Purchasing and Inventory Management

Preparing ..

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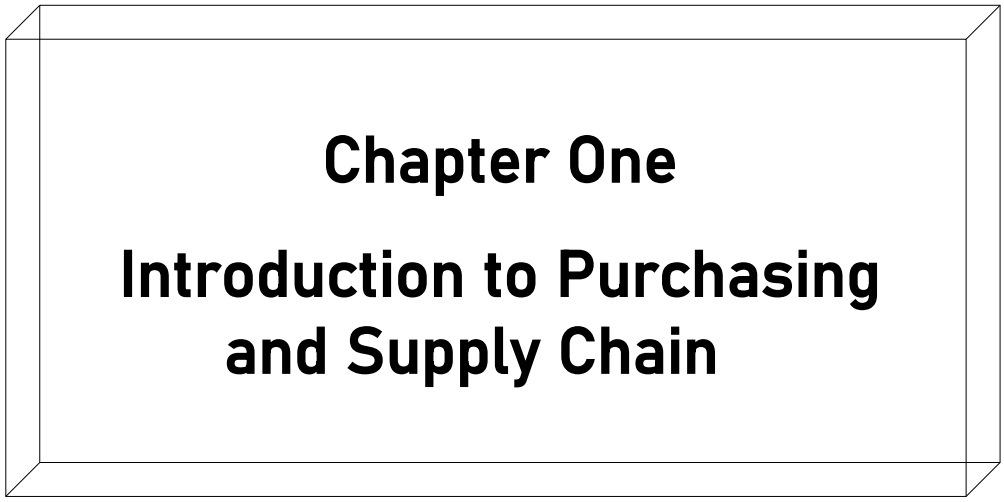
CONTENT



Chapter One

Introduction to Purchasing and Supply Chain

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1) Introduction:

No organization expects to succeed in today's business world without being competitive and world class companies have no question over the importance of purchasing and supply management in helping drive business success. This chapter addresses the following subjects:

1. What is purchasing?
2. Evolution, Trends and development of purchasing.
3. Effective Purchasing Managers' needs
4. Types of purchasing
5. Purchasing objectives and roles in corporate strategy.
6. Ethical Principles for Purchasing

2) What is purchasing?

Purchasing is the act of buying the goods and services that a company needs to operate and/or manufacture products. Many people are ignorant of what purchasing is all about. “Purchasing” is the term used in industries, commerce, public corporations to denote the act of and the financial responsibility for procuring material, supplies and services. It simply describes the process of buying. However, in a broader sense, the term involves determining the needs, selecting the supplier, arriving at a proper price, terms and conditions, issuing the contract or order, and following up to ensure proper delivery. It is known also by the process of purchasing or obtaining materials in the right quantity, in the right quality, at the right price, at the right time, and from the right supplier and delivering to the right place.

3) Materials Management

The basic **material management definition** is “the planning and controlling of all material and

equipment so they are requested in advance, obtained at a reasonable cost and are available when needed." This definition includes not only materials that go directly into the product and the equipment to produce it, but also the spare parts needed for maintenance, in order to ensure uninterrupted operations.

Direct materials

Direct materials are those that go directly into the product being sold, and therefore represent the cost and benefit of the product itself. Availability and quality of direct materials are vital for project success. Poor planning for direct materials can cause significant losses and repercussions to the business.

Indirect materials

Indirect materials are those that are part of the process, but do not go into the product itself. These materials may include items such as equipment and spare parts, etc. Their value to the product cannot be easily quantified, but their absence or breakdown

will negatively impact the process and results.

4) Importance of material management

The importance of the **material management process** is often overlooked, but its poor execution will have severe, negative consequences. To appreciate this, it helps to understand the weight of a material manager's responsibilities. The material manager must ensure the following:

- The right materials
- In the right quantities
- At the right time and place
- From the right source
- At the right price

Failure to achieve any of these can result in operational disruptions, cost overruns and wasted materials, not to mention loss of profits, market share and professional reputation.

5) Objectives of material management

The objectives of an effective materials plan fall into three general categories:

- Lower operating costs
- Optimal material selection
- Ideal inventory control

We will explore each of these objectives below.

Lower operating costs

Operational problems cause significant losses in profits, and material management errors can easily throw the process. while , an uninterrupted flow of materials lowers cost by helping to maximize productivity and efficiency. Material managers play a key role in controlling costs with their choices and control of both direct and indirect materials.

Optimal material selection

An experienced material manager will get the best price possible on high-quality materials to maximize profits. This involves keeping up with

changing variables, such as material availability and price fluctuations, and adjusting the plan accordingly. Businesses rely on **material requisition** of suitable, low-cost options without compromising quality or supply.

Ideal inventory control

Maintaining an ideal inventory is key to an effective material management plan. material manager should minimizes storage requirements and waste, while ensuring direct and indirect materials are available when needed. This means establishing re-ordering plans and projecting inventory levels to hold for work in progress and other needs.

6) How to develop a material management system

Regardless of whether the tools being used are manual, digital, or a hybrid of the two, the requirements of a useful system remain the same. Again, one may ask **"What is material management?"** in the context of a specific organization. In the broadest terms, the system must include:

- Identification of reliable, alternate sources for direct and indirect materials. Having alternate sources promotes healthy competition in cost and quality.
- An appropriate method for determining the optimal combination of price, quantity, quality and purchasing schedule of direct and indirect materials.
- Multiple options for shipping materials, including for materials with shipping restrictions.
- A plan for cost-effective inventory storage that minimizes waste without compromising supply.
- Relationships of trust and goodwill with suppliers and transport companies.
- Streamlined procurement procedures and operations to ensure a smooth flow of materials.
- Appropriate training for all workers who handle or make decisions about materials.

- An impeccable record-keeping system of purchases and inventory with an audit trail that can be validated.
- Good relationships with colleagues in departments throughout the organization.

7) Future of material management

Currently, as in all industries, business processes are undergoing a digital transformation aimed at increasing productivity and profits, reducing waste and ensuring sustainability. The use of integrated digital tools enables decision-makers to access critical information on material availability, cost, order status and inventory.

Historically, the importance of an unbroken supply chain has been undervalued, with minimal attention paid to the vulnerabilities inherent in “just-in-time” inventory models. The COVID-19 epidemic brought this to light, accelerating digital innovations that save costs and make “just in case” models more feasible. These innovations include automated software applications for tasks like material procurement

and tracking, inventory management, analytics and more. Eventual end-to-end digitization of business processes will be critical in balancing efficiency and resilience.

8) Outsourcing

Outsourcing is the use and rental of competencies, powers, individuals, means and services from institutions, companies, or third parties (foreign or local). Certain responsibilities, powers, structures and activities that were usually carried out (self) and performed internally by the requesting agency, through contracting by signing contracts and cooperation agreements that arrange and regulate the duration and subject of recourse, achievements, duties, rights and obligations, filling the gaps and meeting the interests and objectives of the requesting entity.

For example, if a company or institution employs a person to guard a place or something such as a building, equipment, or the like, but to save effort and money, the hiring company has

transferred this task with the help of third-party services (external source, external resources) capable of carrying out the task of guarding And security instead of the guard who was her employee.

Businesses are taking note. A recent study from FM Global, an insurer of commercial and industrial property, found risks to the supply chain were of most concern to financial executives in the UK – more than terrorism or sabotage, which were not viewed as a significant business threat. The survey of 500 financial executives, at companies in Europe and North America with at least GBP300m of annual turnover, found 31 per cent of UK respondents cited supply chain issues as the leading property-related threat.

9) Purchasing's Place In Business

What is the role of purchasing in business management? Why is it important? To answer these questions, the purchasing function will be observed from three points of view: first, as a function of business, second, as one of the basic elements required to accomplish productive

work; and third, as the department responsible for outside manufacturing.

i) Purchasing as a function of business

Purchasing is one of the basic functions common to all types of business enterprise. These functions are basic because no business can operate without them. All businesses are administered or managed by co-ordinating and integrating these six functions:

1. Creation, the idea or design function.
2. Finance, the capital acquisition and financial planning and control function.
3. Personnel, the human resources and labor relations function.
4. Purchasing, the acquisition of required materials, services and equipment.
5. Conversion, the transformation of materials into economic goods and services.
6. Distribution, the marketing and selling of goods and services produced.

ii) Purchased Materials as Resources or Elements of productive work

The basic goal of any industrial activity is the development and manufacture of products that can be marketed at profit. This goal is accomplished by the appropriate blending of what management authorities historically have called the five Mis: machines, manpower materials, money, and management. Materials today are the lifeblood of industry. No industrial organization can operate without them. Materials of the appropriate quality must be available at the right time, in the proper quantity, at the needed location, and at an acceptable price. Failure to fulfill any of these responsibilities concerning materials adds to company costs and decreases company profit just as surely as do outmoded production methods, inefficient personnel, and ineffective selling.

iii) Purchasing as the manager for outside manufacturing

The materials which go into a typical company's products can originate from either of

two sources. The company's production department is the first source; this department converts raw materials into processed parts. The company's purchasing department is the second source. This department not only purchases raw materials, which the production department converts into processed parts, but it also purchases finished parts and components. The parts made by the production department are combined in assembly with the items bought by the purchasing department to make the company's final products.

The percentage of industrial components being purchased externally is constantly increasing compared with the percentage being manufactured internally.

