the cost of understocking should take into account the margin lost from both present and future sales. In conclusion, the cost of overstocking the product and the cost of understocking the product are the two major variables that affect the ideal amount of product availability. When making a purchase at L.L. Bean, we use this relationship to showcase and further build it.

The first thing to note is that choosing an ideal degree of product availability only makes sense when demand is unpredictable. Historically, many businesses have made a consensus projection. Demand projection without any mention of uncertainty. In this scenario, organizations just order the consensus forecast without deciding on the availability level. In the last ten years, businesses have improved their understanding of uncertainty and begun creating projections with some degree of uncertainty. Comparatively to utilizing a consensus forecast, incorporating uncertainty and deciding on the ideal degree of product availability can boost earnings. A purchasing committee at L.L. Bean selects the quantity of each item to be ordered. The purchasers hypothesized the demand distribution for a women's red ski parka to be as indicated in based on demand over the previous few years. This is a departure from its custom of adopting the consensus projection as the average historical demand. We make the simplifying assumption that the total demand is for hundreds of parkas.

## DISCUSSION

We now concentrate on the steps a manager may take to increase supply chain profitability after identifying the variables that affect the ideal amount of product availability.

Profitability and the ideal cycle service level are both increased by raising each unit's salvage value. Increasing profitability by accepting a lower ideal cycle service level reduces the margin lost from a stock out. Selling to outlet shops is one way to boost the salvage value and prevent unused units from being simply thrown away. Some businesses, like Sport Obermeyer, which sells winter clothing in the United States, sell the excess in South America, where winter is equivalent to summer in North America. Sport Obermeyer can raise its profitability and provide a better degree of product availability in the United States thanks to the increasing salvage value of the excess. The emergence of internet liquidators like Overstock.com benefits businesses by raising the salvage value of their overstocked inventory.

A company may increase profits by offering a greater degree of product availability by increasing the salvage value of remaining units since the cost of surplus inventory has decreased. Making arrangements for backup sourcing, even if it is more costly, may help reduce the margin lost in a stock out and prevent consumers from being lost permanently. The previous justification is observed and supports the practice of acquiring goods from a rival on the open market to meet consumer demand. Two significant rivals in the MRO supply sector, McMaster-Carr and W.W. Grainger, are also significant consumers of one another. By offering the client a replacement item, the cost of understocking may also be reduced. By offering a lower degree of product availability since there are alternatives available to service the consumer and reducing the quantity of surplus inventory towards the end of the season, a company may boost profits by lowering the cost of understocking.

The best cycle service level as a function of the ratio between the costs of overstocking and understocking. Keep in mind that the ideal amount of product availability rises as this ratio decreases. This fact explains why a budget shop and a high-end retailer like Nordstrom have different levels of product availability [3]. Due to Nordstrom's larger margins, understocking costs are higher. As a consequence, it ought to provide a greater degree of product availability than a bargain retailer with lower profits and, thus, a smaller stock-out expense. The management of demand uncertainty is a key managerial tool for increasing supply chain profitability. A supply chain management may better match supply and demand by lowering both overstocking and understocking when demand uncertainty is eliminated. In order to lessen demand uncertainty, a management can:

**1. Improved Forecasting:** To lower demand uncertainty, use improved market knowledge and cooperation.

**2. Swift Action:** Shorten the lead time for restocking to enable several orders to be made throughout the selling season.

**3. Delay:** Delay product differentiation in a multiproduct environment till nearer the point of sale.

**4. Tailored Sourcing:** As a backup for a low-cost but maybe lengthy lead-time source, use a low lead-time but possibly pricey supplier. The effects of each of them on supply chain performance are then examined.

**Impact on Profits and Inventories is the Swift Response**

Quick response refers to the series of steps a supply chain takes to shorten the lead time for replenishment. As lead times shorten, supply chain managers are better able to predict demand accurately, which helps them better match supply with demand and boost supply chain profitability. We covered the advantages of reducing lead times for commonly supplied commodities like detergent. Now let's concentrate on the advantages of reducing lead times for seasonal commodities. Consider Saks Fifth Avenue, an upscale department shop, buying cashmere shawls from India and Nepal to highlight the problems. About 14 weeks are

dedicated to the cashmere shawl sale season. Resupply lead times have typically ranged between 25 and 30 weeks. The Saks buyer must place all orders with a 30-week lead time well in advance of the start of the sales season. A buyer finding an accurate demand prediction thus far in advance is challenging. Due to the resulting high demand uncertainty, the customer orders either an excessive number of shawls or an insufficient amount each year. Once they have seen sales for the first week or two of the seasons, buyers are often able to make precise predictions. There may be considerable advantages for the supply chain if lead times can be lowered to make it easier to leverage real sales when placing a portion of the seasonal order.

Think about a scenario where manufacturers can cut the lead time for replenishment to six weeks. The Saks buyer is able to divide the season's worth of purchases into two orders thanks to this decrease. Six weeks before to the beginning of the sales season, the first purchase is placed. The purchaser purchases what the retailer anticipates selling during the first seven weeks of the season [4]. Without seeing any sales, the initial order must be placed. After the season begins, the buyer analyses sales for one week before placing a second purchase. The buyer may make use of sales data from the first week of the season when making the second purchase. Saks may utilize the second order to better match supply and demand thanks to the buyer's estimations being more accurate, which leads to larger profits. Instead, we must simulate or approximate the effects of various ordering rules. We approximate the Saks example from earlier to show the effect of being able to place many orders in a season. The Saks buyer must choose how many cashmere shawls to purchase from Nepal and India for the next winter. Each shawl costs $40 per unit, with a retail price of $150. Any unsold shawls are purchased by a cheap retailer at the end of the season for $30 apiece. Any unsold shawls are sold to the outlet shop after the 14-week sales period.

The buyer predicts that weekly demand will be regularly distributed, with a mean of D 20 and a standard deviation of D 15, before the start of the sales season. We contrast the effects of the two ordering strategies listed below:

1. The supply lead time exceeds 15 weeks. As a consequence, just one order has to be made at the start of the season to satisfy demand for the whole season.
2. The lead time for supplies is cut to six weeks. Due to this, two orders are made for the season, one of which will be delivered at the start of the period and the other of which will be placed at the conclusion of the first week and delivered at the start of the eighth.

We assume that the buyer can properly predict demand for the first seven weeks after seeing sales for the first week this approximation enables us to quantify the advantages of the second order. She still is unable to forecast revenues for the next seven weeks. In terms of the buyer's forecasting capacity for the second seven-week period, we take into account two scenarios: one in which it does not improve and the standard deviation of forecast demand remains at 15 for the second order, and the other in which it does and the buyer is able to lower it to 3 instead. We also believe that demand varies little from week to week.

**Impact of a Postponement on Profits and Inventories**

Postponement the delaying of product differentiation until after the product has been sold. All postponement actions need aggregate predictions that are more precise than projections for each individual product. Close to the time of sale, when demand is more understood, individual product projections are necessary. Therefore, postponement enables a supply chain to more effectively balance supply and demand. Delay is a potent management tool that may be used to boost profitability. Because of the delay that occurs between the moment a consumer places an order and when they anticipate delivery, it may be very helpful for online sales. Profits may rise significantly and inventories can be reduced if the supply chain can

delay product diversification until after receiving the client order. The enhanced supply and demand matching is the main advantage of delay. Postponement can come at a cost, however, since it is often more expensive to produce anything with postponement than it would be without it. For instance, Benetton's manufacturing procedure, which involves dyeing assembled knit clothes, is around 10% more expensive than if knitted from colored thread. Similar to this, production prices rise when merchants mix paint in shops rather than in factories since there are less economies of scale. A corporation should make sure that the inventory advantages of postponing outweigh the extra expenditures given the higher manufacturing cost caused by postponement [5], [6].

A company that offers a wide range of items with erratic, independent, and sizable demand may benefit from postponement. We use the sale of knit clothing in solid colors from Benetton as an example to show this. The garment may be made in two processes, beginning with thread: dying and knitting. In the past, the fabric was knitted after the thread was colored. Benetton developed a process that delays coloring until after the garment has been knit. Each knitted item from Benetton retails for $50. No postponement in Option 1 results in a $20 production cost, whereas delay in Option 2 results in a $22 manufacturing cost per garment. At the conclusion of the season, Benetton sells any unsold items in a clearance for $10 apiece. The whole knitting or production process lasts 20 weeks. We'll suppose for the sake of this discussion that Benetton offers clothing in four hues. Benetton predicts that demand will be regularly distributed, with a mean of 1,000 and a standard deviation of 500, twenty weeks in ahead. Each color has its own unique need. With Option 1, Benetton has separate inventories for each color and decides to purchase each color 20 weeks before to the selling time.

**Impact of Tailored Sourcing on Revenue and Inventories**

In customized sourcing, businesses combine two supply sources, one of which is cost-focused but inflexible and unable to manage uncertainty, and the other of which is flexible and able to do so at a higher cost. It is not enough to have supply sources set up such that one backs up the other for customized sourcing to be successful. The two sources must concentrate on different capacities. The low-cost supplier should concentrate on efficiency and only be needed to meet the demand for the predictable segment of the market. The flexible source should priorities responsiveness and be expected to meet the demand's unpredictable part. Consequently, customized sourcing enables a business to boost profitability and more effectively balance supply and demand. The value of customized sourcing relies on the cost savings that may be realized when one source is not subject to variations.

Because of the increased implementation complexity, customized sourcing may not be the best option if this advantage is marginal. According to the source of uncertainty, tailored sourcing may be volume- or product-based. The predictable component of a product's demand is produced at an effective facility under volume-based customized sourcing, while the unpredictable portion is produced in a flexible facility. Benetton serves as an illustration of volume-based, customized sourcing. Seven months before the start of the sales season, Benetton needs merchants to commit to around 65 percent of their orders. This portion's manufacture is subcontracted by Benetton to low-cost suppliers with lengthy lead periods of several months. Benetton permits merchants to make orders for the remaining 35% far later in the selling season, if not even after it begins. This part of the sequence contains the majority of uncertainty. This component of the order is fulfilled by a Benetton-owned, highly adaptable facility [7].

The cost of manufacturing at the Benetton facility is higher than that of the subcontractor. However, while subcontractors have a lead time of many months, the factory can manufacture with a lead time of only a few weeks. Benetton may decrease its inventory levels

while paying high manufacturing costs for a small portion of its demand by combining the two sources. This enables it to boost earnings. Companies that have relocated a lot of their manufacturing offshore to benefit from cheaper costs should think about volume-based specialized sourcing. Longer lead times have also come along with the cheaper prices. Even if the local source is more costly, having a flexible local source with short lead times might be a useful complement to the lengthy lead time offshore supply in such a case. Large safety stockpiles are needed because of long lead times, and the ensuing imbalance in supply and demand reduces earnings. Due to the local source's availability, the company may carry less safety stockpiles and satisfy any extra demand from that source. The foreign supplier should concentrate on restocking cycle inventory while avoiding uncertainty for the best results. When demand is greater than the amount of goods on hand, the local source is employed as a backup.

A high-tech producer of wireless transmission components with facilities in China and Mexico is described by Allan and Van Maugham. Although the Chinese facility's lead times were five to 10 times longer than those from Mexico, it was less expensive. According to a simulation study, using customized sourcing in this situation was the best course of action. A customized base-surge inventory strategy is suggested by Allan and Van Maugham, in which a consistent base load is obtained from the less expensive source and the responsive source in this case, Mexico is utilised each time inventories drops below a threshold. According to their simulations, a rather successful customized sourcing strategy in practice is to source around 75% of the demand from the less expensive source as a base load, with the remaining 20% coming from the responsive source as required. Their findings demonstrate that when demand and the cost differential with the responsive facility expand, a greater share of the demand is assigned as base load to the less expensive source. As the cheaper source's dependability declines, demand volatility increases, and the cost of storing inventory rises, less of the demand is assigned to it as base load.

Low-volume items with uncertain demand are procured from a flexible source in product-based customized sourcing, while high-volume products with less uncertain demand are procured from an efficient source. Levi Strauss is an example of product-based customized sourcing. Levi offers both pre-made and custom-made jeans in conventional sizes. Compared to personalized jeans, the demand for standard jeans is more uncertain. While regular jeans are made in an efficient facility, custom jeans are made in a flexible facility. Zara uses a similar product-based customizable sourcing approach, sourcing more than half of its manufacturing from flexible factories in Europe and the other portion from more affordable plants in Asia. The least predictable in terms of demand are its most trendy commodities, which are produced in adaptable European factories. Basic T-shirts and other items of clothing that are more dependable and have a longer shelf life come from the less expensive Asian factories. In certain cases, the demand for new items is unpredictable whereas the demand for well-established products is more consistent. A flexible facility focused on new goods and an efficient facility focusing on well-established items may be used to conduct product-based customized sourcing. This often occurs in the pharmaceutical sector [8].

**Summary of Learning Objectives**

Define the variables influencing the ideal cycle service level and estimate the ideal degree of product availability. The two main elements that determine the ideal amount of product availability are the expense of overstocking by one unit and the lost present and future profit from understocking by one unit. The expenses of understocking and overstocking are balanced to achieve the ideal level of availability. It is best to reduce the desired level of product availability as the cost of overstocking rises. Raising the planned level of product availability is ideal as the margin lost due to being out of stock rises. Employ management controls that raise supply chain profitability by ensuring high service standards. A manager

can boost supply chain profitability by raising the salvage value of each overstocked unit, lowering the margin lost from a stock out, using improved forecasting to lower demand uncertainty, using quick response to cut lead times and allow multiple orders in a season, using postponement to delay product differentiation, and using tailored sourcing with a flexible short lead time supply source serving as a backup for a low-cost source. Recognize the circumstances in which delay is advantageous in a supply chain.

When a company provides a wide range of items with extremely unpredictable demand that is about the same size and not positively associated, postponement is advantageous in a supply chain. If demand becomes predictable or positively connected, postponement is less advantageous. If just a small number of items account for a significant portion of demand, postponement is also less advantageous. In this situation, customized postponement works best when base loads are not delayed but the variance. Distribute the limited supply capacity across many items to increase anticipated earnings. When supply capacity is constrained, it should be divided across items according to how much profit margin they are projected to provide. The estimated marginal contribution of each product is the same at the ideal allocation. The estimated marginal contribution of each product at optimality is 0 when there is no capacity restriction [9].

## CONCLUSION

A crucial component of supply chain management is figuring out the ideal degree of product availability, which calls for striking a careful balance between cost effectiveness and customer pleasure. Organizations can satisfy consumer demand, reduce inventory holding costs, and increase profitability by striking the proper balance between carrying costs and stock out costs.

The ideal degree of product availability depends on a variety of factors, including customer preferences, lead times, service level agreements, and demand fluctuation. Making educated judgments may be aided by using data analytics, demand forecasting methods, and inventory optimization models. Organizations may decrease the danger of stock outs, lower the likelihood of missed sales, minimize excess inventory and related expenses, and avoid stock outs by properly anticipating consumer demand.

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# CHAPTER 7

# A BRIEF OVERVIEW: TRANSPORTATION IN SUPPLY CHAIN MANAGEMENT

Dr.Yagnamurthy Raja, Assistant Professor
Masters In Business Administration, Presidency University, Bangalore, India
Email Id: narasimharaja@presidencyuniversity.in

**ABSTRACT:**

The transfer of products and resources from suppliers to consumers is made easier by transportation, which is essential to supply chain management. The relevance of transportation in supply chain management and its effect on total supply chain performance are the main topics of this chapter. The chapter examines a number of transportation-related topics, including as route optimization, mode selection, and carrier management. It talks about how crucial transit is to cutting costs, shortening lead times, and raising customer satisfaction. The summary also emphasizes how technology and data analytics can enhance transportation operations by allowing businesses to monitor shipments, optimize routes, and increase supply chain visibility.

**KEYWORDS:**

Chain Management, Delivery Times, Milk, Package, Supply Chain.

## INTRODUCTION

When a product is being transported, it is being moved from one place to another as it travels from the start of a supply chain to the client. Due to the fact that items are seldom manufactured and consumed in the same place, transportation is a key supply chain driver. Most supply chains suffer expenses that are heavily influenced by transportation. Over 19 billion tons of freight, worth at $13 trillion, were transported over 4.4 trillion ton-miles in the United States in 2002, according to the Bureau of Transportation Statistics .1 Only three industries made up a bigger portion of the GDP than transportation: housing, health care, and food. In 2002, approximately 20 million individuals worked in professions connected to transportation, making about 16% of all occupations in the country. In global supply chains, transportation plays an even more important role. The BTS estimates that in 2004, the U.S. goods transportation network transported goods worth more than $2.2 trillion for export and import, a growth of 168 percent from $822 billion in 1990.

The percentage of GDP that is made up of exports to and imports into the United States climbed from 12 to 21 percent over the same time period. The successful operation of any supply chain is directly related to the efficient utilization of transportation [1], [2]. IKEA, a Scandinavian home goods business, has mostly relied on efficient logistics to establish a worldwide network of around 270 locations across 26 countries. For the fiscal year that ended in August 2009, IKEA generated 21.5 billion euros in sales. Its marketing plan concentrates on offering high-quality goods at competitive pricing. It intends to lower prices by 2 to 3 percent annually. IKEA makes an effort to locate the most affordable worldwide supplier for each of its items as a consequence. IKEA is able to ship its products throughout the globe considerably more cheaply than a typical furniture producer because to the modular nature of its furniture.