The trend in manufacturing is toward the development of three distinct types of factories. The first type does not make finished end products; it is equipped with costly high-volume specialty machines and produces machined and fabricated parts in large quantities at low unit

cost. These parts are sold to numerous factories of the second and third types. The second type of factory, like the first type, does not make finished end products; it makes subassemblies. The required parts for the subassemblies come form factories of the first type, or from the parts it makes, or from a combination of both. The third type of factory makes finished end products. As economic circumstances dictate this type of factory assembles the finished product from a combination of the parts it makes (usually parts that are unique to its product) and the standard parts or subassemblies it buys from factories of the first and second types.

In the multiple-type factory system of today, any company generally uses two distinct sources of supply: inside manufacture and outside manufacture. The production department is responsible for inside manufacture, including the authority to schedule production in economical quantities, and to do so far enough in advance to have materials available when needed.

The purchasing department, on the other hand, has the responsibility and authority to schedule the delivery of outside production. Purchasing executives have the same managerial interests concerning their outside production as production executives have concerning their internal production. Both must schedule accurately. Production executives are interested in low unit costs and high quality. Purchasing executives are interested in keeping their suppliers' costs down. In addition, they are interested in maintaining scheduled deliveries and good quality control to assure that production schedules are met and to minimize the costs of inspection and unacceptable materials.

10) Ethical Principles for Purchasing

The following are the principals that frame all ethical standards and guidelines of purchasing and supply management.

Supply management professionals should:

1. Avoid the intent and appearance of unethical or compromising practice in relationships, actions and communications.
2. Demonstrate loyalty to the employer by diligently following the lawful instructions of the employer, using reasonable care and granted authority.
3. Avoid any personal business or professional activity that would create a conflict between personal interests and the interests of the employer.
4. Avoid soliciting or accepting money, loans, credits or preferential discounts and the acceptance of gifts, entertainment, favors or services from present or potential suppliers that might influence, or appear to influence, supply management decisions.
5. Handle confidential or proprietary information with due care and proper consideration of ethical and legal ramifications and governmental regulations.
6. Promote positive supplier relationships through courtesy and impartiality.

7. Avoid improper reciprocal agreements.
8. Know and obey the letter and spirit of laws applicable to supply management.
9. Encourage support for socially diverse practices.
10. Conduct supply management activities in accordance with national and international laws, customs and practices, your organization's policies and these ethical principles and standards of conduct.
11. Develop and maintain professional competence.
12. Enhance the stature of the supply management profession.

11) Questions

1. Comment: The word “purchasing” is not used interchangeably with the word “procurement”.
2. Write short notes in each of the following:
   a- Effective Purchasing Managers' needs.
   b- Outsourcing.
3. Compare between direct and indirect purchases.
4. List the principals that frame all ethical standards and guidelines of purchasing and supply management.

Chapter Two

Supply Chain Management

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Supply Chain Management

This chapter consists of the following elements:

1- Define the supply chain.
2- Supply chain evolution.
3- Supply chain, value chain and demand chain.
4- Define supply chain management.
5- Importance and benefits of supply chain management.
6- The Seven Principles of Supply Chain Management.
7- E-supply chain management tools.
8- Basic conditions for supply chain management.
9- Elements of supply chain management.
10- Possible solutions for supply chain management.
11- Portfolio of relationships between the organization and suppliers.

1) Definition of the supply chain:

Supply chain is a sequence of organized facilities, functions, and activities that are involved in the production and delivery system of a product or service, which begin with the essential suppliers of raw materials and extending to the end customer.

- The facilities include: warehouses, factories, operating lines, distribution centers, trade offices and agencies.
- Functions and activities include forecasting, purchasing, inventory management, information management, quality assurance, scheduling, production, distribution, and customer service.

Supply Chain: is defined as a business network of facilities and distribution sources that works on processing and converting materials into semi-manufactured (intermediate) materials or finished products.

The supply chain can also be defined as:

1- It is a link of resources and operations, which begins with the source of raw materials and extends to the end customer,

including merchants, industrial facilities, those in charge of supply systems, internal distribution centers, distributors and any other entities .

2- It is to set entrances to achieve efficient integration of suppliers with customers (which includes stores, merchants, wholesalers, warehousing and producers) where products are produced and distributed in the right quantities and at the right time in order to reduce the cost of the system and provide a service at a satisfactory level.

Two terms can also be proposed to express the supply chain:

1- They are the operations that take place from the first raw materials to the final marketing of the finished product, achieving the link or linking between the companies of both the supplier and the user. This definition suggests that the supply chain relates to the theory that depends primarily on the length of physical distribution and transportation using industrial dynamic methods.

2- Functions inside and outside the company that allow the value chain to produce the product and provide services to the customer. This definition calls for a closed loop in the term (value chain) and its relationship to the supply chain, and in addition to that, the supply chain can be defined as the functions that lie within the company and that add value to the products and services through which the organization sells to customers and those that are for receiving customer payments .

It can also be defined as a business network with a consolidated, independent or semi-autonomous business entity responsible for the needs, manufacturing and distribution activities in conjunction with one or more related product families.

It can also be defined as a group of products and factories where they are all directly or indirectly interconnected through product selection decisions so that there is no product in the chain produced by a factory outside the same chain, and no factory produces products outside the chain.

Finally, they can be defined as entities placed and included in the design of the new product and service, the management of raw materials and their transformation into semi-finished and final products and their delivery to the final customer.

A supply chain may consist of three or more organizations that are directly connected by one or more lines of flow of products, services, finance and information, whether this flow is an upward flow (suppliers) or a downward flow from the source to the end customer.

2) Types Of Movement In Supply Chain

There are two types of movement in these systems: the physical movement, usually towards the end of the chain (although not all materials begin at the beginning of the chain) and the movement of information where this is done in two directions across the chain.

2 Definition of Supply Chain Management:

Supply chain management is a cycle that begins and ends with the customer. All materials, finished products, information and transactions flow through this loop, and supply chain management can be a very complex task due to the actual reality, and it is also a mobile network of facilities and organizations, with different and contradictory objectives.

Supply chain management is a combination of science and art to achieve improvement in the way a company obtains the raw materials needed to produce a product or provide a service and deliver it or ship it to customers. This requires some elements such as:

- Strength, high level of company commitment to environmental issues and support from senior management of the initial supply chain.
- Integration of work across functional departments and this includes all the different areas within the company that enable to achieve value from overlap with suppliers (such as management, environment, manufacturing, marketing, research and development, and finally distribution)

- Integrate environmental issues into existing supply chain management and design activities, as well as needs management and distribution processes.
- Effective and necessary processes to achieve the objective of making suppliers comply with the necessary environmental needs.

In addition, the supply chain is a term used to describe all the interrelated elements and processes necessary to ensure the right amount of product in the right places at the right time and at the lowest possible cost. Many software and consulting companies are developing software to access complex supply chain management for large companies according to the cost-benefit approach to maximize the value of their supply chain and to achieve large and multiple returns.

Supply chain management is the coordination of a subject of methods for planning and implementing all steps in the international information network (Internet) to obtain raw materials from the supplier and

convert them into finished products and then send products and provide services to customers and also includes chain information sharing, planning and coordination of resources and the application of international performance measures.

The supply chain management theory also shows that in order for the final product and service to have commercial advantages for the organization, it includes in the process of creating value that must be added to the process to a degree more than the cost, because this value is derived from the consumer market and is later translated into operations or Activities in the supply chain.

The term "management" in supply chain management relates to the simplified view of its administrative dimensions, which include: planning, organizing and controlling supply chain activities.

Supply chain management is the automatic integration of demand from customers to the needs of suppliers through the assessment of the enterprise resource planning system.

Purchasing, transportation, storage, quality assurance and necessary for managing the stock of materials coming into the organization, as well as the internal distribution of resources, these activities are usually combined under the name of materials management in the organization.

has set(David Ross, 1997) defines supply chain management as “the continuous development of the management philosophy, which seeks to unify the combined productive capabilities as well as business resources and functions that exist inside and outside the enterprise of business partners, and determine the importance of supply channels within the framework of competitive advantage and customer synchronization in the flow of products and services to the market and finally the information needed to create excellence as the only source of customer value.

This definition illustrates a challenge facing those responsible for supply chain management in the need to integrate three competing viewpoints:

- Supply chain management as management of the internal supply chain.
- Supply chain management as a supplier focus.
- Supply chain management as a management of the business network of the facilities, which includes the customer in addition to the suppliers.

Supply chain management involves the management of a two-way initiative to coordinate the flows of goods, services, information and finance from raw materials to the end user or consumer. and supply chain oriented organizationSC Orientation is one who recognizes the strategic value of managing operational activities and their flow across the supply chain as their scope extends across organizational or functional boundaries. These activities include purchasing, material flow, internal and external transportation, receiving, material handling, warehousing and distribution, inventory control management, ordering and supply planning, order operation, production planning and scheduling, shipping, operating and finally customer service.

Finally, supply chain management can be defined as an efficient management, as it begins with the design of the product or service and ends at the time when it is sold and finally consumed, and the consumer dispenses with it. It includes product design, needs management, forecasting, planning, production, distribution, fulfillment, after-sales service, and end-of-life purpose.

3) Supply chain , demand chain:

- The supply chain shows the direction of supply, from the source of raw materials to the final customer.
- As for the demand chain, it is represented in the demand that starts from the customer, through the retail and wholesale stores, to the manufacturing operations and suppliers of raw materials.

- Demand supply chain management refers to managing the up and down relationships between suppliers and customers to provide the customer with the optimum

value at the lowest cost. **The term "chain or network oriented-by-demand" refers to that the flow of material managed by customer demand** .