Home furnishings may be transported at a reasonable cost all the way to the retail shop thanks to the scale of IKEA stores and shipments. IKEA is able to provide premium home furnishings at competitive costs all around the world thanks to efficient sourcing and

affordable shipping. Another business that has used transit to meet its strategic objectives is Seven-Eleven Japan. The corporation wants to stock items in its shops that cater to clients' requirements, which might change depending on their location or the time of day. Seven-Eleven Japan employs a responsive transportation system to resupply its shops many times each day in order to assist accomplish this aim and ensure that the items offered meet consumers' expectations. In order to accomplish frequent delivery at an affordable price, goods from various suppliers are combined on trucks in accordance with the needed temperature.

Seven-Eleven Japan reduces its shipping and receiving expenses while guaranteeing that product supply closely matches consumer demand by combining aggregation with a responsive transportation infrastructure. Supply chains may function with fewer buildings and centralized inventory by using responsive mobility. For instance, Amazon employs the postal service and package carriers to transport client purchases from central warehouses [3]. Netflix is able to run a movie renting company without any physical locations because to transportation. The business enables its consumers to obtain and return films they wish to view by using responsive postal transportation and strategically placed warehouses. The party that needs the goods to be sent between two locations in the supply chain is known as the shipper. The entity that moves or carries the merchandise is known as the carrier. For instance, Netflix is the shipper and USPS is the carrier when Netflix employs USPS to send DVDs from the warehouse to the client.

The owners and operators of transportation infrastructure, such as roads, ports, canals, and airports, as well as the international organizations that establish global transportation policy, are two additional stakeholders that have a considerable effect on transportation in addition to the shipper and the carrier. The efficacy of transportation is influenced by the actions of all four parties. The views of all four parties must be taken into account in order to comprehend transportation in a supply chain. A carrier takes investment choices about the infrastructure rail and transportation vehicles trucks, aircraft, etc. before making operational decisions to attempt to maximize the profit from these assets. While maintaining an acceptable degree of customer responsiveness, a shipper, in contrast, employs transportation to reduce the overall cost transportation, inventory, information, sourcing, and facilities. Ports, highways, canals, and airports are just a few examples of the infrastructure that has an impact on how successful carriers are.

The vast majority of transport infrastructure worldwide is owned and operated by governments. Infrastructure management must be done in a manner that makes money accessible for upkeep and expansion of capacity as required. The direction of national resources allocated to enhancing the nation's transportation infrastructure is decided by transportation policy. In addition, transportation policy seeks to balance social, environmental, and energy problems in transportation while preventing the misuse of monopolistic power. We go through significant topics from the perspectives of shippers, infrastructure owners and operators, carriers, and transportation policy makers in the sections that follow [4]. The cost and performance characteristics of various forms of transportation are covered in the section that follows. Following transportation methods are combined in supply chains:

The value contributed to the GDP in 2009 by each form of commercial goods activity in the United States in 2002. It is crucial to note certain significant economic developments in the United States before going into detail about the different modes. In dollars in the year 2000, the real GDP of the United States increased by 176% between 1970 and 2002. Only 73% more ton-miles were transported in the United States over that time span. In 1970, 2.1 tons of freight transportation were required to create $1 in GDP from products. Only 1.1 ton-miles were required to create $1 of GDP in 2002. This pattern reflects product shrinking brought on

by modern technologies and increased freight transportation system effectiveness. Any method of transportation's efficiency is influenced by the carrier's operational choices, infrastructure investments, and transportation legislation.

The carrier's main goal is to make sure that its resources are used effectively while still offering consumers a quality of service that is acceptable. Equipment expenses, fixed operating costs, variable operating costs, the responsiveness the carrier intends to provide its target segment, and market pricing all have an impact on the choices carriers make. For instance, FedEx developed a hub-and-spoke aero plane network for package transportation to provide quick, dependable delivery times. UPS, in comparison, offers less costly transportation with somewhat longer delivery times by combining trucks, train, and aero planes [5]. The price schedule takes into account how the two transit networks vary. FedEx next day delivery fees are mostly determined by package size. In contrast, UPS bases its fees on both the size and the destination. In terms of the supply chain, a hub-and-spoke air network is more suited when costs are constant regardless of the destination and quick delivery is crucial, but a trucking network is better suited when prices vary depending on the destination and a somewhat delayed delivery is acceptable.

## DISCUSSION

Transportation firms like FedEx, UPS, and the U.S. Postal Service are examples of package carriers. They convey tiny items ranging from letters to cargo weighing up to 150 pounds. Smaller items that need to be delivered quickly are transported by air, truck, and train. Because they are more costly than LTL carriers, package carriers are unable to compete on pricing for big shipments. Rapid and dependable delivery is their main service for shippers. Therefore, shippers choose package carriers for quick and small delivery. Additionally, package carriers provide value-added services including package tracking and, in certain situations, product processing and assembly. Package carriers are the primary means of transportation for enterprises that ship tiny items to clients, such as W.W. Grainger and McMaster-Carr, as well as for online retailers like Amazon and Dell. The usage of package carriers has grown dramatically over the last several years as a result of the expansion of online commerce. When monitoring and other value-added services are crucial to the shipper, package carriers priorities smaller, more urgent shipments above air cargo carriers.

Consolidation of shipments is an important strategy for enhancing utilization and lowering costs for package carriers because of the small size of packages and the variety of delivery locations. Trucks used by package delivery services are used to pick up and deliver packages locally. After being transported to sizable sorting facilities, packages are then moved by full truckload, rail, or air to the sorting facility that is closest to the delivery location. The cargo is delivered to consumers on small trucks doing milk runs from the delivery-point sorting center. The placement and capacity of transfer stations as well as the information capabilities to enable and monitor package movement are important challenges in this business. The planning and route of the delivery vehicles is crucial for the ultimate delivery to a client [6].

### Truck

Trucks carry a substantial portion of the products transported across the majority of the globe. Trucks transported 60.1 percent of the nation's commercial goods by weight and 69.5 percent by value in 2002.2 there are two main subsectors of the trucking industry: truckload and less than truckload. Trucking is more costly than rail, but it has the benefit of door-to-door delivery and a faster turnaround. The benefit of not having a transfer between pickup and delivery is another benefit. TL businesses have very minimal fixed expenses, and starting a firm with only a few vehicles is often adequate. Shipments weighing 10,000 pounds or more are what define this sector, and more than 50,000 carriers provide TL services in the US. The difficulty in the TL industry stems from the mismatch between inward and outbound flows in

the majority of markets. For instance, New York has a material inflow that is noticeably greater than its material outflow.

A TL carrier's objective is to plan shipments that generate high income while reducing the amount of idle and empty journey time for vehicles. Because these markets often have the highest pricing, it is ideal to build routes that pick up goods from locations where outbound demand exceeds incoming supply [7]. Since TL is often more cost-effective for bigger shipments, LTL operations are priced to promote shipments in tiny amounts, typically less than half a TL. LTL is ideal for shipments that weigh more than 150 lbs. but less than half a TL yet are too big to send as small parcels. Hub-and-spoke networks that enable the consolidation of partial loads are often operated by LTL operators on a regional or national scale. Since additional loads need to be picked up and delivered, LTL shipments take longer than TL shipments. The U.S. Department of Transportation releases hours-of-service rules that set time limits for truck drivers to work in order to decrease traffic accidents brought on by driver weariness. The number of hours spent behind the wheel correlates with an increase in fatigue-related accidents as does the distance travelled. These guidelines must be taken into consideration when TL and LTL carriers are designing their routes.

**Rail**

Rail transported around 3% of U.S. goods by value, 10% by weight, and more than 30% of all ton-miles in 2002. These numbers demonstrate the extensive usage of rail in the transportation of goods. Rail carriers pay a significant fixed fee for the use of the yards, vehicles, locomotives, and tracks. Although fuel prices do vary significantly with the number of automobiles, a considerable portion of trip-related labor and expenditures are depending on the distance and time needed to go. Once a train is running, any downtime is costly because even when a train is not moving, labor and fuel expenses are still spent. When trains switch cars to reach various destinations, idle time occurs. Additionally, clogged tracks contribute to it. More than 60% of railway expenses are made up of labor and fuel. The efficient use of locomotives and workers is crucial for railways from an operating standpoint. Rail is the best option for transporting bulky, heavy, or high-density goods across long distances because to its cost structure and capacity for enormous loads.

On the other hand, train travel might take a while. Therefore, rail is perfect for large, low-value cargo that don't need immediate delivery. For instance, a significant portion of each railroad's cargo is coal. Rarely do small, urgent, short-distance, or last-minute cargo travel by train. Maintaining optimal utilization of workers and locomotives is a top priority for railway companies. Railroads often have problems with personnel and truck scheduling, track and terminal delays, and poor on-time performance. The lengthy periods of time spent at each changeover have a negative impact on railway performance. Typically, only a tiny portion of a rail shipment's overall time is spent travelling. Because trains are often built these days rather than planned, delays are accentuated. In other words, a train starts moving once it has enough cars to do so [8]. A shipper's uncertainty about the delivery time is increased by the cars waiting for the train to form. Instead of constructing every train, a railroad may increase on-time performance by scheduling some of them. In this situation, it is necessary to implement revenue manage me as part of a more complex pricing plan for scheduled trains.

**Water**

Maersk, Evergreen Group, American President Lines, and Hanging Shipping Co. are significant international ocean carriers. By its very nature, water transport is restricted to a few locations. Within the Inland waterways, such as the Great Lakes and rivers, or coastal waters are used for water transportation in the United States. Large loads may be transported at a cheap cost via water transport. Water transportation is the least expensive method for transporting such cargoes inside the United States and is utilised largely for the moving of big

bulk commodities shipments. The ports and terminals experience severe delays since it is the slowest means of transportation. Although it is successfully utilised in Japan and certain regions of Europe for regular short-haul travels of a few miles, this makes water transport tough to run for trips that are just a few miles long. The Ocean Shipping Reform Act of 1998's enactment in the US has had a major impact on sea transportation. By allowing carriers and shippers to sign private contracts, this law essentially de-regulates the sector. The legislation will probably have a similar effect on the shipping business as the deregulation that took place in the aviation and trucking sectors more than 20 years ago.

Water transport is the most popular method for transporting all goods in international commerce [9]. Products like cars, food, clothing, and other things are delivered by water. More than $718 billion worth of goods were traded between seaports in the United States and abroad in 2001. In terms of weight, 78 percent of the foreign goods sent by the United States was transported by the sea in 2002. Water transport is by far the least expensive means of transportation for the amounts carried and the distances involved in international commerce. The increased usage of containers in marine commerce has been a major global trend. As a result, there is now a need for bigger, quicker, and more specialized boats in order to boost the profitability of container shipping. The management of old containers and delays at ports, customs, and security are significant problems in international shipping. In the United States, port congestion in particular has been a major issue.

**Pipeline**

The main commodities that are transported by pipelines are natural gas, refined petroleum products, and crude oil. About 16 percent of all ton-miles in the US were transported through pipeline in 2002. Setting up the pipeline and associated infrastructure entails a considerable upfront fixed cost that does not considerably change depending on the pipeline's diameter. Usually, pipeline operations are most efficient between 80 and 90 percent of their maximum capacity. Given the expenditures involved, pipelines work best when there is a need for steady, massive flows. The use of a pipeline to transport crude oil to a port or refinery may be efficient. Sending petrol to a petrol station is best accomplished with a truck and does not warrant investing in a pipeline. Typically, pipeline pricing consists of two parts: a set price based on the shipper's peak consumption and a second payment based on the actual amount delivered. With various modes often utilised to offset variations, this price structure encourages the shipper to use the pipeline for the predictable component of demand.

**Intermodal**

The employment of more than one method of transportation to convey a cargo to its destination is known as intermodal transportation. There are several intermodal combinations that may be used, with truck/rail being the most popular. With the expansion of global commerce and the expanded usage of shipping containers, intermodal traffic has surged significantly. Containers make intermodal transportation easier since they are simple to switch from one method to another. Truck, sea, and rail combinations are often used for containerized freight, especially for international shipping. Intermodal is sometimes the sole choice for international commerce since companies and markets may not be close to ports. Truck, boat, and rail intermodal combinations have expanded along with the amount of cargo delivered in containers. Intermodal activity accounted for more than 20% of train revenues by 2001.

On land, the rail/truck intermodal system has the advantages of cheaper costs than TL and faster delivery times than rail, combining diverse means of transportation to give a price/service that is unmatched by any one method. Additionally, it makes dealing with just one organization that represents all carriers that together supply the intermodal service convenient for shippers. The sharing of information to enable cargo transfers between various

modes is a key problem in the intermodal sector since these transfers often create significant delays that negatively affect the performance of delivery times.

**Transportation Systems and Practices**

Some of the main infrastructure components that exist along the nodes and linkages of a transportation network are roads, seaports, airports, rail, and canals. In practically every nation, the government has either assumed complete responsibility for or contributed significantly to the development and management of key infrastructure components. The development of transit and the ensuing expansion of commerce have been significantly influenced by improved infrastructure. It is generally known how important railways and canals were to the economic growth of the US. Improved port, aviation, and road infrastructure has lately had a highly noticeable influence on China's growth. It is worthwhile to look into the history of rail and road infrastructure in the United States to identify some of the challenges involved before discussing policy considerations relating to transport infrastructures.

We summaries part of Ellison's analysis on the development of railways and industry regulation. In the 1850s, the building of railways accelerated in the United States. Although the railways were established with substantial government assistance, sometimes in the form of land grants, they were privately owned. The majority of the United States was linked by the railway network by the 1870s. Every railway served as the only source of transportation across its track. Because of their monopoly, railways were able to set their own prices and standards for customer service. Initial new railway building resulted in some rate rivalry. In response, the railway firms made agreements with one another that essentially abolished competition and increased tariffs. Farmers and other railway customers' protests finally resulted in the creation of the Interstate Commerce Commission (ICC), which forbade discriminatory pricing. Railroads have to submit their rates to the ICC in order for them to be made public. In order to control supplies, the railroads formed cartels in response.

The Sherman Antitrust Act was eventually passed as a result in 1890. In response to the railroads' financial problems in the 1940s, the government permitted limited cooperation among them and exempted them from antitrust laws. The railways were in poor financial condition in the early 1970s due to the development of other routes of transportation and the need to revitalize their assets. The railways were deregulated by the Staggers Rail Act of 1980, which also facilitated entrance and exit and gave them considerable rate-setting authority. The measure also ended the railways' antitrust protection. Following deregulation in the US, the railway sector saw a wave of reorganizations and mergers. Overall, deregulation has improved the railway industry's financial performance and boosted shippers' use of rail. An outstanding analysis of the development of road building and costing is given by Levinson.

In Virginia, Maryland, and Pennsylvania, turnpikes were constructed in the late 1700s using public money, but they were later handed over to private businesses that took tolls. Due to communities' competitiveness for commerce throughout time, further turnpikes were constructed. These roads were mostly constructed using local resources, excluding government land grants. These turnpikes' toll structures were often designed to maintain free local travel while making out-of-area travelers pay for this privilege. Turnpikes endured financial hardship in the middle of the 1800s due to the development of railways and canals, and they finally became public highways. As the ways of travel evolved in the 20th century, better roads were necessary. The construction of a network of toll-free national roads was financed mostly by fuel taxes. Other infrastructure, such tunnels and bridges, were often built concurrently and as toll facilities. Many other nations, like France and Spain, gave privileges

to for-profit businesses that collected toll money. Private toll roads have also been constructed more recently in Malaysia, Indonesia, and Thailand [10].

**Transportation Network Design**

The framework within which operational transportation choices like scheduling and routing are made is established by the architecture of a transportation network, which has an impact on how well a supply chain performs. A supply chain may achieve the appropriate level of responsiveness at a cheap cost with the help of a well-designed transportation network. When planning a transportation network between two supply chain stages, the following three fundamental inquiries must be taken into account:

1. Should there be direct or intermediary sites for transportation?
2. Should the intermediate location store goods or only act as a cross-docking point?
3. Should each delivery route milk run serve more than one location or only one?

**Network of Direct Shipments to a Single Destination**

The buyer designs the transportation network in the direct shipment network to a single destination choice so that all shipments go directly from each supplier to each buyer location. With a direct shipment network, the supply chain management just has to choose the amount to send and the method of transportation since the routing of each shipment is predetermined. As will be covered later in the chapter, this choice includes a trade-off between transportation and inventory expenses. The absence of intermediary warehouses and the direct shipment transportation network's ease of operation and coordination are its main benefits. The choice about one cargo has no bearing on others since it is entirely local.

Because each cargo travels directly, the transit period from the supplier to the customer location is minimal. Only when demand at buyer locations is high enough that ideal replenishment lot sizes are close to a truckload from each supplier to each site, is a direct shipping network to a single destination justifiable. Given that the majority of the locations it established up until about 2002 were huge stores, Home Depot began with a direct distribution network. The shops placed orders in sufficient numbers for local management of ordering inside the store and for direct delivery from the supplier to the retailer. However, when Home Depot proceeded to construct smaller shops, which did not have big enough orders to support a direct shipping, the direct distribution network to one destination proved to be troublesome.

**Shipping Directly with Milk Runs**

A milk run is a path used by a truck to transport goods from one supplier too many retailers or from several suppliers to one buyer location. In direct shipping with milk runs, a supplier makes direct truck deliveries to several buyer locations or a vehicle picks up supplies from various suppliers that are going to the same buyer site. A supply chain manager must choose the route for each milk run while utilizing this option. While milk runs minimize transportation costs by combining supplies to many sites on a single truck, direct delivery has the advantage of avoiding intermediary facilities. When the amount going to one place is insufficient to fill a truck but many locations are near enough to one another, the truck may be filled by the combined quantity, milk runs make sense.