Customer demands control the main flow of the demand- network. Compared to the traditional supply chain, the demand network uses pull strategy. It provides the demand-chain with opportunities to share more information and collaborate with others in the chain. (learn more about bull and push strategy)

The demand network uses the four-level model.

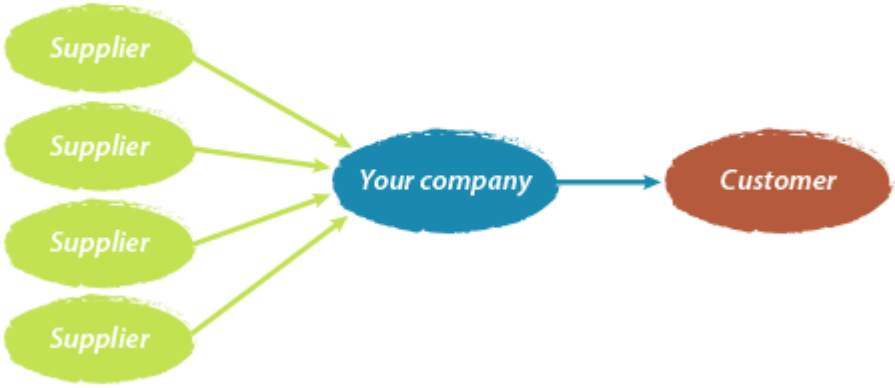
- The first level: is the response
- The second level expectation
- The third level cooperation
- The last level is organized work.

The first two levels focus on the internal supply chain while the other two levels focus on external relations throughout the extended organization.

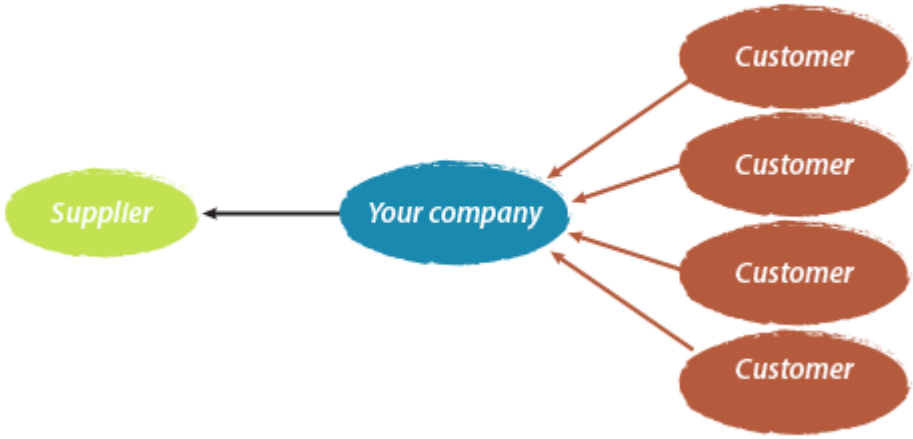
To generate sustainable competitive advantages with a demand network, companies must adhere to three conditions:

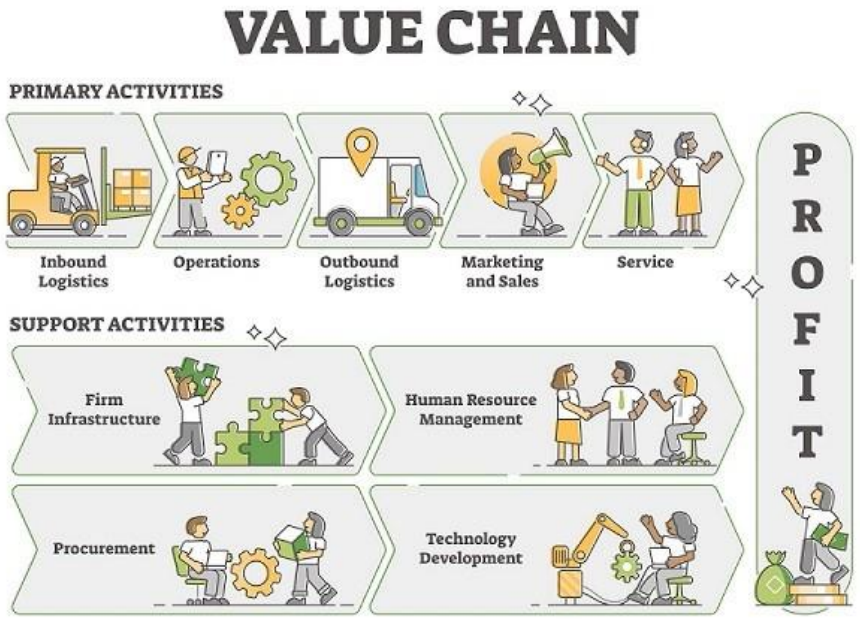
- Regularity (creating joint activities)
- Speed of reaction (responding quickly to short-term change)
- and adaptation (adjusting supply chain design)

Supply Chain Management



Demand Chain Management





4) Push vs. Pull Supply Chain Strategy

A company's supply chain stretches from the factory where its products are made to the point the products are in customer hands. Supply chain strategy determines when product should be fabricated, delivered to distribution centers, and made available in the retail channel. Under a pull supply chain, actual customer demand drives the process, while push strategies are driven by long-term projections of customer demand.

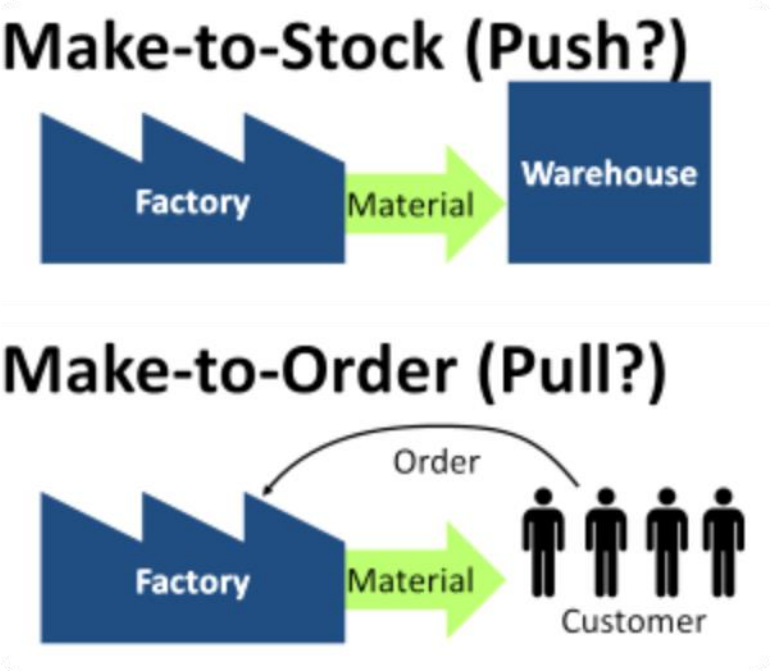
Push Supply Chain Strategies

A push-model supply chain is one where projected demand determines what enters the process. For example, warm jackets get pushed to clothing retailers as summer ends and the fall and winter seasons start. Under a push system, companies have predictability in their supply chains since they know what will come? When? long before? it actually arrives. This also allows them to plan production to meet their needs and gives them time to prepare a place to store the stock they receive.

Pull Supply Chain Strategies

A pull strategy is related to the just-in-time school of inventory management that minimizes stock on hand, focusing on last-second deliveries. Under these strategies, products enter the supply chain when customer demand justifies it. One example of an industry that operates under this strategy is a direct computer seller that waits until it receives an order to actually build a custom computer for the consumer.

With a pull strategy, companies avoid the cost of carrying inventory that may not sell. The risk is that they might not have enough inventory to meet demand if they cannot ramp up production quickly enough.



5) Importance and Benefits of Supply Chain Management:

Since World War II and with the solutions provided by management science and operations research, there has been an increase in the

importance of supply chain planning and management, and by working as a team, supply chain planners and managers and all members at the beginning, middle and end of the chain have the ability to increase revenue and also control cost, in addition to better utilization for assets And finally, customer satisfaction.

The software needed for optimization is integrated at the chain level, in addition to proposing mathematical modeling solutions to supply chain problems. For example, the software package provides us with the optimal way of supplying from the supplier to the product and then to the customer. In sum, fulfilling the desires of customers and enjoying an increase in profitability is a natural result of achieving optimal efficiency through supply chain management.

Optimization allows to improve the performance of the company's supply chain in several diverse areas, namely:

- Reducing the cost of supply.
- Improving the marginal profit of the product.

- Increasing manufacturing efficiency (at all levels).
- Better return on assets (net profit after costs and interest).

The primary benefits of supply chain management to the customer are achieved as there is a reduction in inventory by transporting products directly to the place of purchase and then storing it and being responsible for it. As for the impact on the supplier, it may be more difficult to initially classify it as benefits. The matter varies, but it may include benefits for both customers and suppliers as follows:

Customers:

One of the most important aspects of business is achieving customer contact and acquisition, and supply chain management helps the organization achieve this, because the chain simply begins and ends with the customer. Did he know what he wanted? And when does he want it? And the speed of delivery of products to him.

Cost:

An efficient supply chain can reduce costs, increase market share and sales, and build or achieve strong customer relationships. All of this leads to savings, which means an increase in the cash flows of the enterprise, which raises the market value of the shares. And the supply chain is a means to achieve operational excellence in order to increase the market value of the facility, and good management of the supply chain also ensures that the right quantities are shipped abroad at the lowest prices in order to reduce distribution costs, and transportation and trucks are chosen to ensure timely delivery at the lowest possible cost.

Market value :

Supply chain optimization can positively emphasize five factors that lead to market value: sales growth, cost reduction, efficient use of fixed assets, excellent business performance, and a defined tax bracket. In an efficient supply chain, the right amount of products moves quickly to the market, resulting in high sales. Since the customer finds what he needs when

he goes to buy, the stores do not lose any sales that can be sold.

capital costs:

In an optimal supply chain, capital costs such as factory and warehouse operating costs are minimal. If orders are more than sales forecast, which is the basis for production and manufacturing, production will be more synchronized than customer demand. And then stock on demand is at a minimum, which reduces the number of stores needed to serve the customer.

Capital savings:

In addition to reducing costs, the effective management of the supply chain will maximize the working capital of the company, because inventory will be immediately converted into notes receivable, and from a financial point of view, this transformation of inventory into cash will positively affect the market value of the enterprise.

A clearer understanding of supply chain management leads to some benefits and outcomes, including:

first Helping managers focus on organizational goals and then achieve the effective communication needed to manage initial supply chains, which leads to the success of companies in general in achieving their goals .road Deloitte Consulting showed that 91% of North American producers rated supply chain management as vital to the success of companies (although only 2% said their current supply chains represented a global ranking).

the second Initial supply chains are most likely or most likely to receive support when others cross the organization to understand the importance of supply chain management.

the third Work across functional departmentsCross-functional is the nature of supply chain management to require functional support before companies can create globally ranked supply chains.

The benefits of supply chain management may be:

1- Work faster and more efficiently through the rapid distribution of documents.
2- Make decisions quickly and reduce the time needed to reach the market.
3- A form of partner trading.
4- Better communication.
5- Strengthening relationships with existing clients.

The importance of supply chain management also stems from the need to apply it effectively, and then there are several issues that push organizations to the need to adopt a supply chain management approach, which are:

1- The need to improve operations.
2- Raising the levels of external purchase.
3- Reducing transportation costs.
4- Increase the importance of e-commerce.
5- Increasing competition pressures and expanding the scope of globalization.
6- The complexity of supply chains and hence the need for effective inventory management.

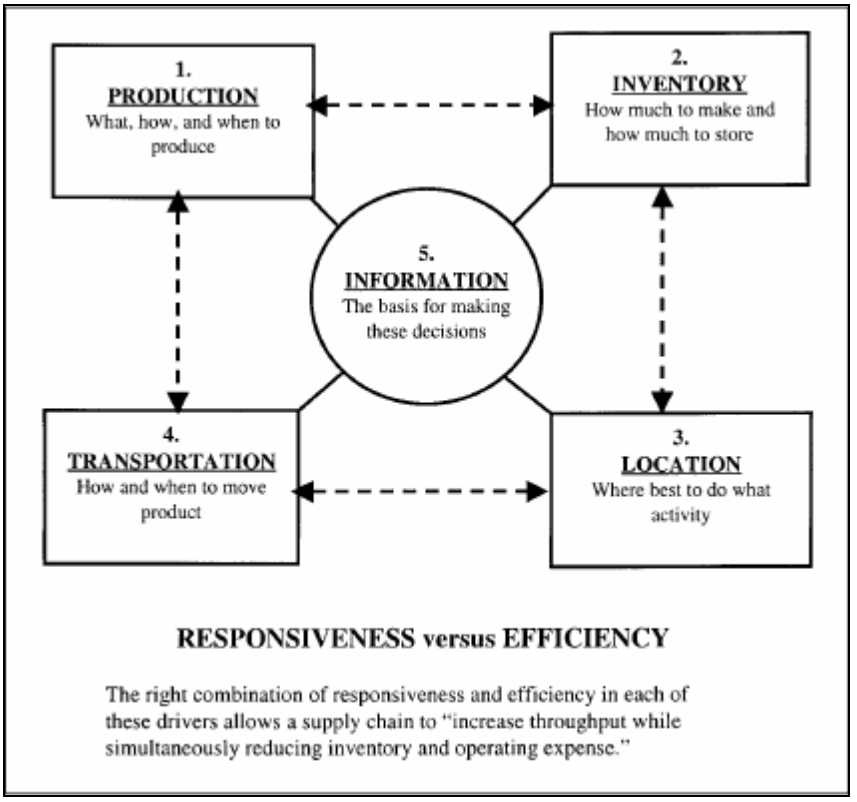
In addition to the above, the possible benefits and obstacles to expected or potential

improvements in the supply chain can be identified, as shown in the following table:

Table (1) Benefits and Constraints of Supply Chain Improvements

Obstacles	the benefits	Possible improvements	the problem
- Increased application costs. Increased supplier costs.	Reducing inventory holding costs.	Reducing inventory volume, more repeat ordering, incoming goods without storing them in warehouses.	* Increasing inventory
It may not be useful. Jobs are likely to be saturated.	- Responsiveness . - Responsiveness .	Elimination of some intermediate stages. Storage necessary for product maturity.	* Length of supply periods
Less diversification.	- Keep some parts. The request is small.	Standard design.	* Increase the number of parts
Inability to control.	Cost reduction. - Raising the level of quality. Focus on operations	External purchase.	* Cost and quality
Less change.	Greater ability to match demand and supply.	Less supply times. Better prediction. Reducing change in product and service.	* Ability to change

6) The Five Major Drivers of Supply Chain



Performance

There is a basic pattern to the practice of supply chain management. Each supply chain has its own unique set of market demands and operating challenges and yet the issues remain essentially the same in every case. Companies in any supply chain must make decisions

individually and collectively regarding their actions in five areas or drivers.

These five areas where companies can make decisions that will define their supply chain capabilities: Production; Inventory; Location; Transportation; and Information can be defined as performance drivers that can be managed to produce the capabilities needed for a given supply chain.

Effective supply chain management calls first for an understanding of each driver and how it operates. Each driver has the ability to directly affect the supply chain and enable certain capabilities. The next step is to develop an appreciation for the results that can be obtained by mixing different combinations of these drivers (see next figure) which are:

Production

What products does the market want? How much of which products should be produced and by when? This activity includes the creation of master production schedules that take into account plant capacities, workload balancing, quality control, and equipment maintenance.

Inventory

What inventory should be stocked at each stage in a supply chain? How much inventory should be held as raw materials, semi-finished, or finished goods? The primary purpose of inventory is to act as a buffer against uncertainty in the supply chain. However, holding inventory can be expensive, so what are the optimal inventory levels and reorder points?

Location

Where should facilities for production and inventory storage be located? Where are the most cost efficient locations for production and for storage of inventory? Should existing facilities be used or new ones built? Once these decisions are made they determine the possible paths available for product to flow through for delivery to the final consumer.

The Five Major Supply Chain Drivers

Transportation —

How should inventory be moved from one supply chain location to another? Air freight and truck delivery are generally fast and reliable but

they are expensive. Shipping by sea or rail is much less expensive but usually involves longer transit times and more uncertainty. This uncertainty must be compensated for by stocking higher levels of inventory. When is it better to use which mode of transportation?

Information

How much data should be collected and how much information should be shared? Timely and accurate information holds the promise of better coordination and better decision making. With good information, people can make effective decisions about what to produce and how much, about where to locate inventory and how best to transport it.

7) The Seven Principles of Supply Chain Management:

Many companies are moving aggressively to improve their supply chain management by balancing customer demands with the need for profitability growth. These efforts reflect the seven principles of supply chain management

that, in combination, can increase revenue, achieve better cost control, and better use of assets as well. To customer satisfaction, and successful application These principles will convincingly demonstrate customer satisfaction and further growth in profitability.

First principle Dividing customers into distinct groups based on their need for service and adapting the supply chain to serve these profitable segments:

The traditional division of customers - into groups according to industry, product, and distribution channel - gives the opportunity to serve each group more efficiently in terms of average costs and profitability within and across customer segments. The question now is, can the company achieve a full understanding of the value associated with the status of customers through the level of service to them? The answer is no.

But dividing customers into segments according to their own needs, enables the

company to develop its services portfolio and makes it more adaptable to different segments. Studies, interviews, and industry research are traditional tools for identifying key segmentation criteria. Today, the advanced and sophisticated product is turning to all advanced analysis methods such as cluster analysis and factor analysis to measure the conflicting advantages of the customer and predict the marginal margin of profitability for each segment.

The advanced producer is the one who makes internal improvements, builds databases of products, divides them according to sales and according to the needs of merchants, fulfills sales orders and uses the necessary accounting standards that support this division

The second principle Preparing the network of supply systems according to the needs of the service and according to the profitability of the customer segments:

Companies take the traditional harmony approach to designing their supply systems

network in organizing their inventory, warehousing and transportation activities in order to achieve a single standard.

For some, the supply chain network may be designed to meet the average service needs of all customers, and for others it may be designed to satisfy the overall needs of a single customer segment.

The last approach to designing a supply chain network - aims to distinguish supply chain management by achieving effective and efficient use of assets - and appropriate for a specific segment, is used in many industries, especially industries that produce final consumer goods, where distribution assets are prepared to meet the needs of individual supply systems Which represents the biggest source of distinction needed for the product more than the actual products, which may not be distinct in a large way.