Milk runs are used by businesses like Frito-Lay that make direct retail deliveries to save their transportation costs. The utilization of milk runs may greatly save transportation costs if many small deliveries are required on a regular basis and either a set of suppliers or a set of merchants are nearby. For instance, Toyota supports its just-in-time production system in both Japan and the US with milk runs from suppliers. Toyota employs milk runs from a single supplier to several locations in Japan since the company has numerous assembly

facilities there that are near to one another. However, considering the considerable distance between assembly facilities, Toyota employs milk runs from several suppliers to each assembly facility in the United States.

**All Shipments Via Intermediate Storage Facility**

According to this choice, goods is transported from suppliers to a central distribution hub where it is held until it is required by customers, at which point it is transported to each customer's location. If transportation economics demand big shipments on the incoming side or shipments on the outward side cannot be coordinated, product storage at an intermediate point is warranted. In this scenario, a big quantity of product is sent to a distribution center, where it is kept in inventory and transferred to buyer locations in smaller replenishment lots as required. Because each supplier sends a sizable cargo to the DC containing merchandise for every location the DC serves, the existence of a DC enables a supply chain to realize economies of scale for inbound transportation to a site near to the ultimate destination. DCs provide service to local regions, therefore the cost of outgoing transit is not excessive. For instance, W.W. Grainger requests that its suppliers transport goods to one of nine distribution centers usually in large numbers, and then each DC replenishes shops nearby with the lesser quantities required.

## CONCLUSION

Between suppliers, manufacturers, distributors, and consumers, transportation is a vital component in the supply chain management process. Organizations must manage transport effectively if they want to save costs, shorten lead times, and improve customer satisfaction. Organizations may optimize their supply chain operations by selecting the right forms of transportation, optimizing routes, and managing carriers well. Utilizing technology and data analytics is another aspect of transportation management that helps with visibility, tracking shipments, and decision-making. Organizations can quickly adapt to market needs, reduce transportation costs, and improve operational efficiency via smart transportation management.

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# CHAPTER 8

# RISK MANAGEMENT IN TRANSPORTATION: EFFICIENT SUPPLY CHAIN OPERATIONS

Dr. Varsha Pratibha, Associate Professor
Masters In Business Administration, Presidency University, Bangalore, India
Email Id: varsha.ps@presidencyuniversity.in

**ABSTRACT:**

Within the supply chain, information technology is essential for risk management and transportation. This chapter examines the value of IT in transport operations and how it helps to reduce risks related to such operations. It goes through how real-time visibility and control over transportation operations are provided by IT solutions like transportation management systems, allowing businesses to plan better routes, monitor shipments, and increase operational effectiveness. The chapter also emphasizes how predictive modelling and data analytics are used in risk management to help organizations detect and reduce possible risks including delays, interruptions, and security breaches.

**KEYWORDS:**

Customer Service, Information Technology, Management Transportation, Project Management, Risk Communication.

## INTRODUCTION

The usage of IT systems is ideal in the transportation sector of the supply chain due to its complexity and size. The most prevalent IT use in transport has been the use of software to plan routes. Customers' locations, the amount of the package, the preferred delivery window, details about the transportation infrastructure such as the separation between points, and vehicle capacity are all inputs for this programmer. These inputs are used to create an optimization problem, the result of which is a set of truck packing lists and routings that minimize costs while still achieving delivery requirements. Vehicle load optimization software aids in increasing fleet utilization along with routing. This programmer creates a strategy to effectively pack the truck while allowing for the maximum ease of unloading and/or loading along the route by taking the size of the container, as well as the size and sequence of each delivery, into consideration. The routing impacts what is packed on a truck, while the packing clearly influences the routing, thus it is crucial that the packing and routing software be in sync.

IT is also used when using global positioning systems to monitor the real-time location of cars and send out electronic arrival notifications. The availability of up-to-date information also enables real-time dynamic optimization of delivery routes. Throughout the supply chain, electronic alerts and tracking enhance customer service and readiness [1], [2]. Companies like Freight zone and Echo Global Logistics have also utilised the Internet to assist connect shipper loads with carriers in the trucking business that have capacity. The most frequent issues with IT usage in the transport industry have to do with cross-enterprise cooperation and the constrained perspective that certain transport software adopts. Given that transportation is often outsourced, effective collaboration in this industry necessitates the cooperation of three or more businesses, which makes it much more challenging. Due to the transportation software's heavy emphasis on effective routing, other issues surface. The programmer often ignores other elements that ought to limit the route chosen, such as customer service and guaranteed delivery timeframes. The supply chain software industry has

the most suppliers and the longest history of use of IT in transportation. Additionally, there has been a significant amount of internal development with a transportation management emphasis.

**Transportation Risk Management**

When sending a cargo between two nodes on the network, there are three primary categories of risk to take into account:

1. The potential for a delayed delivery.
2. The chance that the cargo will not arrive at its destination because external factors have interrupted intermediary nodes or linkages.
3. Hazardous materials risk.

It's critical to recognize the risks' causes and effects in each situation and to develop effective mitigation plans. Congestion on routes like highways or at nodes like ports and airports may create delays. Moving inventory closer to the destination, utilizing other channels, and adding a buffer to the lead time are mitigation techniques for the shipper when congestion is the reason for the delay. By planning a network with numerous paths to the destination and altering routes in real time depending on congestion, congestion delays may be reduced. The owner of the transport node or connection may also utilize congestion pricing to reduce delays caused by traffic jams. The restricted capacity of the transportation system or other infrastructure may also create delays. These delays are more likely to occur when a third party with many clients owns the assets. By owning some transportation capacity or by entering into long-term contracts for transportation capacity with the third party, these delays may be reduced.

It is desirable to do this for areas of the network where utilization is high, given the high cost of holding these assets. There may be disruption at transport nodes or linkages as a result of terrorism or other man-made or natural disasters, such as hurricanes. In this situation, including alternate routings into the transportation network is the greatest mitigating tactic. For instance, the 2011 Japanese earthquake and tsunami affected numerous supply networks' product flow. Due to the earthquake, Toyota postponed the release of a wagon and a minivan, two new Prius models. If there were other factories, they could relocate manufacturing to, businesses like UPS and FedEx assisted customers in designing other routes. Similarly, several businesses made plans for other ports to import goods during the 2002 California dockworkers' strike. Finding sources that are likely to be associated throughout the network is crucial when taking delay and interruption risk into account [3].

As an example, the events of September 11, 2001, disrupted air travel across the whole United States. Since there was no viable other route, alternative routings were worthless as mitigation techniques in this situation. The only solution for such connected sources of risk is to lessen the likelihood of a disruption. When exposed, hazardous material may be damaging to both humans and the environment. Here, risk reduction aims to reduce exposure likelihood and, should exposure occur, to lessen its effects. Utilizing modified containers and low-risk modes of transportation, choosing routes with a low accident probability or with less exposure to the general public and the environment, and altering the physical or chemical properties of the material being transported to make it less hazardous are all examples of mitigation strategies.

## DISCUSSION

To minimize, monitor, and control the probability or impact of unfortunate events or to maximize the realization of opportunities, risk management entails the identification, evaluation, and prioritization of risks defined in ISO 31000 as the effect of uncertainty on objectives. Instability in global markets, threats from project failures at any stage of design,

development, production, or maintenance of life cycles, legal liabilities, credit risk, accidents, natural causes and disasters, deliberate attack from an adversary, or events with uncertain or unpredictable root causes are just a few examples of the many different types of risks that can arise. There are two different kinds of occurrences the former is categorized as dangers and the latter as opportunities. Several organizations, including the Project Management Institute, the National Institute of Standards and Technology, actuarial societies, and ISO standards quality management standards to assist operate more effectively and decrease product failures have produced risk management standards [4]. Depending on whether the risk management approach is used in the context of project management, security, engineering, industrial processes, financial portfolios, actuarial evaluations, or public health and safety, methods, definitions, and objectives differ greatly.

Some risk management guidelines have come under fire for failing to significantly reduce risk while boosting confidence in predictions and judgments. Avoiding the threat, reducing its negative impact or probability, transferring all or part of the threat to another party, and even holding onto some or all of the potential or actual consequences of a specific threat are common methods for managing threats uncertainties with negative consequences. To take advantage of possibilities beneficial future situations with uncertainty, the reverse of these tactics might be applied. A risk manager's job description states that they must oversee the organization's comprehensive insurance and risk management programmer, assessing and identifying risks that could impede the organization's reputation, safety, security, or financial success, and then create strategies to lessen and/or mitigate any unfavorable financial outcomes. When risk data has been gathered and assessed, risk analysts assist the technical side of the organization's risk management strategy by sharing their findings with their managers, who then utilize those insights to choose amongst potential solutions.

Internal audit, financial risk management, and corporate finance are other terms to consider. Since the 1920s, risk management has been discussed in scientific and management literature. In the 1950s, when publications with risk management in the title also showed up in library searches, it was recognized as a formal discipline. Initially, finance and insurance accounted for the majority of research. The ISO Guide 73:2009, Risk management. Vocabulary, defines a commonly used language for risk management. In an ideal risk management strategy, the risks that have the highest loss or effect and the highest likelihood of happening are managed first. Risks that have a lesser chance of happening and a smaller financial impact are addressed last. It may be challenging to estimate total risk in practice, and it's common to manage hazards with high loss but low chance of occurrence incorrectly when balancing resources spent to minimize them with risks with high probability of occurrence but lower loss.

A new form of risk that has a 100% chance of happening but is neglected by the organization owing to a lack of identification skills is discovered via intangible risk management. For instance, a knowledge risk manifests when inadequate information is applied to a scenario. When there is poor cooperation, there is relationship risk. When poor operational processes are used, process-engagement risk might become a problem. These dangers adversely affect knowledge workers' productivity, cost-effectiveness, profitability, service, and quality as well as reputation, brand value, and earnings quality. By identifying and mitigating risks that have a negative impact on production, intangible risk management enables risk management to provide immediate benefit. For risk managers, opportunity cost poses a particularly difficult problem. It may be challenging to decide whether to devote resources to risk management and when to employ them in other ways.

Once again, effective risk management reduces both expenditures or personnel or other resources and the adverse impacts of hazards. Risk is defined as the likelihood that something will happen that will have a negative impact on achieving a goal. So uncertainty is a crucial

component of risk. Managers may get help lowering risk factors through programmers like COSO ERM Committee of Sponsoring Organizations of the Tread way Commission Enterprise Risk Management. Internal control mechanisms vary from organization to company, which has an impact on the results. For instance, the internal environment, objective setting, event identification, risk assessment, risk response, control activities, information and communication, and monitoring are included in the framework for ERM components [5], [6].

**Opportunities Vs. Risks**

In the 1990s, opportunities first emerge in management textbooks or scholarly research. Opportunities are not included at all in the 1987 draught of the Project Management Body of Knowledge. The significance of opportunities is recognized by contemporary project management schools. Opportunities have been discussed in project management literature since the 1990s, such as in the Polk, and they started to play a big role in project risk management in the 2000s, when chapters with the term opportunity management also started to show up in library searches. As a result, opportunity management became crucial to risk management. The notion of modern risk management covers both positive and negative external occurrences. Opportunities are risks that are favorable. Similar to hazards, opportunities may be mitigated in several ways: by being used, shared, enhanced, or ignored.

**Making Transport Decisions in Practice**

Align the transport plan with the business plan. The transportation plan of a company should complement its competitive strategy, according to managers. They ought to provide practical incentives that further this objective. Historically, the ability of a company's transportation department to reduce transportation expenses has been used to measure its effectiveness. Such a concentration results in choices that save transportation costs but compromise client responsiveness and may increase the firm's overall cost. The dispatcher at a DC is likely to delay shipments and reduce customer response in order to attain a bigger load if their performance is judged purely by the degree to which trucks are loaded. Based on the function's overall cost and quality of client response, businesses should assess transport services. Take into account both internal and external transportation.

To satisfy their demands, managers should take into account a suitable mix of company-owned and contracted transportation. Based on a business's capacity to manage transportation economically and the strategic significance of transportation to the success of the firm, this choice should be made. In general, outsourcing is a better choice for modest shipment volumes, but owning the transportation fleet is a better choice for big cargo sizes and critical responsiveness. Wal-Mart, for instance, employs responsive transportation to lower the amount of inventory in its supply chain. It owns and operates its own fleet of vehicles because it understands how crucial mobility is to the success of its plan. Because the majority of its shipments are substantial, it is able to make excellent use of its transportation assets, which makes this simpler. Smaller shipments are sent to clients by businesses like W.W. Grainger and McMaster-Carr, whose prosperity is based more on inventory management than on transportation. Their expenses may be reduced by a third-party carrier by grouping their shipments with those of other businesses. Therefore, both businesses rely on third-party carriers for transportation.

Use technology to enhance the efficiency of transportation. Information technology must be used by managers to reduce costs and boost responsiveness in their transportation networks. Software aids managers in mode selection, delivery route planning, and transportation planning. Carriers can speak with each vehicle and learn its specific position and contents thanks to real-time tracking. Carriers may reduce expenses and adapt costs by using these technologies. Include adaptability in the transportation network's design. Managers should

consider the availability of transport as well as demand unpredictability when building transport networks. Ignoring uncertainty fosters the usage of cheap, rigid transportation methods that function effectively when everything goes according to plan [7]. However, these networks struggle when plans are altered. Managers are more inclined to integrate flexible, albeit more costly, means of transport into their network when they take unpredictability into consideration. Despite the fact that these modes may cost more for a specific shipment, adding them in the transportation choices enables a company to lower the total cost of offering a high degree of responsiveness.

**Learning Objectives**

Recognize how transportation fits within a supply chain. Transportation is the transportation of goods through a supply chain from one site to another. With the expansion of internet sales and supply chain globalization, which both lengthen the distance that goods must travel, the necessity of transportation has increased. Inventory and facility choices within a supply chain are influenced by transportation considerations, which can have an effect on supply chain profitability. Assess the benefits and drawbacks of various types of transportation. The many forms of transportation include pipeline, truck, air, train, intermodal, water, and package carriers. The slowest and often least costly transport is water, as opposed to air and the quickest and most costly are package carriers. For huge, low-value cargo that do not need to be carried quickly, rail and water are the best options.

The greatest options for tiny, high-value, emergency shipments are air and package carriers. Rail and water are slower than intermodal and TL carriers, but they are also somewhat more costly. Small shipments that are too big for package carriers but considerably less than a TL are best served by LTL carriers. Talk about the function of transportation policy and infrastructure. Transportation is significantly impacted by infrastructure including ports, highways, and airports. The majority of transport infrastructure needs public ownership or oversight due to its inherently monopolistic character. Pricing based on average cost in the event of public ownership results in overuse and congestion. It is crucial to implement some kind of congestion pricing so that users are compelled to absorb the rise in network costs they contribute to.

List the relative advantages and disadvantages of several choices for designing the transportation network. Networks are made to either transfer the product via a consolidation point or straight from point of origin to point of destination. When moving huge amounts, direct shipments are the most efficient option. Even though it takes longer and is more complicated, using an intermediate warehouse or DC when shipments are modest reduces transportation costs by combining smaller shipments. Milk runs that pick up from many sites or drop off at multiple places might likewise combine shipments. List the compromises that shippers must make when planning a transportation network. Shippers must weigh the trade-offs between transportation costs, inventory costs, operational costs, and customer responsiveness while constructing transportation networks. The supply chain's objective is to reduce overall costs while maintaining the appropriate degree of customer response.

**Therapies that might Reduce Risk**

All risk management strategies fit into one or more of these four broad categories after hazards have been recognized and evaluated:

1. Avoiding eliminating, withdrawing from, or avoiding involvement.
2. Reduce improve mitigate.
3. Transferring, outsourcing, or insuring.
4. Budget acceptance and retention.

It may not be feasible to utilize these risk control measures in the best way. Some of these could entail compromises that the company or individual making the risk management choices finds unacceptable. Defense Acquisition University, a different source from the US Department of Defense, refers to these categories as ACAT, which stands for Avoid, Control, Accept, or Transfer. Similar to another ACAT for Acquisition Category used in US Defense sector procurements, where Risk Management plays a significant role in decision-making and planning, this usage of the acronym is reminiscent of earlier uses of the abbreviation. Similar to hazards, opportunities may be mitigated in several ways: by being used, shared, enhanced, or ignored [8].

**Risk Reduction**

This involves refraining from engaging in risky activities. One such instance is refusing to buy a home or company in order to avoid legal responsibility. Avoiding aviation travel because of concern about hijacking. Although avoiding risks could seem like the best course of action, doing so also results in forfeiting any possible gains that accepting (retaining) the risk would have provided. Avoiding a company to reduce the danger of loss also eliminates the opportunity to make money. Hospitals now treat patients with lesser risks rather than those who arrive with greater risks due to increased risk control.

**Risk Mitigation**

Reducing the severity of the loss or the possibility of the loss happening is referred to as risk reduction or optimization. For instance, sprinklers are made to put out a fire in order to lower the danger of fire-related damage. This approach may not be appropriate since it could result in a bigger loss from water damage. Halona fire suppression systems might reduce that danger, but they could be too expensive. Taking into account the fact that risks may be either positive or negative, optimizing risks entails striking a balance between a negative risk and the advantages of the operation or activity, as well as between risk reduction and the amount of work put forth. Organizations may attain acceptable levels of residual risk by properly implementing Health, Safety and Environment HSE management requirements. Through incremental software development and delivery, modern software development approaches lower risk. Early approaches suffered from the fact that they only produced software at the last stage of development; any issues found during earlier stages required expensive rework and often put the project as a whole in danger.