Third principle.: perceive market signals, and map demand congruently via The supply chain,

achieving accurate forecasting and optimal allocation of resources:

Forecasting is a historical procedure based on a time series, and at the level of different departments, which may work independently, there may be forecasts for the same products and each department has its own assumptions, measures and level of detail, because the career orientation of many companies creates some problems in the process of forecasting demand Because self-centered forecasting and based on the company's administrative departments is considered incompatible with the distinguished management of the supply chain.

To achieve excellence in the supply chain, the producer must focus on applying the planning process across functional departments(CFPP) Cross Functional Planning Process based on Demand Planning Software (DPS).

Fourth principle Achieving complete product excellence for the customer and rapid transformation across the supply chain:

Producers build production goals - traditionally - on probabilistic estimates of demand for finished products as well as stock and reserves of those products, taking into account forecasting errors, and these producers tend to know the supply periods in the system, which are often fixed periods, with a final time for transferring materials into products to meet customer needs.

Whereas all traditional methods can achieve cost savings by reducing setup costs, manufacturing cells, procurement methods, manufacturing and purchasing on demand.(JITP) and the high probability of remaining at the minimum for traditional strategies.

This is because in the large production strategy according to the customer's request, the producers tend to meet the needs of the individual customer efficiently, and here the problem of postponing production may arise due

to the lack of obtaining the assembly needs from the suppliers, and there is no doubt that postponing production delays the product excellence for the customer, and the supply chain management deals with this problem Through stock keeping units(SKU) as well as the supply strategy at production through the automatic supply process.

Fifth principle Strategically manage the source chain in order to reduce the total cost of materials and services:

The producer traditionally does not have to care for warm relations with suppliers because the right supplier from the producer's point of view is the one who offers the lowest possible price for the materials while remaining constant without regard to these relations. However, superior supply chain management requires more focus of mind to recognize and be satisfied with the supplier's cost structure. Hence, the objective of cost reduction across the supply chain is to achieve the lowest market prices for the final product in the chain, thus increasing the

profit margin. A logical extension of this is profit/sharing arrangements where Each individual contributing to increased profitability is rewarded.

Sixth principle Developing the supply chain with a technology expansion strategy that supports multiple levels of decision-making and gives a clear view of the flow of products, services and information:

With the continuity of the process re-engineering approach (by abandoning the career orientation and focusing on the operations orientation), many advanced companies are undertaking the replacement process despite the weak integration of information systems with the company's main operating systems. One company put in full year revenue for the widespread use of its software and services in its operations. The United States as a whole in 2002.

Many companies have found themselves a victim of the new transformation systems that they put into practice, because many of the

leading information systems can obtain large sets of data, but it is not easy to translate this in a viable manner, to the extent that increases the real value of the operations globally.

Seventh principle Adopt a channel that links performance measures to ensure aggregate success To the end user efficiently and effectively:

Most companies look inward and apply any number of functionally oriented metrics, but a great supply chain manager takes an outward look, adopting metrics that apply to every link in the supply chain and include both the service provided as well as the financial aspects:

Or not: The level of service is measured in terms of the completion of the order until it reaches where it was agreed, Which completepricing, and invoicesoundAnd the contents are not spoiled, and the whole thing is not only that it relates to the supply chain as an advanced performance measure that must happen but also the view of performance from the customer side as well.

Secondly Distinguished supply chain managers determine the true profitability of the service from their point of view by determining the actual costs as well as the revenue from the activities needed to account for the ledger. cost derivatives.

8) Electronic Supply Chain Management Tools:

There are a number of tools available to organizations to facilitate supply chain management and some of these key tools can be presented as follows:

1- International Information Network (Internet)

In the years from 1990-1992, the use of the information network became available globally and major developments occurred for organizations based on that. .

has set(Bateson), in cooperation with his wife (Margaret Mead), the importance of information for electronic supply chain management in the extent of the success of

cooperation between the various parties involved in the supply chain in addition to its presence in the environment, as information such as language requires a real translation of meanings when cultural boundaries are crossed. In electronic supply chain management, when information leaves one user destined for the other user, it needs to be applied effectively on the part of that user.

The visible part of the international information network (the Internet) has emerged in electronic commerce as a new channel of trade and distribution.

2- Electronic data exchange:

Over the last decade, which is characterized by the phenomenon of a single economy, the growth of technology and market forces, the process of reinventing supply chain strategies has emerged, and some of these forces include business globalization, the impact of product diversification, the increasing complexity of supply networks and the shortening of product life cycles.

In order to achieve competitive advantages, companies seek to achieve greater coordination and cooperation with the participants in the supply chain in what is known as the entrance to (supply chain integration).

Supply chain networks are primarily designed to serve the goal of speedy completion or expediting the fulfillment of business demand.

The use of the electronic data interchange process helps organizations to document the electronic exchange of business, as well as providing standard procedures established for organizations to follow among themselves and between suppliers and customers.

The existence of the term e-business aims to accelerate the achievement of the goal of supply chain integration, as it refers to the planning and implementation of operations at the front and end of the supply chain using the international information network.

The e-business approach helps companies achieve significant returns through efficiency improvements that result from: better use of assets, faster access to the market, reduction in

total time to complete the order, increased customer response service, penetration of new markets, and then a high rate of return on Assets, and in general increasing the wealth of owners (shareholders).

3- Software used in electronic supply chain management:

The best picture of a supply chain management program is that a program can be segmented for each group of applications in the factory. The supply chain as well as a program that helps in implementing the same supply chain steps as follows:

First: Supply Chain Planning Program: Supply chain planning

This program uses algorithms and mathematics to help improve the flow and efficiency of the supply chain, as well as reduce inventory to a minimum.

There are planning applications available for the five major components or elements of a supply chain: plan, source, manufacture,

delivery, and returnsThese applications determine the volume of products required to meet the different customer demands.

Some organizations may go further, as this program includes several sub-programs:

أ- Material Requirements Planning Program:

Material requirements planning is one of the effective tools used in supply chain management, as it is based on the philosophy that every raw material and part or assembly parts required in production must arrive simultaneously. This also helps in the planning and coordination process of the supply chain in the organization.

Effective planning of material needs is linked to the rapid fulfillment of demand, as the former allows the manufacturing process to be placed at the center of supply chain performance. Added to both the company and the end customer, information arises from the manufacturing process, technical details, accuracy, as well as real time production,

moreover the value generated by all participants across the supply chain, this information remains mainly at the heart and core of advanced planning and scheduling software Advanced planning and Scheduling, which - with distinct environmental participation at all levels of the chain - leads to the collaborative decision-making of production scheduling to meet customer demand expectations.

B- Enterprise resource planning program: Enterprise Resource Planning

Enterprise resource planning helps organizations to maximize the returns achieved by maximizing the use of those organizations of fixed resources needed for supply with the help of information technology, related to places of demand, shipping forms and power phased operation. It also includes marketing, inventory control, transportation orders, customer services. Finance and human resources.

C- Distribution Needs Planning Program:

Distribution Requirements Planning:

It is a necessary system for inventory management and distribution planning, as it is an extension of the concept of material needs planning, and this system divides inventory into different groups of stores where it starts with demand at the end of the distribution channel and works backward through the storage system to obtain or achieve an interim timing to replace the tables necessary for the movement of inventory Through the storage network or warehouses. It is used by management to plan and coordinate transportation, warehousing, labor, equipment, and financial flows.

Second: Supply Chain Implementation ProgramSupply chain Executive

The Supply Chain Management Executive Program automates the different steps of the five components of supply chain management. In a simplified way, this is done electronically, starting with the orders at the factory and even the suppliers needed to provide the manufacturing needs of the products.

9) Basic Conditions for Supply Chain Management:

Supply chain management strategies should focus on business relationships that are characterized by:

1- long term.
2- Collaboration is in nature.
3- Demonstrate that the system is open in the sense that information must be shared between all elements of the chain.
4- Find an end to hostile relations with suppliers of products and services.
5- Looking at the ultimate goal is to ensure that the supply chain manager is not just a functionally specialized technical expert but a relationship manager as he focuses objectively on both internal and external relationships.
6- Seeking to exploit modern information technologies in order to raise the competitive advantages of all members of the supply chain, which results in a reduction in mediocrity Disintermediation, which means reducing one or more steps of the supply chain by abbreviating one or more internal intermediaries.

Depending on the previous element, it is also possible to benefit from what is known as the second information technology: I 2 Technologies, where this technology was found in 1988 on the principle that manufacturing planning can not be implemented alone faster, but it can be based on the real objectives of the business and the conditions surrounding the facility.

Since that time, the second information technology has been developing rapidly and in an integrated manner, as smart planning technologies have been developed for all aspects of production? Delivery and sale of products and services comprehensive solutions that support smart e-business and e-commerce.

Some detailed conditions are also required for supply chain management to operate efficiently and effectively, which are:

1- Customer Satisfaction:

Customer satisfaction is a desirable end result of a supply chain management strategy, and a typical measure of customer service is a

company's ability to deliver orders in a timely manner or its ability to deliver products to customers within the agreed time frame.

2- Inventory:

Industrial entities have stocks of raw materials, in-process products and finished products. In addition, there are often warehouses or distribution centers between the different levels of the supply chain, and there is no doubt that inventory is a disruption of capital. Moreover, the cost of holding inventory is often 20: 40% of the stock value. It is also desirable to avoid what is known as idle stock.

3- Flexibility:

Flexibility in general is the ability to respond to environmental changes. In the case of a product that depends on the manufacturing process, flexibility is the ability to change output in response to changes in demand. Inventory .

10) Elements of Supply Chain Management:

The elements of supply chain management are represented in five main elements, followed by some complementary sub-elements, which determine how to work in the supply chain in detail, namely:

1- planThe plan is the strategic part in supply chain management because the primary goal is to achieve the customer's demand for the product and service. The largest share of planning is focused on developing the matrix set up to control and direct the supply chain so that it can be described as efficient, achieving the lowest cost, highest quality and highest value for customers.

There are some detailed elements:

أ- Customers: i.e. determining what products and services are required by customers.

ب- Forecasting: Predicting the quantity and time of a customer's order.

2- SourceIt is the process of selecting the suppliers needed to ship or deliver the

products and services needed to create the product and provide the service, in addition to determining the appropriate price, shipments and payments to suppliers, creating the necessary matrices for control and improving relationships with these suppliers, as well as setting up the combined processes for managing the inventory of products and services to be received from suppliers. Including receiving shipments, verifying them and transferring them to production facilities. It includes some sub-elements such as:

أ- Inventory: That is, meeting demand needs with effective management of inventory holding costs.

ب- Evaluation: ie evaluating potential suppliers and then achieving quality control for them, taking into account delivery on time and flexibility, in addition to maintaining relationships with suppliers.

3- madeThis component relates to the manufacturing step, where the activities necessary for production, testing, packaging and preparation for delivery are scheduled. This step is considered the most intense and heaviest part of the supply chain, where the

levels of quality of outputs are measured and the productivity of human resources is measured. It includes two sub-components:

أ- Design: This means the integration of customers and their needs, with the manufacturing capacity and the time required to reach the market.

ب- Operation: In which the focus is on quality control and work scheduling

C- Location: ie determining the locations of the facilities.

4- Delivery: This component is called the termLogistics means the best supplying systems and means the best movement and storage of materials by managing the processes related to coordinating the receipt of orders from customers, developing the warehouse business network, arranging a transportation fleet to deliver finished products to customers, and setting up an effective system for preparing invoices and receiving receipts from customers. In addition to the above, there are five basic issues for the effectiveness of supply systems: product movement, information movement, time and service, cost, integration internally between different systems and externally between

different organizations involved in the supply chain.

In addition, supply systems require several components to be effective, including:

- Quick response to orders from the time the order was received, during shipment, until the delivery of the invoice and obtaining the financial dues.
- Preparing the batch in terms of packaging, trademark, printing on the covers and placing them in bales.
- Coding.
- Completeness and accuracy of orders - that is, no return orders.

5- Yields This relates to receiving returns from defective or redundant products to customers, and receiving complaints from customers regarding the products delivered to them and working to solve them.

11) Possible solutions for supply chain management.

1- Supply Chain Strategy:

It enables organizations to achieve alignment between overall business strategy and current supply chain operations, in order to build a value base, taking into account the element of time, to achieve the required improvements and create sustainable value for business operations and roadmap systems at the long-term level.

2- Product life cycle management:

It is those that achieve the integration of solutions placed across the central network, which enables the organization to collaborate with customers, suppliers and partners, in order to achieve information sharing during the product life cycle, by integrating supply chain solutions at the level or stage of product design, customers can be helped to achieve the design suitable for them, and launch the most innovative products faster while reducing costs to a minimum.

3- Advanced Planning Solutions:

This helps to plan for customers, manage the flow of raw materials and achieve more accurate demand forecasting, effective inventory

planning and production schedules, and also allows full understanding and knowledge of salesmen, customers, distribution channels, operations and integration of various capabilities in the organization, and can also extend the scope of this across the facilities involved in operations Multi-business, achieving the feasibility of the supply chain for all its participants.

4- Procurement, procurement and management of strategic needs:

This allows to increase strategic partners and suppliers, as well as manage relationships with the supplier more successfully, in addition to achieving the flow of procurement operations through the use of full automation and the rules of the international information network "Internet" and the application of self-service method.

It also helps to identify customers with a world-class rating, share information, and manage more effectively to deal with suppliers and evaluate their performance for all

operations from the moment the product is designed until the needs are met.

5- Supply Chain Operations:

It means focusing on how to manage the production process efficiently and more reliably whenever possible, and implementing the manufacturing process and managing inventory and stores, and this can help improve the efficiency of production processes, raise the quality of manufacturing and increase the quality of the final product.

6- supply system:

It is the setting of borders with trading partners in order to manage external issues that revolve around the required strategy, as well as managing operations across functional areas, which include transportation within the organization, transportation outside the organization and physical distribution, as well as between near and far buyers' facilities.

7- Dealing with business partners:

This helps to increase trust between participants in the supply chain and in sharing data, applications and processes through the means of the international information network technology rules "Internet". It also helps to establish the technology and processes necessary for electronic interaction, improve information flow, and clarify the feasibility of sharing data throughout the supply chain.

8- business network:

It is the one that achieves integration and trade exchange with the international information network "Internet". These exchanges allow interaction, where a balance or total balance can occur for the supply chain community. It can also help to create efficient commercial structures that can reduce the cost related to the supply chain. Improving the delivery cycle and raising the efficiency of total quality management.

12) E-Commerce :

The concept of e-commerce is related toEC is closely related to supply chain management, as the latter seeks to separate the barriers between organizations and rely on speed in making decisions and providing products, as well as speed of response to customer needs. The traditional form of e-commerce, whether to promote products or to purchase parts, in order to achieve the degree of speed required to perform operations and perform tasks.

E-commerce can be defined as the use of computers and advanced means of communication in the organization's daily dealings, which can affect the organization's daily operations, such as daily dealings with suppliers, customers and distributors in order to achieve the organization's goals. Electronic commerce is necessary when modern and rapid means of communication are available with customers, suppliers and members of the supply chain network, but the primary objective of e-commerce is to create a new type of commercial environment in an electronic way to

link the buyer and seller, which reduces the costs of commercial transactions.

13) Portfolio of relationships between the organization and suppliers:

suggest(Bensaou 1999) A portfolio of relationships between the organization and suppliers depends on the interaction of two factors:

1- Buyer's Specific InvestmentsBuyer's Specific Investment represented by the vertical axis and includes:

أ- Tangible investments: buildings, tools, equipment or products.

ب- Intangible investments: such as individuals, time and efforts made to educate and raise the performance of the supplier or exchange information, training and knowledge necessary to develop the form of the relationship between them.

2- Fixed investments of the supplier:

Supplier's Specific Investment

It is represented by the horizontal axis and includes:

أ- Tangible investments: such as a factory or a distribution site (wholesaler).

ب- Intangible investments: such as sending engineers to develop information systems to be compatible with buyer's databasesDSS, or data exchange protocol electronicallyEDI.

This interaction created four types of relationships, which are illustrated in the following figure:

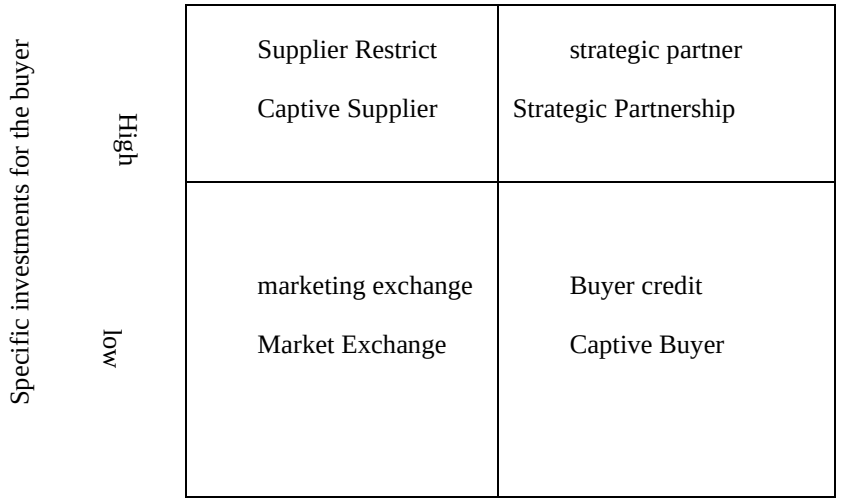


Figure (1) Portfolio of relations between the organization and suppliers

1- Strategic partner: in which both partners provide specific and high-value assets to the relationship, They are considered as real commitments to the force Relationship.

2- Restrict the supplier : Asymmetry in the relationship, the supplier is held hostage by Buyer, while the buyer can switch from a customer to another freely.

3- Marketing exchange: in which each development partner offers assets to work with other ways, and each partner in this situation can Entering the market and switching to another partner at the lowest cost A possible loss.

4- Buyer restriction: asymmetry in the relationship, the buyer is considered a hostage to the supplier, while the supplier can freely switch from one customer to another.

The type of appropriate relationship is determined according to the type of product offered, the current market and the conditions of the supplier.

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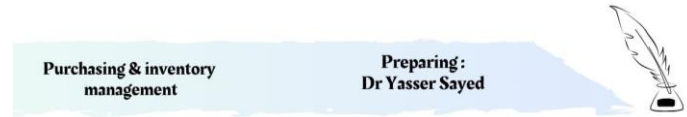

Chapter three
The Organization and Process of Purchasing Management

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The Organization and Process of Purchasing Management

1) Introduction:

The purchasing function has changed dramatically over the last several years. And it continues to change and evolve almost daily. This chapter addresses the following subjects:

1. The role and objectives of purchasing department.
2. Modern Purchasing Department.
3. Centralization and Decentralization of Purchasing.
4. How to design a Purchasing Process.
5. Organization's Purchasing Process

2) The Role and Objective of Purchasing in Organizations

The ability to source adequate supplies from reliable companies in the timeframe required is only one definition of good purchasing. The purchasing function has to also ensure that everything is available at the right price but also the right quality.