Software projects may keep lost effort to a single iteration by developing in iterations. If the outsourcer can show greater capacity in managing or lowering risks, outsourcing may be an example of a risk-sharing plan. For instance, a firm could run its own operations while contracting out solely its software development, hard product manufacturing, or customer service requirements to another organization. With less concern about managing the development team, the production process, or locating a physical place for a center, the corporation can focus more on business growth. A further method for lowering risk is the implantation of controls. Controls that either identify the core causes of undesired failures so that the team can prevent them or that identify the causes of unwanted occurrences before the consequences of using the product arise. Controls could concentrate on how decisions are made or managed. All of these might facilitate improved risk-related decision-making.

**Sharing of Risk**

To put it simply, it is sharing with another party the burden of loss or the benefit of gain, from a risk, and the measures to reduce a risk. In the false notion that you may transfer a risk to a third party via insurance or outsourcing, the phrase risk transfer is often used in lieu of risk-sharing. In reality, the initial risk will still most likely return to the first party if the insurance company or contractor file for bankruptcy or lose in court. As a result, both

practitioners and academics often refer to the acquisition of an insurance policy as a transfer of risk. Although legally speaking the transferred losses remain the buyer of the contract's legal duty, it is more correct to refer to insurance as a post-event compensation mechanism. For instance, a personal injury insurance coverage does not expose the insurance provider to the risk of an automobile accident. The policyholder, or the individual who has been in the accident, is still at risk. The insurance policy only states that in the case of an accident the event involving the policyholder, the policyholder may be entitled to compensation commensurate with the suffering or damage. Numerous categories exist for risk management techniques. Technically, risk-retention pools hold the risk for the group, but dispersing it throughout the whole group implies transfers among the group's individual members. This is distinct from typical insurance in that losses are distributed equally among all group members rather than a premium being transferred upfront between group members.

**Retention of Risk**

When an occurrence happens, risk retention entails accepting the loss or gain resulting from the risk. Authentic self-insurance comes under this heading. For tiny risks where the cost of insurance would outweigh the overall losses incurred over time, risk retention is a practical option. By default, any risks that are not mitigated or transferred are kept. This covers hazards that are so significant or catastrophic that they cannot be covered by insurance or whose premiums are unaffordable [9]. War is an example since most assets and risks are not covered by war insurance, thus the insured is responsible for paying any losses that are related to war. Additionally, any prospective losses risk in excess of the insured amount are considered retained risk. This could also be appropriate if there is little likelihood of a very substantial loss or if paying more to insure would significantly impede the organization's ability to achieve its objectives.

**Communicating Risks**

An extract from Risk communication may be found here. Risk management includes risk communication as a multidisciplinary academic discipline that is connected to other disciplines like crisis communication. By appealing to their values, it is hoped that the targeted audiences would comprehend how dangers affect them or their communities. In preparation for large global catastrophic risk, public health, and disaster preparedness, risk communication is crucial. As an example, as the effects of climate change and climate risk affect all aspect of society, conveying those risks is crucial for societies' ability to prepare for climate adaptation. Similar to other types of prevention, recognizing risk enables communities to better respond to emergencies and limit the spread of illness.

Possible hazards are discussed in risk communication, which tries to increase public knowledge of them in order to promote or induce behavioral adjustments that will reduce threats over time. Crisis communication, on the other hand, aims to increase public knowledge of a particular sort of danger, its scale, effects, and specific behaviors that might be used to lessen the threat. In terms of food safety, the risk analysis framework includes risk communication. Risk management, risk assessment, and risk communication all work together to lower the number of foodborne infections. For food safety agencies in nations that have ratified the Agreement on the Application of Sanitary and Phytosanitary Measures, communicating food safety risk is a required task. On a local basis, risk communication also takes place. For instance, the individual and their family must be informed of the dangers involved with personal medical choices [10].

## CONCLUSION

Within the supply chain, information technology is crucial for managing hazards and facilitating transportation, allowing businesses to maximize efficiency and reduce risks.

Organizations may obtain real-time insight and control over transportation operations by using IT solutions like transportation management systems TMS, which improves productivity, lowers costs, and improves customer service. Organizations may detect and mitigate possible risks proactively via the use of data analytics and predictive modelling in risk management, minimizing interruptions, delays, and security breaches.Additionally, IT enables better communication and coordination among supply chain participants, facilitating seamless cooperation. To secure data integrity, safeguard private information, and keep their transportation networks resilient, organizations must priorities spending on a solid IT infrastructure and cybersecurity measures.

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# CHAPTER 9

# AN INTRODUCTION TO SOURCING DECISIONS IN A SUPPLY CHAIN

Dr. Vinay Muddu, Professor
Masters In Business Administration, Presidency University, Bangalore, India
Email Id: muddu.vinay@presidencyuniversity.in

**ABSTRACT:**

Critical factors that affect operational effectiveness, cost-effectiveness, and overall supply chain performance include sourcing choices. The relevance of sourcing choices and their effects on different supply chain components are the main topics of this chapter. It examines the important factors that go into sourcing choices, such as contract negotiations, supplier appraisal, and supplier selection. The chapter examines the trade-offs that must be made when choosing a supplier, including those between cost, quality, dependability, and sustainability. Additionally, it emphasizes how strategic sourcing techniques, such supplier engagement and long-term relationships, may improve sourcing results.

**KEYWORDS:**

Bright Star, Chain Surplus, Economies Scale, Supply Chain, Third Party.

## INTRODUCTION

The process through which businesses get raw materials, components, goods, services, or other resources from suppliers to carry out their activities is known as purchasing, sometimes known as procurement. The whole range of business procedures needed to make purchases of products and services is known as sourcing. The most important choice for each supply chain function is whether to outsource it or carry it out internally. When the supply chain function is outsourced, a third party completes the task. One of the most significant concerns a company must deal with is outsourcing, and responses vary across sectors. For instance, the MRO distributor W.W. Grainger has always owned and operated its distribution facilities. On the other hand, delivery of items from distribution centers to clients has always been contracted out to a third party. Grainger is switching from an all-outsourcing to a third-party approach for less-than-truckload outbound transportation to a hybrid one where Grainger owns certain vehicles.

Dell was credited with increasing earnings up to 2005 by keeping the retail operation in-house and doing direct sales to clients. However, Dell has begun to contract out retailing to companies like Wal-Mart since 2007. Additionally, Dell has raised the percentage of assembly that it contracts out to other parties. Why, up until about 2005, did Dell think vertical integration into retailing was a smart idea, but not after 2007? Was Dell correct to outsource manufacturers for a larger portion of assembly? Apple, as opposed to Dell, has greatly increased the insourcing of retailing over the same time period by expanding Apple retail shops. Nobody is urging Procter & Gamble to take the retail operation in-house, and the company has never tried to sell detergent to consumers directly [1], [2]. What made Dell's decision to integrate vertically into retailing a good one but not a good one for P&G?

In the majority of Latin America, Motorola sells its mobile phones via a distributor. In contrast, the majority of its sales in the US don't involve distributors. Why does Motorola's distribution outsourcing work well for Latin America but not for the US? Before we continue, it's crucial to understand the differences between offshore and outsourcing. If a company relocates the manufacturing site overseas even if it retains ownership, it offshores a supply

chain function. In contrast, a company outsources if it employs an outside company to carry out a task instead of doing it in-house. The choice to offshore has been thoroughly. Instead, then offshore, outsourcing is the topic of discussion in this chapter. We discuss a company's outsourcing of supply chain operations based on the following three inquiries:

1. In comparison to carrying out the operation internally, would using a third party raise supply chain surplus?
2. How much of the excess growth does the company get to keep?
3. How much do risks increase with outsourcing?

Recall that the supply chain surplus is the difference between a product's value to the consumer and the entire cost of all supply chain operations necessary to deliver the product to the consumer. The entire amount of the pie that each supply chain participant including the customer gets to keep is known as the supply chain surplus. Our fundamental tenet is that outsourcing makes sense if it generates supply chain surplus while minimizing risks presuming, we get to retain part of the gain. We even go so far as to assert that a supply chain participant can only remain viable over time if their participation raises the supply chain surplus. Then, one may argue that each party's profit in a supply chain is tied to how much it raises the excess. Following a decision to outsource, the sourcing process includes the choice of suppliers, creation of supplier contracts, and cooperation on product design, acquisition of materials or services, and assessment of supplier performance. The method used to evaluate supplier performance is known as supplier score and evaluation.

Based on their effect on the supply chain excess and overall cost, suppliers should be contrasted. Unfortunately, sourcing choices are sometimes made exclusively on the basis of a supplier's pricing. The overall cost of doing business with a supplier is influenced by a wide range of other supplier qualities, including lead time, dependability, quality, and design competence. A robust supplier scoring and evaluation procedure must be able to recognize and monitor performance along all dimensions and measure the effects on overall supplier costs. To choose the best supplier, supplier selection leverages the results of supplier score and evaluation. The supplier is then approached to discuss a supply agreement. A good contract should take into consideration every element that influences the performance of the supply chain and be built to maximize profits in a manner that is advantageous to both the supplier and the customer. It is critical that suppliers take an active role at this stage since design determines around 80% of a product's cost.

Collaboration in design enables the producer and the supplier to create components for the final product together. Collaboration in design also makes guarantee that all parties engaged in the products creation and production are properly informed of any design modifications. Procurement is the procedure through which the supplier provides the goods in response to orders made by the buyer once the product has been developed.

The purpose of procurement is to make it feasible for orders to be made and delivered promptly at the most affordable total cost. In order to find chances to reduce the overall cost, sourcing planning and analysis must also analyses expenditure across a range of suppliers and component categories [3]. For the majority of large firms, cost of goods sold accounts for far over 50% of sales. Purchased components today make up a significantly larger portion of COGS than they did a few decades ago. Companies have decreased vertical integration and outsourced the production of numerous components, which has led to this development. Businesses like Cisco have gone a step farther and outsourced a significant portion of the assembly capacity. Good sourcing selections will have a stronger influence on a firm's cost leadership and competitive advantage as demand to reduce costs increases and suppliers' proportion of COGS increases.

## DISCUSSION

Effective sourcing practices inside a company may boost overall supply chain surplus and the firm's revenues in a number of ways. When choosing a supplier, it's critical to precisely identify the factors that can increase earnings. The following are some advantages of making wise sourcing decisions:

1. Orders inside a company may be pooled to gain better economies of scale.
2. Procurement processes that are more effective may dramatically lower the total cost of buying. This is particularly significant for goods that see a high volume of low-value transactions.
3. Design cooperation may lead to goods that are less expensive to produce and market overall.
4. Good procurement practices may enable collaboration with the supplier and enhance forecasting and planning. This element is especially crucial for components that significantly contribute to product cost and value. Lower inventories and improved supply-demand matching result from improved coordination.
5. The pooling of risk via appropriate supplier contracts may lead to increased earnings for both the supplier and the customer.
6. By using auctions to boost competition, businesses may reduce the buying price.

It is crucial for a company to be clear about the variables that have the biggest effects on performance and to focus improvement efforts there. For instance, increasing the effectiveness of procurement transactions will be of low value if most of a company's expenditure is on materials and there are just a few high-value transactions. However, increasing design cooperation and supplier coordination would be of great benefit. On the other hand, improving the efficiency of procurement transactions would be beneficial when sourcing goods with lots of low-value transactions. We go through the variables that affect the choice to outsource in the next section.

### Internal or External Source

The choice to outsource is based on the expansion of the supply chain excess offered by the third party and the rise in risk associated with doing so. If a company's excess is growing significantly but the danger is just somewhat rising, they should think about outsourcing. If the growth in excess is little or the rise in risk is significant, it is better to handle the task internally.

### Third Parties Expand the Supply Chain Surplus

If third parties improve customer value or reduce supply chain costs in comparison to a company conducting the activity internally, the supply chain surplus increases. If third parties can successfully aggregate supply chain assets or flows to a greater extent than a business itself, they may raise the supply chain excess. We go through numerous methods third parties might use to increase the excess.

1. **Aggregation of Capacity:** By combining demand from several companies and achieving manufacturing efficiencies of scale that no one business can alone, a third party may raise the supply chain surplus. In a supply chain, this is the most typical justification for outsourcing manufacturing. The fact that Intel supplies several computer manufacturers and benefits from economies of scale that Dell would not have access to if it designed and produced its own processors is one of the reasons Dell and every other PC maker outsources the design and manufacturing of the CPUs in its PCs to Intel. When a company's demands are much smaller than the quantities necessary to achieve economies of scale, the rise in surplus from outsourcing is at its strongest. Magna Styr, a

third party that has taken over car assembly for multiple automakers, is a suitable example in this context [4].

Magna Styr has created flexible labor and capacity that enable it to inexpensively make automobiles that are sold in small quantities. It has created the Grand Cherokee for Chrysler, the G class for Mercedes, and the X3 for BMW. Every time, the models had a little amount of demand. There would not have been enough economies of scale for each company to assemble its model. Although the expense of this adaptability cannot be justified based on a single model, Magna Styr benefits from economies of scale by working with several vehicle manufacturers. If a firm's volume needs are substantial and consistent, a third party is unlikely to boost the excess via capacity aggregation. This is supported by the fact that no automaker contracts with a third party to produce its best-selling vehicles.

2. **Aggregation of Inventory:** By combining stocks from several different clients, a third party may raise the supply chain excess. MRO providers like W.W. Grainger and McMaster-Carr provide value by combining inventories for tens of thousands of clients. They may greatly reduce total uncertainty via aggregated data, which also enhances buying and transportation economies of scale. As a consequence, compared to what would be needed if each client elected to carry inventory independently, these MRO distributors carry substantially less safety and cycle inventory. Bright star, a distributor that enables deferral for mobile phones, is another example of inventory aggregation. The Bright star warehouse in Miami receives these phones after they are produced in the Far East and adds software and accessories when South American customers place their purchases. Bright star is able to expand the supply chain excess via inventory aggregation and postponement thanks to a wide range of products and a large number of small clients.

3. **Transportation Intermediates that Aggregate Transportation:** By consolidating the transportation function to a greater extent than any shipper can on their own, a third party may raise the surplus. Examples of transportation intermediates that boost supply chain excess by pooling transportation across a range of shippers include UPS, FedEx, and a number of LTL carriers. The inherent economies of scale in transportation are what drive the value offered in each situation. Each shipper wants to transmit less than the transportation medium can handle. The transportation middleman pools shipments from several shippers, bringing down the cost of each cargo below what the shipper could accomplish on their own.

   When shippers deliver packages or LTL volumes to clients that are spread out geographically, a transportation middleman raises the supply chain excess. A transportation intermediate may increase the excess for TL shipping by pooling the resources of many companies with imbalanced transportation flows, where the volume entering and leaving a location are considerably different from one another. For a corporation like Wal-Mart, when shipment volumes are high and the company also accomplishes aggregation among the several retail outlets that it controls, a transportation middleman is likely to contribute the least to the supply chain excess [5]. In such a situation, the only option for a transportation middleman would be to acquire superior backhauls than Wal-Mart.

4. **The Use of Storage Intermediates to Aggregate Transportation:** The supply chain excess may also be increased by a third party that keeps goods by combining incoming and outgoing transit. Storage middlemen like W.W. Grainger and McMaster-Carr sell to hundreds of thousands of consumers while keeping inventory from over a thousand different manufacturers. They may combine goods from many manufacturers into one

vehicle for incoming shipping. As a consequence, shipping costs are cheaper than what any producer could have obtained on their own. They combine shipments for customers at a single destination on the outgoing side, which results in a substantially cheaper transportation cost than can be obtained by each client alone. For instance, the Grainger distribution center in Chicago loads different trucks with parcels for each neigh boring state. As soon as a truck for instance, one going to Michigan is full, it is transported to the UPS sorting facility there. Customers cannot do this degree of aggregation on their own. As a result, Grainger and McMaster-Carr's storage of products boosts the supply chain excess by combining incoming and outgoing transit. In nations like India, distributors provide a comparable service. A distributor consolidates deliveries for numerous manufacturers due to the limited size of retail outlets, thus reducing the outbound transportation expense.

5. **Aggregation of Warehouses:** By combining the storage requirements of many clients, a third party may raise the supply chain excess. The increase in surplus is made possible by decreased warehouse processing expenses and real estate costs. If a supplier's storage requirements are minimal or change over time, warehouse aggregation might result in cost savings. In either scenario, the middleman with the warehouse may leverage many clients to aggregate and take advantage of economies of scale in warehouse building and operation. An example is the Indian third-party logistics company Safe press. Many of Safe press' clients employ the nationwide distribution of warehouses that the company operates. The majority of its clients don't need enough storage to warrant opening a warehouse of their own in every area. For small suppliers and businesses that are just getting started in a particular region, ware housing aggregation by an intermediary significantly increases the surplus [6], [7].

6. **Aggregation of Purchases:** If a third party consolidates purchasing for several small businesses and promotes economies of scale in ordering, manufacturing, and inbound transportation, the supply chain surplus will expand. The most efficient procurement aggregate involves several small buyers. One company that uses aggregate purchasing to provide small truck fleets with reduced costs for truck equipment and services is Fleet change. With a few major clients, procurement aggregation is unlikely to play a significant role. Contract manufacturers, for instance, in the large clients of the electronics sector, including HP and Motorola, have not been persuaded to outsource the procurement process.

   Both HP and Motorola are so big that minimal marginal gain from further aggregation may be anticipated, yet there is a possible drawback in that, if they outsourced procurement, they would relinquish the connection with the supplier to the contract manufacturer. However, the procurement aggregate provided by a contract manufacturer might dramatically increase the supply chain excess for a small electronics firm. Aggregation of information. By gathering data to a greater extent than a company conducting the service internally, a third party may boost the excess. Every shop compiles data about goods from many producers in one place. Customers will pay less for searches because to this information aggregation. One store that focuses exclusively on information aggregation is bags. Although bags have a small inventory, it serves as a hub for information about bags from various manufacturers.

7. **Online Consumer, Bags Greatly Lower Search Costs by Collecting Product Information:** If every manufacturer created their own website and online shop in comparison to bags, customers would pay more for searches and each manufacturer would have to invest in the information infrastructure. By lowering the cost of search and lowering investment in information technology, bags enhance the supply chain surplus via information aggregation. W.W. Grainger and McMaster-Carr are two further

businesses that use information aggregation. Both provide a comprehensive website and a product catalogue. This streamlines consumer search and gathers product data from over a thousand manufacturers.

8. **Aggregation of Receivables:** If a third party can aggregate the risk of the receivables to a larger degree than the company or if it has a lower cost of collection than the company, it may raise the supply chain surplus. With the exception of Brazil, Bright star is Motorola's distributor in the majority of Latin American nations. The regions modest, locally owned retail establishments sell cell phones. For a manufacturer, collecting receivables from every retail location is a costly endeavor. Given that a retailer purchases goods from several producers, each manufacturer's ability to collect is similarly diminished. As a distributor, Bright star can pool collections from all of the manufacturers it works with, which lowers the cost of collecting. Bright star also reduces the risk of default by pooling collection to a larger degree than any one manufacturer can. Bright star can boost the supply chain surplus in comparison to having manufacturers handle this task due to lower collection costs and risk. The same is true of distributors in India who often supply the same store on behalf of a big number of manufacturers.

9. **The Aggregation Of Relationships:** By reducing the number of connections between various buyers and sellers, an intermediary may raise the supply chain excess. Without a middleman, it takes a billion connections to match a thousand vendors with a million customers. The needed number of connections is reduced to little over a million in the presence of an intermediary. By aggregating relationships, most retailers and MRO distributors like W.W. Grainger enhance supply chain excess. By enlarging each transaction and reducing the overall number of transactions, relationship aggregation raises the supply chain surplus.

   When several consumers periodically buy modest quantities at a time, yet each order often contains items from many vendors, relationship aggregation is most successful. As a result, Grainger may expand the excess by acting as an aggregator of relationships for MRO items. However, a third party that aggregates links between a small number of buyers and sellers whose relationships are substantial and long-lasting does not raise the surplus. For instance, Cotising has not been able to establish relationships in the automobile sector, particularly for direct materials.

10. **Higher Standards And Lower Prices:** If a third party offers products or services at a cheaper cost or of greater quality than the company, the supply chain surplus may rise. These advantages are probably durable in the long run if they result from learning and specialization. Long-term advantage is likely to be maintained by a specialized third party that is farther down the learning curve for particular supply chain activity. However, it is often the case that the third party has access to a less expensive site than the company. Lower labor and overhead costs are only a temporary justification for outsourcing in this case; if the wage gap persists and the third party provides none of the other benefits mentioned earlier, it would be best for the company to retain ownership and offshore production to the low-cost location [8].

**Factors Affecting a Third Party's Surplus Growth**

Scale, unpredictability, and the distinctiveness of assets are three crucial variables that influence the rise in surplus that a third party delivers. If the scale is great, it is probable that the business itself will experience enough internal economies of scale. It is improbable that a third party could generate more scale efficiencies in this situation and raise the excess. Wal-Mart's transportation requirements are large enough for it to benefit from economies of scale while using only one truck. Going to a third party would decrease control and not result in an

increase in the surplus. In contrast, the third party may significantly enhance the surplus if a firm's demands do not allow for substantial economies of scale. Given their geographical dispersion, Grainger would not be able to obtain economies of scale for door-to-door delivery despite having a significant quantity of outgoing parcels. In this instance, a third-party package carrier increases the excess.

The unpredictability of a firm's demands is the second significant aspect. If the demands are predictable, the excess rise from a third party is constrained, particularly if the business has enough size [9]. In contrast, the third party may raise the surplus by aggregating with other customers if the firm's demands are very varied over time. For instance, Grainger's demands for warehouse space are predictable. When scale is large enough, it owns and runs its own distribution centers. In comparison, demand for MRO items is very ambiguous for the majority of businesses. They choose to employ Grainger as a middleman instead of keeping these things in stock. Finally, the specificity of the assets that the third party requires has an impact on the rise in excess. A third party is unlikely to raise the surplus if the assets needed are unique to a business and cannot be utilised for other purposes since all it does is transfer the assets from one firm to another. There is no way for the third party to combine data from different clients.

**Using a Third Party Can Be Risky**

When outsourcing any task to a third party, businesses must assess the following risks:

1. **The Method Is Flawed:** The largest issues occur when a company outsources supply chain operations simply because it no longer has control over the process. Remember that adding a third party to a dysfunctional supply chain process will only make it worse and more difficult to manage. Getting the process under control should come first, followed by a cost-benefit analysis, and only then should outsourcing be chosen.
2. **The expense of coordinating is understated:** Underestimating the work necessary to coordinate operations across many organizations doing supply chain duties is a typical error made while outsourcing. This is particularly true if a company intends to contract out certain supply chain duties to various outside parties. If the company sees being a coordinator as one of its fundamental assets, outsourcing tasks to several third parties is possible (and may be quite successful). Cisco is a prime instance of a capable coordinator. However, due to coordination issues, even Cisco had issues in the early 2000s and was left with a significant amount of excess inventory. In 2000, there were issues with collaboration between Nike and i2 Technologies. Nike put the responsibility for its $100 million loss on inventory management errors that it traced to i2's supply chain planning software; i2 put the blame on Nike's use of the product. Clearly, poor communication between the two businesses contributed to this disaster.
3. **Lessening of supplier/client interactions:** By using an intermediary, a company may lose communication with its suppliers and customers. For businesses who sell directly to customers but choose to utilize a third party to either collect incoming orders or transport exiting items, the loss of client interaction is very important. Boise Cascade is an excellent example; it contracted with other firms to handle all of its outbound distribution. As a result, there was a large drop in consumer interaction. Boise Cascade made the decision to internalize outbound deliveries for clients near its distribution centers. The extra gain in excess that a third party might supply was negligible given the large consumer density near its distribution centers, but the benefit from enhanced client interaction was substantial. Boise Cascade chose not to internalize distribution beyond this stage since the excess offered by a third party was sizable.

4. **A decline in internal capabilities and an increase in external power:** If internalizing a supply chain function would considerably reduce the third party's influence, a company could decide against outsourcing it. The electronics sector is one place to look for an illustration. Companies like HP and Motorola have outsourced the majority of their production, yet despite contract manufacturers having established these competencies, they are hesitant to outsource procurement or design. It might be claimed that a contract manufacturer can reach a greater degree of aggregation in both procurement and design assets given the commonality of components. However, given the possible loss of authority and the fact that both HP and Motorola are rather big companies, they are hesitant to outsource procurement to contract manufacturers. Keeping a portion of a supply chain function in-house is particularly crucial if a third party's negotiating position would be considerably strengthened by the loss of all capabilities. The in-house capacity is then used as a back-up plan that may be used if necessary. The choice also places a cap on the portion of the supply chain excess that the third party may retain for itself.

5. **The disclosure of private data and information:** A company must reveal demand information and, in certain situations, intellectual property when using a third party. Leakage is always a risk if the third party also provides services to rival businesses. Businesses often demand on firewalls inside the third party, but a firewall raises asset specificity, restricting the rise in surplus that the third party may provide. Firms often decide to maintain the role in-house when leakage is a problem, particularly with respect to intellectual property.

6. **Contracts that are invalid:** Contracts with performance standards that skew the third party's incentives often drastically cut any outsourcing benefits. For instance, even if the third party exposes its records, incentive issues arise with cost-plus pricing of third-party services. With this price structure, there are no longer any incentives for the third party to develop further and cut expenses. The company is responsible for making changes. Another instance is when businesses stipulate in contracts that distributors or suppliers must have a specific number of days' worth of goods on hand. A contract of this kind lessens the third party's motivation to adopt measures to lower inventories. In this case, it would be preferable for the company to contract for the required service level while giving the third-party greater latitude over the quantity of goods. The third party is therefore motivated to concentrate on lowering the amount of inventory needed to offer a certain level of service.

7. **A reduction in supply chain visibility:** The use of third parties decreases supply chain operations' visibility, making it more difficult for the company to react swiftly to regional customer and market needs. Long supply chains may be especially hurt by this lack of visibility.

8. **Negative effects on reputation:** In many cases, a third party's activities affecting labor or the environment may have a substantial detrimental effect on the company's image. Regarding labor practices and the environment, Nike has had issues with a number of its suppliers. Nike published its first supply chain report on Chinese suppliers in 2008 and detailed various dubious labor practices, such as the use of minors, failure to pay salaries, and faked chapterwork. Companies like Nike that have strong brands might suffer especially from the reputational damage caused by supplier behavior [10].

## CONCLUSION

A supply chain's overall performance and competitiveness are significantly shaped by its sourcing selections. Organizations may gain a number of advantages by carefully choosing suppliers, assessing their skills, and negotiating advantageous contracts. Organizations may combine economic concerns with issues affecting quality, dependability, and sustainability by

making wise sourcing selections. Organizations may stimulate innovation, enhance supply chain resilience, and realize cost savings via strategic sourcing practices such supplier engagement and long-term relationships. The effects of globalization and digital platforms broaden sourcing options even more, enabling businesses to work with a larger pool of suppliers and take advantage of technology-enabled supplier relationship management.

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# CHAPTER 10

# BASIC INTRODUCTION TO PRICING AND REVENUE MANAGEMENT IN A SUPPLY CHAIN

Dr. Ramalingam Mageshkumar, Assistant Professor
Department of Management, Presidency University, Bangalore, India
Email Id: mageshkumar@presidencyuniversity.in

**ABSTRACT:**

In order to increase performance and maximize profitability in supply chain management, pricing and revenue management are essential. Companies have several difficulties in successfully managing pricing strategies and maximizing revenue generation throughout the supply chain in today's fiercely competitive and changing business climate. In a supply chain setting, this chapter gives a general understanding of pricing and revenue management. Choosing the best prices in a supply chain that are in line with demand trends, market dynamics, and operational restrictions is the goal of pricing and revenue management.

**KEYWORDS:**

Capacity Inventory, Differential Pricing, Higher Price, Management Strategies, Revenue Management.

## INTRODUCTION

Pricing is used in revenue management to boost the excess and profit produced by a finite quantity of supply chain assets. Capacity and inventory are the two types of supply chain assets that exist. In the supply chain, there are capacity assets for storage, transportation, and manufacturing. The supply chain contains inventory assets that are transported to increase product availability. When there are several categories of customers, revenue management tries to increase profits by selling the appropriate asset to the appropriate customer at the appropriate price. Revenue management involves altering prices in addition to capacity and inventory to increase profits by better balancing supply and demand. Telluric and Van Resin provide a great examination of revenue management strategies in theory and practise. Think about a transportation business with ten vehicles. In the event that there is excess capacity, one strategy the company might use is to establish a fixed price for its services and utilize promotion to boost demand.

While there are clients whose desire to pay fluctuates with certain aspects of the service, such response speed, the company might do much more via revenue management. One strategy is to charge customers who are prepared to commit their purchases in advance a reduced price and late-order customers who need transportation capacity a higher price. Another strategy is to charge customers with long-term contracts less money and consumers wishing to buy capacity at the last minute more money. Charge higher prices at times of strong demand and lower prices during times of low demand is a third strategy. Think about a store that buys seasonal clothing to sell. Higher supply chain profits will emerge from a plan that changes pricing depending on product availability, consumer demand, and the remaining sales season than from a strategy that sets prices for the whole sales season

Differential pricing is a key lever in each of these revenue management techniques that helps to maximize profits. In order to improve supply chain surplus and profits, revenue management may also be referred to as the use of differential pricing depending on client segment, time of usage, and product or capacity availability. The effectiveness of the supply chain may be significantly impacted by revenue management. One of the most often

mentioned instances is American Airlines' effective use of revenue management to compete with and ultimately beat people Express in the middle of the 1980s. Beginning in Newark, New Jersey, People Express provided services at prices that were 50 to 80 percent less expensive than those of other airlines. People Express was first overlooked by other airlines since they had little interest in the low-fare sector. However, People Express was operating 40 aircraft by 1983 and had load factors of greater than 74%. People Express and other recent arrivals were significantly encroaching on the territory of established carriers. Due to their greater operational expenses, the current airlines were unable to compete by lowering their fares to those of People Express.

The first company to use revenue management as a successful countermeasure was American Airlines. Instead than lowering the cost of every ticket, American reduced the cost of certain seats to levels comparable to or cheaper than People Express [1]. On flights that were more likely to have empty seats than not, when there would have been no income, there were more low-priced tickets available. With the use of this tactic, American was able to draw clients who appreciated the cheap pricing without losing business from clients who were prepared to pay more. Soon after, other airlines, including United, adopted a similar strategy, luring many of People Express's customers. This was enough to reduce People Express's load factors to a level below 50%, where the airline could no longer operate. People Express failed before the year 1986 was out. The main reason American Airlines was successful was because it employed differential pricing to cut costs for a portion of the seats and draw customers away from People Express. For the small portion of seats taken by business travelers who did not utilize People Express, American did not reduce costs. Successful revenue management is based on targeted differential pricing. When one or more of the following four circumstances present, revenue management modifies asset price and supply and significantly affects supply chain profitability.

1. The product's worth changes across various market sectors.
2. There is product wastage or the product is very perishable.
3. There are seasonal and other peaks in demand.
4. The item is offered for sale both in bulk and on an individual basis.

An item whose value differs depending on the market sector is airline seats. If a flight fits within a business traveler's itinerary, they will pay a premium cost. A leisure traveler, on the other hand, often adjusts his or her plans to get a reduced ticket. An airline that can charge business travelers a greater rate than leisure travelers will always do better than an airline that charges one rate for all passengers. Similar concepts may be used when talking about hotels and automobile rentals, when there is a big disparity between business and pleasure travelers. Seasonal clothing and fashion are two examples of extremely perishable goods since they depreciate over time. At the beginning of the season, customers tend to place a higher value on high-fashion clothing because they want to be the first to wear it. By the conclusion of the season, shoppers will only purchase the item at a significant discount. Similar to this, unused manufacturing, storage, and transportation capacity is completely worthless since it cannot be replaced.

The transportation capability of a truck for a given day is lost permanently without yielding any profit if it is not utilised. As a result, every capacity is also a very fragile asset. In such a situation, revenue management aims to gradually modify the price in order to maximize the profit made from the existing inventory or capacity. Many popular tourist locations exhibit a very seasonal trend in the demand for hotel rooms. For instance, resorts in Phuket, Thailand, bill guests at a substantially cheaper cost in the summer than they do in the high season. They may draw consumers with some temporal flexibility with this price structure during the less expensive summer months, reserving the winter capacity for customers who are ready to spend more to visit Phuket during the winter. Similar tactics are used by certain commuter

trains to manage the separate peaks in passenger traffic. Peak times have higher rates, whereas off-peak travel has reduced fares. It is crucial to remember that setting various prices for peak and off-peak times boosts revenues in a way that respects consumer priorities. Peak times, being the most desired, would have surplus demand in the absence of peak pricing, but off-peak hours would have a significant amount of idle capacity.

Customers who really value the peak hour would pay the higher price under differential pricing, while others who were not time-constrained would migrate to the off-peak period to benefit from cheaper rates. Such a move results in a bigger supply chain surplus, more earnings for the company, and asset utilization by consumers that is in line with their demands. Every item and every capacity unit is available for both bulk and spot market sales [2]. For instance, the owner of a warehouse must choose between renting the whole warehouse to clients willing to sign long-term contracts and holding back a section of the warehouse for use in the spot market. Although the long-term contract is less prone to risk than the unreliable spot market, its average price is often lower. By selecting the ideal portfolio of long-term and spot-market consumers, revenue management boosts earnings. Every owner of a piece of property in a supply chain may find revenue management to be a useful tool.

If there are groups that are willing to pay various rates for different lead periods to utilize the capacity, or if there is seasonal demand, owners of any kind of capacity production, transportation, or storage may employ revenue management. When one segment wants to utilize capacity immediately and is prepared to pay more for the privilege while another segment wants to pay less and is willing to commit far earlier, revenue management may be beneficial. Owners of any perishable goods need to manage their revenue effectively [3]. Airlines, car rentals, and hotels are some of the most effective instances of revenue management utilization in the travel and hospitality sector. According to American Airlines, revenue management strategies boost its annual sales by more than $1 billion. Marriott's revenue management strategies increase sales by more than $100 million per year. All phases of a supply chain that meet one or more of the four prerequisites mentioned previously may be affected similarly by revenue management. The numerous scenarios in which revenue management is successful are covered in the sections that follow, along with the methods used in each.

## DISCUSSION

The demand from the segment paying the lower price often materializes sooner than the demand from the segment paying the higher price in differential pricing situations. A provider could offer a cheaper price to a customer who commits in advance and a higher price to a customer who wants to make an order right away. Even if there is sufficient demand from the lower-price sector to use the full available capacity, the supplier must restrict the amount of capacity committed to lower-price consumers in order to benefit from revenue management. The amount of capacity to set aside for the higher price range is now under issue. If demand could be predicted, the solution would be straightforward. In reality, demand is a moving target, therefore businesses must consider unpredictability while making this choice. The fundamental trade-off that a supplier with manufacturing capacity must weigh is whether to accept an order from a customer who will pay less or wait for a customer who would pay more.

In this case, spoiling and spillage are the two main dangers. When capacity set aside for customers willing to pay more is lost due to a lack of demand from this market, spoilage occurs. Spill happens when purchasers paying more must be turned away because the capacity has already been reserved for buyers paying less. In order to reduce the anticipated cost of spoilage and spill, the supplier should decide on the capacity to commit for the higher-

priced consumers. The predicted income from waiting for a higher-priced customer should be contrasted with a present order from a lower-priced buyer. If the anticipated income from the higher-priced customer is less than the present revenue from the lower-priced buyer, the order from the lower-priced buyer should be accepted.