Managing purchasing effectively well will ensure that it continues to perform as desired by the organization. A key competence for any organization is the ability to always make the right "make or buy" decisions, or "do or buy" for service organizations.

Essentially the role of purchasing is to support the organization's corporate strategy in three key ways:

- Minimizing the organization's expenditure to improve profit and/or contribute to growth and success by getting better value for money, reducing costs or both as appropriate. This also includes implementing processes that are cost

effective so that time and other resources are not spent on activities which add little value.

- Minimizing commercial exposure by managing supply chains to ensure confidence; apportioning risk appropriately; ensuring compliance with relevant legislation etc.
- Bringing knowledge of the supply market and opportunities that the company can exploit for profit.

There are many different purchasing **strategies**, but all need to respond to the basic objectives of serving the markets in which the organization operates. For instance, one organization might benefit from a supplier rationalization program i.e. dramatically reducing the number of suppliers to give more business to fewer suppliers in exchange for lower costs and improved terms and conditions and service. This would then deliver a more cost competitive product where price is the key order winner. Another might benefit from standardization of products in order to generate

leverage i.e. more business of the same type to offer the market place. Purchasing and supply management professionals must have a wide range of solutions that need to be carefully selected to support an organization's corporate objectives.

The **objectives** of a world-class procurement organization move far beyond the traditional belief that procurement's primary role is to obtain goods and services in response to internal needs. To understand how this role is changing, we must understand what purchasing is all about, starting with the primary objectives of a world-class purchasing organization.

1- Support Operational Requirements:

This requires purchasing to:

- Understand business requirements
- Buy products and services
    - At the right price
    - From the right source
    - At the right specification that meets users needs

- In the right quantity
- For delivery at the right time
- To the right internal customer

2- Manage the Procurement Process and the Supply Base Efficiently and Effectively:

To manage the procurement process and supply base efficiently and effectively procurement must follow the following key steps:

- Identify opportunities
- Manage internal operations
- Achieve objectives

- Identify opportunities where the procurement team adds true value:
  - Evaluation and selection of suppliers
    - All purchases should go through the approved procurement processes
    - Engineering and other functional inputs are part of this process
    - Sales personnel should not be allowed to enter contractual agreements without procurement's involvement

    - Increasing use of sourcing teams
- Review of specifications or statement of work
    - Review the requirements for the material or service being provided
    - May be able to suggest alternative standardized materials that can save the organization money
    - Periodic review of requisitions can allow greater leveraging of requirements
- Acting as the primary contact with supplier
- Determining the method of awarding contracts
- Managing the supply base
    - Current suppliers are competitive
    - Identification of new potential suppliers and develop relationships
    - Improvement and development of non-competitive existing suppliers
- Manage its internal operations efficiently and effectively, including:

- Management of procurement staff
- Developing and maintenance of policies and processes
- Introducing and leveraging appropriate technology and systems
- Defining procurement strategy and structure
- Developing plans and measures
- Providing procurement leadership to the organization
- Providing professional training and growth opportunities for employees

- Achieve this objective through :
  - Leadership of procurement for the organization
  - Sourcing management
  - Ownership and accountability for sourcing processes
  - Communication of purpose, process and pay off
  - Collaboration, partnering and teamwork.

3- Develop Strong Relationships with Other Functional Groups

Internal customers of purchasing include:

- Marketing
- Manufacturing
- Physical distribution centers
- Engineering and technical groups
- Research and development
- Information technology
- Transportation and other services

4- Support Organizational Goals and Objectives:

Develop integrated purchasing strategies that support organizational strategies. Effective purchasing strategies involve:

- Monitoring supply markets and trends (e.g., material price increases, shortages, changes in suppliers) and interpreting the impact of these trends on company strategies

- Identifying the critical materials and services required to support company strategies in key performance areas, particularly during new product development
- Developing supply options and contingency plans that support company plans
- Supporting the organization's need for a diverse and globally competitive supply base.

3) Modern Purchasing Department

Here are 10 signs of a modern purchasing department:

1. The head of purchasing reports directly to the CEO of your company
2. Your department is responsible for procurement in “non-traditional” spend areas such as healthcare benefits, fleet management, facilities and construction, temporary labor, and travel

3. Purchasing is actively involved in senior management level, long-term strategic planning.
4. The purchasing staff is responsible for manually placing only a small percentage of your organization's purchase orders
5. Logistics and inventory functions either fall under purchasing on the organizational chart or are integrated into the work of purchasing staff
6. Maverick buying is a thing of the past
7. When dealing with large, frequently used suppliers, no paper is exchanged between the time that a need for a product or service is defined until the time that the supplier receives payment.
8. No major sourcing process is conducted without the use of a cross-functional team
9. You are buying from global sources and measuring non-domestic spend as a percentage of total spend.

10. Your department has social responsibility goals and measurements in place.

4) Centralization or Decentralization of Purchasing

A centralized purchasing function and a decentralized one each confer their own advantages. In a company with a centralized purchasing function, a corporate-level purchasing department makes decisions and exercises control over purchasing throughout the organization.

In a company with a decentralized purchasing structure, business units or departments purchase their own materials and supplies with no oversight from corporate headquarters. Some companies adopt a hybrid structure, in which some classes of items are purchased centrally and some are purchased locally; or a spending limit is given, with local managers responsible for purchasing goods up to a certain monetary limit.

Should you consider centralizing or decentralizing your operational activities? The answer lies in understanding the costs and benefits of both options in terms if the impact to purchase cost and customer service. There are some criteria that should be evaluated to make an informed decision.

Is the purchase strategic?

Strategic purchases are linked to your organization's value proposition. For example, special ink that is specified for use with high capital-cost printing equipment is a strategic purchase for a printing firm as the results will have a direct impact on the quality of the work. Buying office supplies for the organization to support its operations is not strategic. To ensure your organization has a competitive advantage it's sensible to source strategic purchases centrally. This will also ensure high visibility and control of purchasing dollars.

What is the cost impact?

Future trends in purchasing are elevating it from a purely transactional activity to one of strategic importance. This translates to

organizations partnering with fewer suppliers in an effort to cut costs and improve quality. Whether the reason for the proliferation of suppliers in your organization is multiple service locations, corporate acquisitions or simply 'that's how we have always done it', evaluating the benefits of centralization is a worthwhile exercise. Typically, organizations are able to achieve cost savings of 10% - 15% just by consolidating requirements with a single supplier. Some examples of areas to consider include office supplies, travel, janitorial services and equipment maintenance.

What is the service impact?

The decision should also consider the impact on service levels. For example, if your organization has three warehouse locations in North Africa and you are looking to centralize fork lift maintenance services, will the supplier be able to service all locations (i.e. do they have North Africa coverage)? What will the response time be for a rush service call? In some situations, a local supplier may have a faster speed of response than a national supplier. If a

delayed service response time for maintenance means you are not able to load trucks to ship product to your customer, the costs savings for centralization are lost and this creates a negative impact to your customer.

Where is the expertise located?

It is important to take into account where the purchasing talent is located. If each location has local expertise to source for their needs, it may make sense to keep the structure decentralized rather than have someone from 'head office' make decisions for materials that they are not familiar with. On the other hand, if the resident expert is at head office, this individual may be able to help other locations by using this knowledge to make better decisions for the whole organization.

While the best solution may sometimes not be clear, it makes sense to at least investigate alternatives for your organization. It need not be one way or the other; most organizations have a 'hybrid' structure where they gain from the benefits of both centralization and decentralization.

Advantages of centralized and decentralized purchasing functions[1]

A company's ideal position along a continuum from a decentralized purchasing organization to a centralized one depends on its overall organization, its products, and the degree of commonality among the items and services it buys.

Centralized	Decentralized
Reports to a higher level, giving purchasing greater muscle within organization	Broadens job definition for purchasing professionals, leading to greater job satisfaction
Consolidates buying volume for greater negotiating power and lower costs	Enables access to local and more specialized sources
Enables a reduction in supplier base	Finds specialty suppliers for products with a competitive edge
Focuses on overall corporate strategy	Focuses on customers and end users, recognizing their particular needs
Leverages the company brand and stature	Responds more quickly to extraordinary situations
Enables tighter control of purchasing policies and procedures	Empowers the business unit
Allows business units to	Communicates more readily

focus on their core competencies	with operations departments

A company whose business units all use the same types of parts, if not interchangeable parts, gains most from centralizing its purchasing.

This centralized procurement function consolidates the purchasing of similar items in all its business units and leverages that combined volume, producing lower costs, improved quality, and better service. On the other hand, a company whose business units each have unique requirements for parts and materials benefits more from a purchasing structure that puts buyers closer to end users.

Nonetheless, all companies benefit from a central purchasing administration--common processes, procedures, forms, and systems. Companies use data from a central administration, such as an enterprise resource planning (ERP) system, to evaluate the effectiveness of the purchasing function. Such a system provides information from across the entire organization, which is essential for

making intelligent decisions about the company's position along the centralization/decentralization continuum. A company's optimum balance between centralization and decentralization is dynamic, requiring continuing review and adjustment.