**Perishable Asset Pricing and Revenue Management**

A perishable asset is one that depreciates over time. Fruits, vegetables, and medications are all obviously perishable. This list also contains items that depreciate in value when new versions are released, including computers and mobile phones. Because it cannot be sold at full price after the season is over, high-fashion clothing is perishable. All types of manufacturing, transportation, and storage capacity are also considered perishable assets if they are not used to their full potential. Past capacity that hasn't been utilised has no value. Therefore, all unused capacity is equal to capacity that has already expired.

The original Filene's Basement in Boston is a well-known illustration of revenue management in clothing retail. First, full price was charged for merchandise in the main shop. Overstock items were relocated to the basement and gradually dropped in price over a 35-day period until they sold. Any unsold goods were subsequently donated to a good cause. Nowadays, the majority of department shops gradually mark down items during the sales period and then sell any unsold stock to an outlet store that uses a similar price scheme. The practice of overbooking by the airline industry is another example of revenue management for a perishable asset. Once the aircraft takes off, a seat has no more value. Airlines offer more reservations than the capacity of the aircraft in order to increase projected income since passengers often do not arrive for flights even though they have made reservations [4], [5].

**Overbook Asset Sales to Reflect Cancellations**

Dynamic pricing, the practice of changing prices over time, is appropriate for goods like clothing that have a certain date beyond which they lose a significant portion of their worth. By April, winter-specific clothing is no longer very useful. A business has a variety of alternatives for its pricing approach after purchasing 100 ski coats in October. It may demand a hefty price at first. Less jackets will be sold early in the season but at a higher price as a consequence of this approach, leaving more jackets to be sold later in the season, when they will be of less value to buyers. Another option is to set the price lower at first, selling more jackets early on in the season although for less, and keeping fewer jackets available for sale at a discount. The retailer's earnings are based on this trade-off. A perishable asset's owner must be able to predict the effects of price changes on consumer demand and estimate the asset's worth over time in order to successfully change the price over time.

**Overbooking**

The strategy of overbooking or overselling the available asset is appropriate in any circumstance when consumers have the option to cancel orders and the asset's value drastically declines after a deadline. Airline tickets, Christmas-specific merchandise, and manufacturing capacity are a few examples. Each time, there is a finite supply of the asset, orders may be cancelled, and the item depreciates after a given time. The overbooking level is simple to calculate if the cancellation or return rate can be forecast with accuracy. The cancellation or return rate is unpredictable in practice, however. The fundamental trade-off to take into account when overbooking is whether there will be wasted capacity or inventory due to frequent cancellations or if there will be a lack of capacity or inventory due to infrequent cancellations, in which case a costly backup will need to be planned. The profit that would have been made if the capacity had been employed for production is the cost of unused capacity. The loss per unit incurred as a consequence of switching to a backup source

is the price of a capacity deficit. By minimizing the cost of capacity shortfall and lost capacity, the overbooking decision seeks to maximize supply chain revenues.

**Price Management for Seasonal Demand and Revenue Management**

In many supply networks, seasonal demand surges are a typical occurrence. The month of December is when the majority of American merchants generate a significant portion of their yearly revenues. Amazon is one such example. The need for picking, packaging, and transportation capacity at Amazon considerably rises as a consequence of the seasonal peak. In November, Amazon usually provides free delivery on all purchases. Because of the price reduction, some consumers move their demand from December to November, which lowers Amazon's December peak and increases its ability to make a profit. Additionally, this tactic gives clients who are prepared to place an early purchase a price reduction. When faced with seasonal peaks, charging a higher price during the peak period and a lower price during off-peak times is an effective revenue management strategy.

The demand shifts from peak to off-peak times as a consequence. If the cost is reduced due to a lower peak and the rise in income during the off-peak time more than offsets the discount offered during the off-peak period, this result is advantageous. Differential pricing by day of the week and season is used in the hotel sector. In this case, the objective is to boost demand during times of low demand by luring price-sensitive clients, such travelling families, with a price reduction. In this endeavor, the Marriott Corporation has had considerable success. Hotel room demand is known to change depending on the day of the week [6]. The busiest travel days for Marriott, which caters to corporate travelers, fall in the middle of the week. In order to entice families to stay at the hotel on weekends, Marriott provides discounted prices. Charge guests a lesser fee if they stay for a longer length of time that also includes low-demand days. This is another revenue management strategy that Marriott employs.

The Next restaurant in Chicago, which was opened by renowned chef Grant Chats in 2010, is an intriguing illustration of peak price. Tickets for seatings at various times are available in advance from the restaurant. The cost of a ticket varies depending on the menu and the length of time a client joins up for. As a result, a Tuesday night sitting at 9.30 P.M. is more costly than a seating on Saturday night at 8 P.M. Similar to this, many sports teams charge more for games against well-liked rivals and less for matches against inferior foes at off-peak periods. Because it is costly to change capacity over time, off-peak discounting may be a successful revenue management strategy for owners of manufacturing or transportation capacity in any supply chain encountering seasonal high demand. This strategy boosts revenues for the asset owner, lowers the prices paid by a small percentage of consumers, and attracts prospective new clients during the off-peak discount time.

**Pricing and Revenue Management or Bulk and Spot Contracts**

The majority of businesses operate in a market where some clients buy in bulk at a discount while others purchase individual items or small quantities at a higher cost. Think of a supply chain owner who has warehouse capacity. Storage space may be rented in small or huge quantities, depending on the firm. If order cancellations happen and the asset is perishable, over reserving or overselling it is a useful strategy. The degree of overbooking is determined by the trade-off between the cost of wasting the asset if there are too many cancellations that result in unused assets and the cost of setting up a backup if there are too few cancellations that result in committed orders that are larger than the capacity that is available, whether for large companies for their emergency needs or to small businesses. In comparison to the other companies, the major firm that leases space in bulk often receives a discount.

Thus, the owner of warehousing space must choose between two options: lease part of the space at a reduced rate to the bulk buyer or save some of it for future, uncertain demand for

tiny quantities of warehouse space at a higher price. Owners of supply chain assets often seek to meet all demand resulting from large sales and only attempt to assist small clients if any assets are left over. In contrast, a company like McMaster-Carr solely targets clients that need MRO products urgently. Any bulk purchaser looking for a discount will be declined by McMaster-Carr. With this approach, McMaster-Carr is a highly successful company [7]. Targeting one of the two extremes is a wise approach for a business that wants to be a niche player. It enables the company to concentrate its activities on catering to either the bulk sector or the spot market. However, for some businesses, a hybrid approach that caters to both categories is ideal. Firms must choose which portion of the asset to sell in large quantities and which portion to reserve for the spot market in this scenario. A company that serves two market sectors would have a comparable basic tradeoff. The company must choose the pricing for the bulk and spot markets as well as how much of an asset to reserve for the spot market. Equations 16.1 and 16.2 may be used to calculate the pricing for each section.

In order to ensure that the predicted marginal income from the spot market meets the existing revenue from a bulk sale, a certain amount should be set aside for it. The difference in margin between the spot market and bulk sale, as well as the distribution of demand from the spot market, have an impact on the reserved quantity. Equations 16.3 and 16.4 may be used to calculate the quantity of asset that needs to be kept for the spot market if we assume that the bulk buyers are the lower-price segment and the spot market is the higher-price sector. Each buyer of manufacturing, storage, and transportation assets in a supply chain must make a similar choice. Think about a business seeking shipping capacity for international operations. It may choose to get into a long-term bulk agreement with a shipping company. Purchasing shipping capacity on the spot market is an additional option. Long-term bulk contracts have the benefit of being set and inexpensive, but they also have the drawback of being squandered if they are not used. Although the average price on the spot market is greater, it has the benefit of never being wasted. The buyer must take this trade-off into account when determining how many long-term bulk transportation contracts to sign.

**Practically Using Price Management and Revenue Management**

**1. Carefully assess your market:** Identification of target client categories and their demands is the first stage in revenue management. Understanding what the client is purchasing is more important than understanding what you are selling. An airline cannot employ revenue management if it views itself as merely selling tickets. It must consider itself to be in the business of selling tickets, allowing last-minute reservations, changing flight schedules, and selling the ability to book. Opportunities for revenue management don't emerge till after that. After determining the demands of the market, it is critical to collect accurate and comprehensive information on the goods and pricing provided, the level of competition, and, most importantly, customer behavior. Customer behavior data is a useful resource for determining consumer preferences. Successful revenue management ultimately relies on a thorough comprehension of client preferences and a quantification of the effects of different strategies on consumer behavior.

**2. Calculate the revenue management's advantages:** Before beginning the project, it is essential to quantify the anticipated advantages of revenue management. To best estimate the advantages via simulation, historical data and a solid model of client preferences should be employed. Explicit revenue goals that are expected to be met via revenue management should be the consequence of this phase. All parties involved should have faith in the revenue objectives. The effort put forth in revenue management should then be contrasted with the anticipated gain.

**3. Establish a forecasting procedure:** Any revenue management system's forecasting function is its cornerstone. An airline has to be able to anticipate cancellation trends in order

to employ overbooking to any significant degree of effectiveness. We do not imply getting an estimate that is always correct when we say we are predicting. Demand estimation and assigning a forecast's predicted inaccuracy are both steps in the forecasting process. Any revenue management model requires crucial inputs, including the predicted value and the expected inaccuracy.

At the micro level, where every behavior is basically individual, it is often difficult to predict. For instance, it will be challenging for an airline with 100 ticket classes to predict demand for each class as well as consumer behavior when they discover a fare class is filled. Therefore, it's crucial to make sure that revenue management strategies are designed at a level that is sufficiently aggregated to allow for accurate forecasting. Finally, reforecast when new information becomes available to see if the present revenue management strategies are still effective. The level of market activity will determine how often forecasts are made. The prediction and the revenue management choice should ideally be evaluated after each transaction.

**4. Maintain simplicity:** Through the use of a few parameters for differential pricing, the majority of the advantages of revenue management are realized. Complexity increases the amount of work necessary without necessarily offering much benefit. By adopting a limited number of price classes, an airline, for instance, may reap the majority of the advantages of revenue management. Adding complexity won't necessarily increase revenue; it will only make predicting harder.

**5. Involve both operations and sales:** Salespeople need to be aware of the revenue management strategy being used so they can adapt their presentation. If the sales team keeps directing customers towards the time when prices are highest, a company's off-peak discount is useless. The sales team has to identify which clients really use the supply chain asset during peak hours and which ones might profit from having their orders moved to off-peak hours. Such a strategy will improve business revenues while also gratifying clients. Operations must be aware of real results and comprehend the possible effects of the revenue management strategies in place. For instance, operations of an airline that uses overbooking must be prepared to rebook customers into other practical flights if they are unable to board the full trip.

**6. Recognize and educate the client:** If revenue management strategies are merely marketed as a way to maximize profits, customers will view them negatively. Such a view may eventually make customers less loyal and motivate them to attempt to manipulate the system. As a result, it's critical that the company design its revenue management programmer such that income grows while service is improved in a manner that matters to the most expensive clients. Both objectives should be met by a suitable use of revenue management strategies, as was previously mentioned in the chapter. This information has to be shared with the company's most significant clients. Do not forget that a shift in this group of consumers' behavior has the power to negate any possible revenue management programmer benefits!

**7. Complement revenue management with supply planning:** Although the concepts of supply planning and revenue management that we cover in this book have value on their own, combining them may provide even greater benefits. The idea here is to mix revenue management with supply-side choices rather than using it in isolation. For instance, a factory should consider expanding its short lead time capacity if revenue management reveals that the bulk of its profits come from the manufacturing of a short lead time facility [8].

## CONCLUSION

Pricing and revenue management are essential for maximizing a supply chain's efficiency and profitability. Organizations may gain a competitive edge, maximize income production, and

improve overall operational efficiency by managing pricing strategies and revenue sources properly. Understanding consumer behavior and market dynamics is a crucial component of pricing and revenue management. Companies may adjust their pricing strategy to maximize income by examining client preferences, demand trends, and price sensitivity. Advanced data analytics and forecasting methods may provide insightful information about market trends, enabling businesses to create flexible and dynamic pricing systems.

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# CHAPTER 11

# INTRODUCTION TO INFORMATION TECHNOLOGY AND ITS APPLICATION

Ms. Pramoda Hegde, Assistant Professor
Masters In Business Administration, Presidency University, Bangalore, India
Email Id: pramodah@presidencyuniversity.in

**ABSTRACT:**

Information is essential to a supply chain's effectiveness since it serves as the foundation for supply chain managers' choices. Information technology is made up of the instruments used to acquire knowledge about information, analyses it, and act on it to enhance the performance of the supply chain. We examine the value of information, its applications, and the technology that help supply chain managers utilize information to their advantage in this chapter. Information is a crucial component of the supply chain because it acts as the bond that enables the other supply chain drivers to cooperate to produce an integrated, coordinated supply chain.

**KEYWORDS:**

Chain Management, Inventory Levels, Macro Processes, Supply Chain, Service Center.

## INTRODUCTION

Information is a crucial component of the supply chain because it acts as the bond that enables the other supply chain drivers to cooperate to produce an integrated, coordinated supply chain. Information is essential to supply chain success because it provides the framework on which managers make decisions and supply chain processes carry out transactions. A management cannot know what consumers want, how much inventory they have on hand, or when to make or ship additional merchandise without information. In other words, information gives managers insight into the supply chain, enabling them to take action to improve the performance of the chain. IT is made up of the people, technology, and software used across a supply chain to collect, process, and use information. In a supply chain, IT acts as management's eyes, ears, and sometimes a piece of the brain, gathering and analyzing the data required to make wise decisions. As an example, an IT system at a manufacturing may display the completed products inventory at various points in the supply chain as well as the ideal production plan and level of inventory based on information about demand and supply.

The effectiveness of a company may be significantly impacted by the use of IT systems to collect and analyses information. A significant producer of computer workstations and servers, for instance, discovered that the majority of its data on customer demand was not being utilised to determine production plans and inventory levels. The manufacturing team was effectively forced to make inventory and production choices on a blind basis since it lacked key demand information. The business installed a supply chain software system, which allowed it to collect and examine demand information to provide suggested inventory levels. The firm was able to reduce its inventory by half thanks to the IT system since management could now base choices on data about consumer demand rather than manufacturing's informed predictions [1], [2]. Large effects like this highlight how crucial IT is to the functioning of the supply chain. A supply chain's performance depends on the availability and analysis of information to guide decision-making. Seven-Eleven Japan, Walmart, Amazon, UPS, and Netflix are a few businesses whose success has been based on

the accessibility and analysis of information. Information has to meet the following requirements in order to enable efficient supply chain decisions:

1. **The facts must be correct:** Making sound judgments is challenging in the absence of information that accurately depicts the condition of the supply chain. This is not to suggest that every information must be entirely accurate; rather, it is to state that the facts provide a picture that is at least roughly accurate.
2. **Quick access to information is required:** There is often accurate material out there, but by the time it is made accessible, it is either outdated or not in an accessible manner. A manager requires current, simple access to information in order to make wise judgments.
3. **The proper information must be provided:** Decision-makers need accessible information. Businesses often possess vast volumes of data that are useless for decision-making. In order to avoid wasting precious resources gathering useless data while critical data is not being collected, businesses must consider what information should be recorded.
4. **Information should be distributed:** A supply chain can only be productive if all of its participants have a same understanding of the data that they are using to guide their business choices. Different information from various stakeholders leads to mismatched action plans that lower the performance of the supply chain.

As will be detailed below, information is employed while making a range of choices on each supply chain driver:

1. **Building:** Information on the trade-offs between efficiency and flexibility, demand, currency rates, taxes, and other factors is necessary to determine the location, capacity, and schedules of a facility. For instance, the demand data from Walmart's retail locations is used by suppliers of Walmart to plan their manufacturing schedules. Walmart places its new shops and cross-docking facilities based on information about demand.
2. **Counting:** Demand patterns, inventory costs, stock-out costs, and ordering costs must all be considered when determining the best inventory policies. For instance, in order to make these judgments on its inventory strategy, Walmart gathers comprehensive data on demand, costs, margins, and suppliers.
3. **Transport:** Making informed judgments on transportation networks, routings, modes, shipments, and suppliers need knowledge of costs, client locations, and cargo quantities. Walmart integrates its operations with those of its suppliers closely using information. Cross-docking may be implemented by Walmart thanks to this connectivity, which reduces the cost of both inventory and transportation. Making the right supply chain choices will maximize profits.

**Framework for the Supply Chain**

We provide a framework so that managers may comprehend the function of IT in the supply chain. Its primary function is to offer supply chain transaction data access and reporting. Then, more sophisticated IT systems add an analytics layer that makes use of transaction data to proactively enhance supply chain performance. As a starting point, for Amazon, excellent IT systems will capture and report data on demand, inventory, and fulfilment. Amazon is then able to choose whether to establish additional distribution centers and how to supply them thanks to IT tools that give data. Enterprise software serves as the backbone of a supply chain IT system since reliable transaction data is necessary for both reporting and analysis. With SAP and Oracle as the two dominant companies, this market has developed from the early 1990s to the early 2000s [3].

## DISCUSSION

During this time, best-of-breed analytics vendors like i2 and Manugistics tried to offer transaction level capacity while enterprise software suppliers like SAP and Oracle strove to expand their analytics capabilities. Enterprise software vendors emerged as the winners, and the market saw major consolidation in the first decade of the twenty-first century. We suggest that the supply chain macro processes covered in be used to frame future supply chain IT development.

### The Supply Chain's Major Operations

Supply chain management has increased the range of options available to businesses when making choices. From attempting to optimize performance throughout the division, the organization, and most recently the whole supply chain, this scope has grown. This expansion of the subject area highlights how crucial it is to include supply chain operations at every stage of decision-making. All supply chain processes, from the standpoint of a company, may be divided into three primary categories: downstream processes, internal processes, and upstream activities. The three macro supply chain processes are defined as follows using this classification:

Management of customer relationships. Processes that concentrate on client interactions downstream from the organization. ISCM, or internal supply chain management. Processes that concentrate on an enterprise's internal operations. Even though the emphasis is only on the company, the software industry sometimes refers to this as supply chain management. CRM, ISCM, and SRM are all included in our definition of supply chain management. Relationship management with suppliers. Processes that concentrate on supplier-business connections upstream. The transaction management foundation, which consists of infrastructure software, integration software, and fundamental enterprise resource planning systems, underpins all operations and analytics pertaining to the macro processes. For the three macro processes to run and interact with one another, TMF software is required.

### Pay Attention to Macro Processes

Firms must concentrate on these macro processes since an enterprise's success is increasingly correlated with that of its supply chain. Good supply chain management is not a zero-sum game in which one step of the supply chain enhances profits at the cost of another, as we have emphasized throughout this book. In order to achieve breakthrough performance, good supply chain management instead aims to increase the supply chain surplus, which necessitates that each business look outside of its own internal processes and at the whole supply chain in terms of the three macro processes [3]. All the large-scale operations are coordinated across all phases of a good supply chain. Apple is an example of a business that has synchronized its macro-operations to release and market blockbuster products like the iPad2. In its dealings with consumers, Apple has been tremendously successful in creating items that satisfy their demands as well as in running Apple retail as a successful and lucrative business. While every of its items are made by a different company, they are all internally created. Despite this, Apple was able to successfully satisfy enormous demand when the iPad2 was released. Strong coordination across all of the macro-operations has been essential to Apple's degree of success. The function that IT plays in each of the macro-operations is now covered.

### Management of Customer Relationships

The downstream supply chain interactions between an organization and its clients make up the CRM macro process. The macro-CRM process' objectives are to create consumer demand, make order transmission and tracking easier, and enable order tracking. When this

procedure is weak, demand is lost and customers have a bad experience since orders are not properly processed and carried out. The following are the main CRM processes:

1. **Advertising:** Making choices on which customers to target, how to target them, what items to sell, how to price them, and how to manage the actual customer-targeting campaigns are all part of the marketing process. Effective CRM marketing IT systems include statistics that help with pricing, product profitability, and customer profitability choices, among other marketing-related tasks.
2. **Sell:** In contrast to marketing, where procedures are more focused on determining who to sell to and what to offer, the sell process is more concerned with actually making a sale to a consumer. Providing the sales force with the knowledge necessary to close a deal and then carrying it out are both parts of the selling process.
3. **Controlling orders:** It's crucial to monitor client orders as they go through an organization so that both the customer and the business can plan and carry out order fulfilment. This procedure links the enterprise's supply with the customer's demand. Good IT systems make it possible to see orders at all of the stages they pass through before being delivered to the client.
4. **Contact or service center:** A company's call or service center is often the first point of contact with its clients. A call/service center assists consumers with placing purchases, makes product recommendations, addresses issues, and gives updates on order progress. By facilitating and lowering the labor done by customer service agents and by directing consumers to representatives who are most qualified to handle their request, effective IT systems have contributed to improved call/service center operations.

**Management of the Internal Supply Chain**

As we just stated, ISCM is focused on internal company activities. All procedures involved in preparing for and completing a client order are included in ISCM. The following are the different ISCM processes:

**Planning strategically:** The supply chain's network architecture is the process' main emphasis. Location and facility capacity planning are important factors.

**Demand management:** Demand planning is predicting demand and assessing how demand management strategies like price and promotions will affect it. See Chapter 7 on demand forecasting as well as on pricing for a more thorough treatment of this procedure.

**Planning your supply:** The demand estimates generated by demand planning and the resources made available by strategic planning are inputs into the supply planning process, which subsequently generates an ideal plan to satisfy this demand. Supply planning software often offers the ability to plan factories and inventories [4].

**Satisfaction:** Once a strategy to meet demand has been developed, it must be put into action. Each order is associated with a particular supply source and mode of transportation during the fulfilment process. Software for managing transportation and warehouse operations is often included in the fulfilment area.

**Field work**

The product will ultimately need to be maintained once it has been delivered to the consumer. Setting spare component inventory levels and scheduling repair calls are the main goals of the service procedures. The inventory difficulties are conventional inventory management challenges, and some of the scheduling issues are addressed in a way akin to aggregate planning. Strong integration between the ISCM and CRM macro processes is required since the ISCM macro process strives to satisfy demand that is created by CRM operations. CRM

engagement is crucial for demand forecasting since these apps touch the client and have the most data and insights into their behavior. Similar to how the SRM macro process should be tightly integrated with the ISCM operations. The SRM procedures are reliant on suppliers, as are supply planning, fulfilment, and field service. If your supplier is unable to provide the components needed to create your product, it is of little value for your firm to have the capacity to satisfy demand [5], [6]. Order management, which we covered under CRM, has to work closely with fulfilment and serve as a component of efficient demand forecasting. Once again, broader supply chain management calls for cross-process integration. Successful ISCM software vendors have improved ISCM processes' decision-making. On both an organizational and software level, however, there is still a lot of room for improvement in terms of CRM and SRM interaction. Future prospects are probably going to include both enhancing each ISCM procedure and enhancing integration with CRM and SRM.

**Management of Supplier Relationships**

Processes targeted at interactions between the company and suppliers upstream in the supply chain are included in SRM. Given that incorporating supplier restrictions is essential for developing internal plans, there is a natural connection between SRM procedures and the ISCM processes. The following are the main SRM processes:

**Teamwork in design:** With the help of suppliers and manufacturers, this software strives to enhance product design. The software makes it easier to choose components together with suppliers that have beneficial supply chain traits like simplicity of manufacture or commonality across numerous end products. Sharing engineering change orders between a manufacturer and its suppliers is another activity that involves design cooperation. By doing this, the expensive delays that arise when many suppliers are simultaneously creating components for the manufacturer's product are eliminated.

**The source:** Software for sourcing supports supplier qualification, supplier selection, contract administration, and supplier assessment. Analyzing the amount spent by an organization with each supplier is a crucial goal since it often identifies interesting patterns or potential improvement areas. Lead time, dependability, quality, and pricing are some of the major factors that are taken into account while evaluating suppliers. This assessment benefits in supplier selection and performance improvement. Since many supplier contracts include intricate details that must be monitored such volume-related price reductions, contract management is a crucial component of sourcing. Successful software in this space aids in contract management and supplier performance analysis.

**Strike a deal:** A request for quotes is the first stage of several processes that comprise negotiations with suppliers. The planning and carrying out of auctions may also be included in the negotiating process. An effective contract that sets a supplier's pricing and delivery requirements in a manner that best meets the goals of the organization is what is intended by this approach. The execution of auctions and the RFQ procedure are both automated by effective software.

**Buy:** The actual acquisition of materials from vendors is carried out through buy software. This covers the development, administration, and approval of purchase orders. The procurement process is automated using effective software, which also helps reduce processing costs and times.

**Collaboration on supply:** When a company and a supplier have a supply agreement in place, supply chain performance may be increased by working together on forecasts, manufacturing schedules, and inventory levels. Assuring a consistent strategy across the supply chain is the aim of cooperation. Collaborative forecasting and planning in a supply chain should be made easier by good software in this area.

**Supply Chain in the Future**

The three SCM macro processes will, in our opinion, continue to drive the development of supply chain IT. The visibility and reporting of supply chain information can still be much enhanced, but the relative importance of better analysis to assist decision making will only increase. The supply chain's use of IT will be impacted by the following three significant trends:

1. The expansion of SaaS software as a service.
2. More real-time data is available.
3. More people are using mobile technologies.

Software that is owned, distributed, and maintained remotely is referred to as SaaS. One of the most well-known pure SaaS supply chain software suppliers in CRM is Salesforce.com. By 2014, SaaS, which made up roughly 10% of the market for commercial software in 2009, is expected to account for around 16% of all software sales worldwide, according to Gartner. SaaS offers cheaper launch and maintenance costs than apps that are installed physically, hence this move is likely to take place. These elements are especially crucial for small and midsized businesses. The SaaS approach is being used by established corporate software providers like SAP, Oracle, and Microsoft to expand the availability of their products [7].

In the majority of supply chains, the amount of real-time information available has multiplied. There is a significant opportunity to develop software that will use real-time information to assist frontline supply chain staff such as in transportation and warehousing in making smarter and faster decisions that are revisited frequently. Current supply chain software is primarily focused on improving strategy and planning decisions often at the corporate level that are revisited infrequently. The chance is to create systems that offer quick insight based on current data. Some supply chains now have the chance to employ differential pricing to more effectively match supply and demand because to the greater usage of mobile technologies and real-time information. A good example is Group on Now, a project that provides mobile customers with bargains that are location- and time-specific. Offering discounts when business is sluggish in some places helps businesses increase profits. Getting a bargain when and when they want it is advantageous to consumers.

**Management of Risk**

The use of IT in the supply chain has a number of hazards, and using IT to expand existing supply chain capabilities may be risky business. The danger of having a detrimental effect on operations increases with the size of the IT system modification. The likelihood that a company won't be able to operate normally in the event of a significant IT failure increases as IT gets increasingly integrated into businesses. Here, we go through some of the main dangers associated with employing IT in the supply chain as well as some suggestions for reducing them. Two broad categories may be used to separate the primary IT risk areas. The risk associated with establishing new IT systems is the first, and maybe the biggest. A company is compelled to switch from the outdated operational methods it utilised to the modern ones in its IT system while implementing new IT systems. Both technological problems and corporate operations might cause problems in this situation. New IT systems often call for staff to follow new procedures in terms of business operations.

These may be difficult to master, need training to carry out properly, or even face direct resistance from staff members who prefer the traditional method of doing business. Because senior management is often not actively engaged in making this transition, it may be especially challenging to get the whole organization on board with changes brought about by a new IT system. In addition to changing business processes, implementing new IT systems requires overcoming enormous technical obstacles. Overwhelming amounts of integration

between several systems often need to be done. When a company transitions to a new system without sufficient integration, the new system often falls short of expectations and sometimes even outperforms the system it replaced. Making the switch to the new system is often a difficult balance, even when the staff has bought into the new process and all technical obstacles have been removed [7].

The second kind of risk is that any IT issue, such as software bugs, power outages, or infections, might entirely halt a company's operations the more a corporation depends on IT to make decisions and carry out activities. These are significant dangers that a company must prepare for. IT also carries a danger since it has a propensity to codify procedures. Perhaps a system just permits one method for a procedure to be carried out. The company then develops a routine for constantly carrying out this procedure in that manner. Clearly, this has enormous efficiency advantages, but the company also bears the risk that the process does not function at the same level as its rivals and that its systems make it difficult to switch to newer, more successful processes. There are several mitigation measures for each of the main risk categories. There are three things to bear in mind while adopting IT systems. The first is to incrementally deploy new IT systems as opposed to doing it in a big bang manner. This enables a business to identify trouble areas during installation and reduce damage in the event that anything goes wrong. In order to confirm that the new system is operating well, businesses might conduct backup systems. By this, we mean that the business is able to operate both the new and the old systems concurrently.

**Apply The Supply Chain**

When making a choice on supply chain IT, managers need to bear in mind a few broad principles in addition to the sets of specific recommendations for each supply chain macro process that were previously covered.

**1. Decide on an IT system that solves the main success elements for the business:** The primary success elements vary depending on the sector and even the firms inside it. The two or three components that really decide whether or not a firm will be successful are referred to as the key success factors. It's critical to choose supply chain IT solutions that can provide a business an edge in the areas that matter most to its success.

**2. Take little actions and evaluate the results:** When businesses attempt to install IT systems in several processes at once and fail, this is known as the big bang strategy and is the cause of some of the biggest IT catastrophes. Because so many business operations are concurrently involved in the same debugging cycle, which stifles production, the effect of these errors is increased. Designing IT initiatives with progressive milestones is one method to assist assure their success [8], [9].

**3. Match the sophistication degree to the sophistication required:** Management must take into account how thoroughly an IT system addresses the crucial success elements for the company. The degree of complexity of a system and its simplicity of implementation are trade-offs. Therefore, it's crucial to think about how much complexity a business requires in order to accomplish its objectives and then make sure the system it chooses corresponds to that degree. While aiming to be too complex increases the likelihood that the whole system may collapse, erring on the less sophisticated side leaves the company with a competitive vulnerability.

**4. Rather of using IT systems to make choices, use them to support them:** While many supply chain management choices may be made using the software that is now available, not all judgments can be made using IT tools. Installing a supply chain system, then limiting management attention to supply chain challenges, is a mistake business may make. Because

the supply chain must adapt in tandem with changes in the competitive and customer environments, management must maintain its emphasis on the supply chain.

**5. Consider what is ahead:** Managers must consider the future status of the company when making decisions regarding IT systems, even if doing so is more challenging than doing so with the present in mind. Managers must ensure that their IT decisions take these trends into consideration if developments in a company's industry suggest that now irrelevant features may become essential in the future. Managers must take the time to determine how adaptable the systems will be if, or rather when, modifications are needed in the future since IT systems often endure for many more years than was first anticipated [10].

## CONCLUSION

The use of IT in the supply chain has a number of hazards, and using IT to expand existing supply chain capabilities may be risky business. The danger of having a detrimental effect on operations increases with the size of the IT system modification. The more entrenched IT becomes. In businesses, the likelihood that a catastrophic IT failure may prevent the company from operating as intended increases. Here, we go through some of the main dangers associated with employing IT in the supply chain as well as some suggestions for reducing them. Two broad categories may be used to separate the primary IT risk areas. The risk associated with establishing new IT systems is the first, and maybe the biggest.

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# CHAPTER 12

# SUSTAINABILITY AND SUPPLY CHAIN: BALANCING ENVIRONMENTAL

Dr. Yagnamurthy Raja, Assistant Professor
Masters In Business Administration, Presidency University, Bangalore, India
Email Id: narasimharaja@presidencyuniversity.in

**ABSTRACT:**

The use of sustainability throughout the supply chain has been a crucial topic of emphasis in recent years since it has attracted substantial interest across a number of sectors. The use of sustainability concepts in the supply chain is thoroughly reviewed in this chapter, with an emphasis on the advantages, difficulties, and possible solutions. The research addresses how incorporating sustainability practices may improve corporate performance and increase stakeholder value by examining the essential elements of a sustainable supply chain, including environmental, social, and economic factors.

**KEYWORDS:**

Emphasis Sustainability, Energy Consumption, Greenhouse Gas, Gas Emission, Sustainable Supply.

## INTRODUCTION

The design and management of supply networks with the aim of increasing supply chain surplus have been the main topics of this book. However, each supply chain only makes up a tiny portion of the whole planet. Every supply chain's and every person's existence ultimately rely on how well the environment is doing. Thus, it is crucial to broaden the scope of a supply chain's objectives beyond the interests of its members which the supply chain excess represents to include those of potential stakeholders. In light of this, the 21st century has witnessed an increase in the emphasis on sustainability. Sustainable development is defined as development that meets the needs of the present without compromising the ability of future generations to meet their own needs by the Brundtland Commission of the United Nations.

A paradigm recognizing economic, environmental, and social sustainability as the three pillars of sustainable development was unveiled during the 2005 United Nations World Summit. For sustainability to exist, all three pillars must be balanced. The emphasis on sustainability has risen as the economies of big nations like Brazil, China, and India have expanded. On the one hand, the development of developing markets is raising living standards worldwide in a level that may be unprecedented in human history. On the other hand, this increase also places unprecedented strain on the environment and its resources. It has become more obvious that the world's resources and environment cannot support this level of expansion if supply chains do not become more sustainable than they have been in the past [1], [2]. Three different categories may be made out of the reasons influencing the greater attention being paid to sustainability:

1. Lowering risk and enhancing the supply chain's financial performance.
2. Getting clients that care about sustainability.
3. Increasing global sustainability.

Even while all three categories have received a lot of attention, the supply chain risk reduction and financial performance improvement initiatives have seen the most tangible action. Customer demand or the aim to improve global sustainability has led to far less

success. It is intriguing to observe that there is still a sizable possibility even if supply chains merely put effort into lowering risk and raising financial performance. Nearly 40% of [greenhouse gas] abatement could be achieved at negative marginal costs, meaning that investing in these options would generate positive economic returns over their lifecycle, according to a McKinsey analysis on greenhouse gas emissions. Although there is still more to be done, several businesses have declared progress in enhancing sustainability.

The Dutch-British consumer products behemoth Unilever has made enormous investments to assist developing nations like Brazil and India as they battle poverty, water shortages, and climate change. The business assisted tomato farmers in Brazil who wanted to switch to drip irrigation. Nearly half of the company's revenues and the bulk of its growth are attributed to developing markets. It purchases around 10% of the world's tea crops and 30% of all spinach. With a sustainability-focused approach, Unilever can simultaneously ensure supply of the items it needs to support this expansion while also enhancing the economic and environmental wellbeing of the markets where it is projected to experience the majority of its future growth. Given the criticism it was receiving from environmental groups, Wal-Mart began putting more of an emphasis on sustainability as a defensive strategy. However, the business has seen several advantages to its bottom line. Its energy expenses have been greatly reduced as a result of installing skylights for natural light and upgrading the light bulbs in its shops. Packaging reduction has contributed to lower material and shipping costs.

Another example is how Wal-Mart and Costco redesigned the one-gallon milk container to utilize less material and enhance packing density during shipment. Despite the fact that it took some time for the public to embrace the new design, the effort saved 10 to 20 cents a gallon compared to old jugs. 2 Another firm that has prioritized sustainability for important commercial reasons is Starbucks. The business understood in the late 1990s that its expansion ambitions would not be viable without assisting coffee producers in increasing their output in a sustainable way. In order to analyses the sustainable production of coffee along four dimensions product quality, economic accountability, social responsibility, and environmental leadership the firm established its coffee and farmer equity practices [3]. The first two categories, which guarantee fundamental coffee quality, financial transparency, equality, and the sustainability of the coffee supply chain, are requirements for participation in the programmer, according to the firm.

The level of safety and humaneness at work is a measure of social responsibility. Suppliers' environmental leadership is evaluated based on their efforts to manage waste, protect water quality, conserve energy and water, preserve biodiversity, and reduce the use of agrochemicals. The score an applicant receives across the four criteria determines whether they are awarded preferred supplier status. Preferred suppliers get a $0.05 per pound price premium and advantageous contract conditions. According to the corporation, 84 percent of the coffee it purchased in 2010 came from third-party verified sources. Or certified via Fairtrade, C.A.F.E. practices, or another system that has undergone an external audit. These initiatives have helped Starbucks decrease supply risk and maintain a steady supply of high-quality coffee, the most important input for its company, in addition to attracting clients who care about sustainability. When sustainability entails actions that don't immediately provide a profit for a firm, it has shown to be more difficult to implement.

Customers themselves haven't always been prepared to pay extra for sustainable items, despite their own statements about how important sustainability is. Business executives cited three main obstacles to a greater emphasis on sustainability: a lack of adequate return on investment, consumers' reluctance to pay more for green goods, and difficulties measuring sustainability over a product life cycle.3 Maintaining the emphasis required for creating more sustainable supply chains is significantly more difficult when the economic case for an increased focus on sustainability is not clearly articulated for particular enterprises. In the

short to medium term, a better focus on sustainability provides benefits that are shared but costs that may be local to a firm, whereas the status quo provides benefits that are local to firms but a cost that is global. This is one of the biggest challenges to building sustainable supply chains, as we discuss in the next section.

## DISCUSSION

Hardin defined the tragedy of the commons as a predicament that arises when the common good does not fully line with the good of particular entities in an important chapter. It is beneficial to look at his example in a little more depth. Think of a pasture that is accessible to all cattle herders. Each herdsman tries to get the most out of this common resource. He benefits from his cattle's development when they are fed in the pasture, and he is the only one who benefits. However, any costs associated with overgrazing are shared by all herders whose cattle graze on the pasture. Because the negative value of -1 is shared among all herders, overgrazing by any herdsman's cattle results in a positive utility of +1 for that herdsman but only a portion of a negative utility of -1. Because the benefits of adding another animal to his herd outweigh the disadvantages of excessive grazing, every reasonable herdsman keeps growing his herd. Therein lies the tragedy, as Hardin puts it. Each guy is trapped in a system that forces him to expand his herd without restriction in a finite planet [4], [5].

In a society that values the commons' independence, all men race towards ruin, everyone looking out for his own best interests. Freedom in a common leads to everyone's downfall. Hardin continues by explaining how the tragedy of the commons effectively captures the problem of environmental contamination. Waste and pollution are released into the environment by each and every person, business, and organization in the form of sewage, chemicals, and carbon dioxide. The expense of minimizing the quantity of garbage a person or business discards would fall entirely on them, as opposed to the cost of polluting the environment, which is borne by everyone. Even if everyone is harmed by garbage, it is challenging to convince every organization to participate in waste reduction initiatives given that the common environment is accessible to everyone at no cost.

The national level is where this problem is also present. Even though the majority of the increase in atmospheric carbon dioxide has come from the United States and Western Europe, the Intergovernmental Panel on Climate Change, a United Nations body that has been monitoring global warming since 1990, has written that poorer nations closer to the equator are likely to pay the biggest price. Global warming will mostly affect Africa and the crowded river deltas in southern Asia and Egypt, along with small island nations, where there is a danger of drought, disturbed water supply, and ocean swell due to melting ice sheets.4 Gaining any consensus on an action plan in such a situation is challenging since the best collective action, whether at the corporate or national level, is not always the best individual action. It makes sense why it has been so difficult to reach a climate change pact that every nation would abide by. The abuse of natural resources like fish, water, and forests are further instances of the tragedy of the commons. It is commonly known that sturgeon is overfished in Russia and that dammed rivers' salmon runs are destroyed.

Every business and supply chain that functions in a global setting must contend with the tragedy of the commons. They must contend with rivals who could be using shared resources or the environment to their advantage without contributing to their upkeep. They must compete in a market where consumers often priorities cheap costs and are unwilling to pay more for more sustainable solutions, whether via increased prices or decreased use [6], [7]. Without some kind of intervention, it is impossible to foresee a durable solution arising unless all customers overnight alter their mindset. While everyone believes that intervention is necessary, there is significant debate over the kind of assistance that is necessary.

**Alternatives Exist to This Tragedy**

Hardin focused on the issue of the commons being free to everyone in his chapter. He claimed that no resolution could be reached without curtailing some of the participants' freedom in the commons. He remarked, we might sell them off as private property. in reference to the US national parks. We may continue to treat them as public property while dividing up access rights. By using an auction mechanism, the distribution might be based on wealth.

It could be based on merit, as determined by a set of accepted norms. It may be decided by lottery. Or it may be given to those in lengthy lines on a first-come, first-served basis. These are all undesirable in my opinion. But we have a choice to make, or we must let the loss of the commons we refer to as our National Parks. It is crucial to understand that Hardin's main argument is that we must select decisions among possibilities that are unlikely to be supported by everyone's own free will, rather than focusing on his various ideas. In the chapter, Hardin proposes the concept of mutual coercion, in which social structures or processes compel all individuals to act in a manner that advances the common good.

Mutual compulsion may be undertaken through market mechanisms or a command-and-control strategy. In a command-and-control strategy, the authorities impose regulations that everyone must follow. As an example, consider the United States' requirements for new cars' carbon monoxide emissions. Another example is the European Union's Waste Electrical and Electronic Equipment Directive, which promotes effective recycling and landfill avoidance in the electrical and electronics sector. The problem with command-and-control methods is that they are often rigid and inefficient. We provide a few examples of market mechanisms that have been discussed in the context of greenhouse emissions, an issue that is only becoming worse as supply chains become more global but have not yet been implemented in the United States as of October 2011. There is currently no charge for generating greenhouse gases, and there are no clear, tightly enforced restrictions. The ecosystem is the commons in this case, and the absence of any kind of mutual coercion results in an excessive amount of greenhouse gas emissions into the atmosphere. The goal is to put in place procedures that will enable a long-term solution to the issue.

One approach, known as cap-and-trade, limits overall emissions by establishing a finite number of tradable emission permits, which emission sources must acquire and release in proportion to their emissions. A sizable fee is assessed for any failing to submit the proper quantity of permits. The system begins with the creation by the government of a finite number of total permits, which are then distributed to all participants in the economy. Players may sell excess permits to others who may be polluting beyond their limit and want new allowances if they produce less emissions than the allowances they already hold. The supply and demand for allowances will determine the price of allowances under this process. Because they may profit from this improvement by selling their extra permits to others who want to buy them, such a structure provides businesses with an incentive to cut their emissions.

That are unable to cut their emissions or are unable to do so. By executing emissions reduction plans or purchasing permits on the open market, companies are expected to pick the least costly method of complying with the emissions limit. However, this method faces a number of difficulties. The first has to do with the process for assessing the initial allowances given to each organization. Should they be proportional to either desired or present pollution levels? How will the estimated desired pollution levels be determined? If a corporation is unable to deliver permits for its emissions in a certain year, how should the penalty be calculated? Emission taxes are a second method for reducing emissions. Each producer of greenhouse gases is subject to a tax based on the volume of their emissions.

The congestion-based toll we mentioned to control traffic congestion is conceptually comparable to this. The use of any strategies whose marginal costs are lower than the charge will motivate enterprises to minimize their emissions if emissions are taxed. The overall quantity of greenhouse gases generated will go down as a consequence of an emission tax. The performance of either mechanism is significantly influenced by the answers to each question. Given the difficulty in estimating the cost of these emissions to society, there is still a lot of disagreement among experts on each topic. Whether these methods can be implemented at the national level or need international coordination remains a serious problem. Given that the majority of current emissions have come from the industrialized world, and that future emissions are projected to come from nations that are still emerging as a result of global expansion, this is a particularly relevant problem [8].

**Key Sustainability Metrics**

As we have discussed, there are several ways to increase sustainability and supply chain excess. For instance, IKEA's use of modular design enables the business to carefully package its components for shipment from the manufacturing facility to its retail locations. The corporation can simultaneously cut emissions and shipping expenses thanks to modular architecture. Manufacturer of cleaning products and other consumer goods SC Johnson claims that between 1990 and 1999, the company's eco-efficiency initiatives allowed it to reduce waste by more than 420 million pounds and save $125 million. One may use financial indicators to assess sustainability efforts in situations like these, when sustainability improvements also boost the supply chain's financial performance.

However, the bulk of sustainability-related initiatives come at a cost to the supply chain in exchange for a potential benefit that is more widespread. Determining precise criteria that may be used to evaluate supply chain actions linked to sustainability is crucial in such circumstances. In this section, we highlight a few key indicators and categories that supply chains should pay attention to. There are certain similarities across different corporate social responsibility reports, but there is also a great deal of variation in the indicators they select to publish. Some social and environmental parameters are reported by all businesses. However, there is a significant variety in the specific measures presented. For instance, whereas pharmaceutical businesses place more emphasis on waste management and water usage, transportation industries often report on greenhouse emissions, fuel consumption, and transportation efficiency. From an environmental standpoint, all businesses should track and report on the following four areas:

1. Energy use is one.
2. Drinking water.
3. Carbon dioxide emissions.
4. Waste production.

The measurement and reporting of the four categories in a supply chain present two main difficulties. The first difficulty has to do with how a category is assessed. Think about a business that only discloses the energy used for internal operations. Even if the energy consumption across the whole supply chain may have grown, if it chooses to outsource portion of its manufacturing to an offshore provider, its own energy consumption will show a decrease. Even though the energy consumption for the whole supply chain has dropped, if it chooses to move certain manufacturing in-house and onshore, the energy consumption inside its operations will rise. Therefore, it is crucial to specify the parameters within which all metrics are monitored and reported. The Greenhouse Gas Protocol initiative specifies three scope levels with regard to greenhouse gas emission. Direct emissions, also known as Scope 1 emissions, come from GHG sources that the reporting business owns or controls.

Indirect emissions from grid-sourced power and other utility services including heat, steam, and cooling are referred to as scope. Scope denotes the addition of additional indirect emissions from the manufacture of bought materials, outsourced tasks, cars owned by contractors, trash disposal, and employee travel. The size of direct emissions is often just a minor portion of indirect emissions in the supply chain for the majority of businesses. For instance, a thorough examination by the drug maker Abbott revealed that its indirect emissions were between 6 to 14 times more than its direct emissions. To fully understand the influence of the supply chain on the environment, all categories should ideally be monitored throughout the whole supply chain, from the consumer to the lowest tier provider. The use of absolute or relative performance metrics is the second barrier in measuring and reporting.

While a relative measure could provide the amount of energy used per unit of output, an absolute measure gives the entire quantity of energy spent. The benefit of adopting an absolute measure is that it assuming we choose scope 3 shows the whole effect of the supply chain along the category being examined. The drawback is that, even if the firm may not have made any changes, a decline in supply chain sales and production for example, during a downturn would reveal a better absolute measure of energy usage. A relative performance metric is better at identifying improvement. Choosing a fundamental unit may be difficult when using a relative measure since each category might be quantified in terms of production in kilograms, dollars of sales, or a number of other units. In order to gain a full view of their performance, it is often preferable for businesses to measure and report both absolute and relative measurements.

**Supply Chain Drivers and Sustainability**

By comparing the numerous supply chain drivers addressed in the book with the four categories we have established energy consumption, water consumption, greenhouse gas emissions, and waste creation, opportunities for increasing supply chain sustainability may be found. The objective is for every company to assess the environmental effect of each driver across all four categories. We go through a few of the options each driver has in this section and provide some examples.

**Facilities**

Facilities often have high energy and water consumption rates, as well as high waste production and greenhouse gas emissions, making them substantial targets for profitable improvement. A company should categories the improvement possibilities into those that provide positive cash flows and those that do not after measuring the direct effect of each facility in terms of energy, water, emissions, and waste. The lucrative initiatives are first identified and implemented by successful businesses. Walmart has created and established a working store prototype that is up to 25 to 30 percent more energy efficient and generates up to 30 percent less greenhouse gas emissions than the baseline 2005 shop, according to its 2011 CSR report. At its current locations, energy usage has been decreased by installing skylights for natural light and using more energy-efficient light bulbs. Additionally, Walmart has attempted to turn waste management at its facilities from a loss to a profit.

**Inventory**

As we've discussed in this book, most supply chains concentrate on raw materials, work-in-progress, and completed products inventory, but very few pay attention to the inventory that is often stored in landfills. Even though it may not appear on a company's financial sheet, inventory in a landfill is one of the most detrimental factors from a sustainability standpoint. Hazardous additives or materials and energy that are still trapped in landfills may be the cause of the damage. When a product is put into a landfill, it is perhaps the biggest waste in any supply chain since the resources and energy required to make it are now gone forever and

might even cause damage. Every supply chain should strive to keep track of its garbage inventory and sort it according to potentially dangerous additives and unused value. A life cycle assessment (LCA) is a method for determining the environmental effects of a product from conception through disposal.

In order to unlock the unused value in items when they are removed, the detrimental inventory should be reduced or at least limited [9]. According to McDonough and Braun art, cradle to cradle design is crucial if we want to significantly reduce the amount of waste that a supply chain generates for the landfill. Designing goods that, when their useful life is over, do not become useless waste but can be thrown onto the ground to decompose and become food for plants and animals and nutrients for soil; or, alternatively, they can return to industrial cycles to supply high quality raw materials for new goods is suggested by the authors. For instance, Walmart lowered the hazardous phosphate content of laundry and dish detergents in the Americas by 14.5% in 2011 with the aim of achieving a 70% reduction. The business also changed the way its packaging was made, eliminating 91% of the jeweler pallets and using recyclable materials for all of its jeweler boxes.

**Transportation**

Another factor where businesses may discover multiple options for favorable cash flow is transportation. Any supply chain innovation that reduces the cost of transportation tends to also decrease the emissions and waste produced by transportation. Walmart said in its 2011 CSR report that between 2005 and 2010, company used 65 percent less gasoline to transport a case of goods in the United States. The reduction in cost and environmental harm brought about by this development via greater aggregation, more effective loading of transportation vehicles, and an increase in their fuel economy. In order to achieve greater economies of scale in their recycling activities, four companies Hewlett-Packard, Electrolux, Sony, and Braun joined forces to develop the European Recycling Platform. According to Lee, HP only pays 1- or 2-euro cents to recycle digital cameras in nations that have the environmental platform, compared to 7-to-1.24-euro cents in those that do not.

The supply chain's main Application of sustainability are as follows:

**Green Procurement:** The choice of environmentally friendly suppliers is the first step in creating sustainable supply chains. Companies might develop standards for assessing their suppliers' environmental practices, such as their use of sustainable materials, waste management, and energy efficiency. Businesses may lessen their environmental impact and advance sustainable practices across the supply chain by prioritizing green buying. Transportation and warehousing are only two logistics-related activities that have a big influence on sustainability. Carbon emissions may be decreased by utilizing eco-friendly transportation strategies, such as driving electric cars or planning routes that use less gasoline. Implementing sustainable storage practices, such as employing energy-efficient buildings and waste management plans, also supports sustainability initiatives.

**Ethical Labor Practices:** A crucial component of sustainability is ensuring respect for human rights and fair labor practices all throughout the supply chain. Companies should do due diligence to confirm that their suppliers uphold labor laws, provide secure workplaces, and uphold employees' rights. A sustainable and socially responsible supply chain may be created by putting an emphasis on ethical labor practices.

**Recycling and Waste Reduction:** Promoting recycling and reducing waste production are essential for sustainability. Energy use and material waste may be decreased by putting waste reduction techniques, such as lean manufacturing principles, into practice. To handle and dispose of waste products responsibly and promote a circular economy, businesses may also set up recycling programmers.

**Collaboration and Transparency:** For a supply chain to be sustainable, parties must work together. Building a healthy supply chain ecosystem requires open communication among suppliers, customers, and other stakeholders on information, best practices, and objectives. Stakeholders are better equipped to make informed choices and work together to achieve sustainability goals when reporting and communication are transparent.

**Life Cycle Assessment:** Life cycle assessments (LCAs) are used to examine how goods' environmental effects change over the course of their whole lives, from the extraction of raw materials through their eventual disposal. LCAs provide light on potential improvement areas for sustainability, such cutting down on energy use [10].

## CONCLUSION

It is becoming more and more obvious that unless supply chains become more sustainable, the world's resources and environment will not be able to support the rise of new nations. A greater emphasis on sustainability has enabled certain supply chains to lower risk, become more efficient, and even draw in some consumers who appreciate these efforts in addition to the need to make the world more sustainable. Many acts that increase a supply chain's sustainability include local costs to a person, a company, the supply chain, or a nation, but they also bring about widespread benefits that are more universal. Disregarding sustainability, on the other hand, results in local gains but global costs. Therefore, it might be difficult to promote sustainability without some outside pressure, such as a government mandate or financial incentive.

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