Improving the company's process

1. **Centralize for greater cost control and corporate leverage.**

Leading companies consider the benefits of centralizing purchasing. A central purchasing function sees the company's entire spending pattern and analyzes it to find opportunities for cost savings and efficiency. Because the central purchasing department buys in greater volume than a local business unit, it negotiates lower prices with suppliers. Furthermore, a central purchasing department helps in inventory control. The need for some materials may vary within an individual business unit but become fairly constant when spread across the entire company. Thus, deliveries can be routed to the department needing the supplies next.

2. **Decentralize for quicker procurement responsiveness.**

Companies in fast-changing industries that need lightning-fast product introduction cycles benefit from decentralized purchasing. They avoid a heavy-handed corporate control that stifles entrepreneurial spirit by bringing purchasing decisions close to the end user of the materials.

A decentralized purchasing structure develops faster communication between purchaser and end user so that purchasing understands the end user's needs. Purchased materials meet user requirements and buying decisions are not inhibited by bureaucratic restraints. The effect is to push decision making down to a lower level, empowering business units to innovate and experiment.

3. **Centralize procurement of common products.**

The need for certain products, such as those used in maintenance, repair, and operations (MRO), varies little from location to location. If local business units purchase these items separately, the company may find that one unit

is paying more than another for the same item. To eliminate such discrepancies, effective companies manage purchasing of these items centrally.

Centralizing purchasing of commonly used items also consolidates information about their use. By centralizing, companies gain access to spending and inventory data that would otherwise be fragmented among the business units.

4. **Decentralize procurement of specialized products.**

Although hammers and pencils can be purchased in volume for an entire organization, and the same knobs and handles can fit on many of a company's product models, many situations require unique or specialized supplies. A single chemical process, for example, may need a particular solvent. Or a specialty medical device may include a component manufactured by few suppliers. In such cases the engineers involved will be more knowledgeable about prospective suppliers than a central purchasing department at corporate headquarters. In addition, distant

business units may have different needs and want specialized products to address those needs. Leading companies decentralize purchasing in such cases to preserve the benefits of specialization.

5. **Align purchasing structure with corporate structure and strategy.**

Because of purchasing direct effect on a company's bottom line, smart companies ensure that the structure of the purchasing function enhances the company's strategy. Company acquisitions or changes in product strategy cause a company to realign its purchasing structure. In addition to these internal situations, external challenges such as competition and environmental issues can force a company to centralize or decentralize its purchasing structure.

6. **Vary the centralization approach depending on the class of goods and services procured.**

Whether a company takes a centralized approach to procurement may depend upon the company's product and the nature of its materials. A large consumer packaged goods

company like Cincinnati, Ohio-based **Procter & Gamble** (P&G), with a variety of products, can use different approaches. One of P&G's major products is coffee. Successful coffee bean procurement requires that three disparate activities be connected: sourcing and commodity training, coffee tasting and quality management, and logistics. To meld these activities successfully, the purchasing organization for coffee needed people and tasks from both manufacturing and product development in a centralized and integrated function.

On the other hand, when P&G acquired Giorgio Beverly Hills fragrances, management discovered that Giorgio's procurement team focused less on fragrance sourcing and more on the logistics of day-to-day supply replenishment. To relieve the sourcing team of the complexities of logistics, P&G divided the procurement function between a small group working on strategic sourcing and a very large group dedicated to the logistics flow. In this case the purchasing function was split into smaller, more focused groups.

7. **Adopt a procurement organization structure appropriate for the company's size.**

The level of a company's total expenditure frequently dictates certain challenges in procurement. A small company lacks the purchasing volume to negotiate more advantageous prices from suppliers. But large companies often become fractured and fail to amalgamate their expenditures to take advantage of the greater volume.

5) Organization's Purchasing Process

The purchasing process for companies breaks down into eight clear steps. In the first step the company identifies a need, for which the answer is the purchase of a product. The final step is the execution of a purchase contract. The steps in between build an organized, informed process that results in the company purchasing the right product for the need from a qualified

supplier whose product is the most durable for the price.

With the introduction of modern technology, purchasing processes have been able to change dramatically. Improved methods of communication have meant that order requests can be transferred electronically, notification of delivery emailed, supplier payments automated.

While many businesses may find the utopia of fully automated procurement a strategy rather than reality, purchasing departments often find themselves in a hybrid where a mixture of technology, partners and culture may be unable to accept a fully automated approach and traditional and contemporary processes co-exist.

In designing purchasing processes, it is important to take into account both how information systems can be leveraged and where business constraints and governance exist. Whilst some fundamentals e.g. originating need – communicating the need to the supplier – delivery – the payment of the supplier - may exist in most processes – how they are deployed

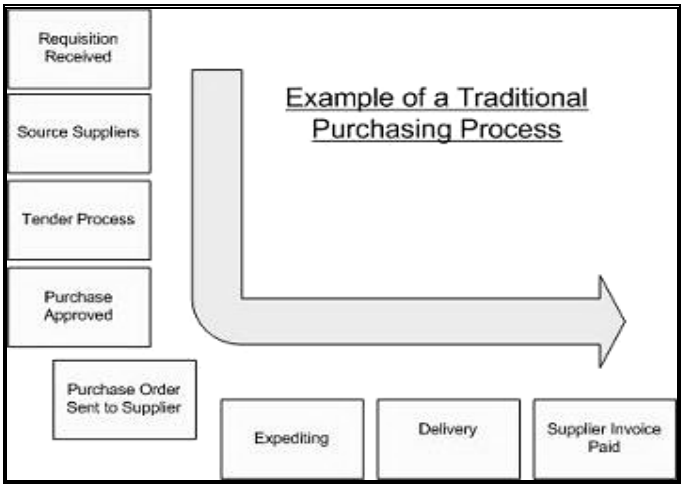
can vary depending on the overall strategy of the business and the prevalence of, and confidence in, Information Systems.

When designing purchasing processes it is helpful to understand both the traditional and contemporary methods in order to select the appropriate element that applies (or can apply) to your organization.

Traditional Purchasing Process

Where information technology is not heavily ingrained - Traditional Purchasing processes tend to be characterized by high levels of bureaucracy, encumbered with manual authorization (often requiring multiple signatures independent of the order value.), slow communications and a focus on unit price rather than long term commodity arrangements. Due in part to the lack of readily available Management Information.

The diagram below provides an example of a traditional purchasing process.



Traditional Purchasing Process

- The process may require authorization at various intervals – including at the requisition, Purchase Order, supplier payment process – this may be multiple authorizations at each stage e.g. the operator and his/her supervisor.
- Sourcing and tendering may focus on obtaining multiple cost/availability options from various suppliers rather than leveraging formal long term contracts. There may be little to no pressure on limiting the number of suppliers used.
- Manual Purchase Orders are raised and sent to suppliers – manual

acknowledgements are also requested. Communication is slow and paper based.

- Periodic expediting activity takes place to ensure delivery schedules are adhered to.
- Items are delivered and forms/documents are transferred within the business to close down orders.
- Manual invoices are submitted and subject to authorization procedures often requiring signatures to indicate that the Purchasing process has completed satisfactory (and that the order has been met).

Contemporary Purchasing Process

Where information systems are prevalent much of the authorization and communication methods that are present in the traditional process can be automated or eliminated. Management Information is also more widely available (and of better quality) and enables the organization to move towards automated processes which rely more on exception

management rather than transaction management.

The resultant culture is therefore one that focuses more on Supplier Relationship Management and a long term approach that one that focuses purely on Transactions.

- Modern ERP systems monitor inventory and trends and automate requisitions based on forecast need.
- Automated workflow and approvals engine route requirement to be authorized (where applicable)
- Where formal orders are required suppliers informed electronically either as part of established B2B network or via electronic message. Supplier acknowledgement and changes to terms updated in real time.
- For low value or less complex supplies – a mixture of Procurement Cards and online catalogues can be used negating the need for formal orders whilst ensuring that robust controls are still in place.

- Use of barcodes/RFID speed up the delivery process, electronic messages covering proof of dispatch and delivery are transmitted by the ERP and stakeholders are advised in real time.
- Electronic Invoices are submitted and are matched by the ERP against the Purchase order and delivery and then routed for payment negating the need for human intervention. Where Procurement Cards are used – Transaction Management systems route and aide process activity.

Systems can dramatically reduce the amount of paper documents within a purchasing environment while streamlining the process via use of workflow systems.

Questions

1. Discuss the role and function of purchasing management in organizations.
2. Compare between traditional and contemporary purchasing process.
3. Issues to be considered when designing purchasing processes.
4. List 10 signs of a modern purchasing department.

Chapter four

Strategic Sourcing Process

Chapter four

Strategic Sourcing Process

1) Introduction:

Traditional price-based relationships among customers and suppliers are changing. Long-term relationships are now built on total cost, trust, innovation, quality, and flexibility. Development of a strategic sourcing plan is driven by the recognition that tactical sourcing will not succeed in yielding a supply base that results in the benefits of collaborative relationships and strategic alliances.

This chapter will address the criteria of selecting the best suppliers, ways of improving customer supplier relationship and how to evaluate suppliers. The subjects will be addressed are:

1. Criteria of Selecting the best suppliers
2. Improving Supplier Relationships
3. Suppler Selection and Evaluation Process

2) Criteria of Selecting the Best Suppliers

Quite often, organizations use price as the determining factor when considering which supplier to select. While price is an important determining factor, other dimensions such as quality, lead time and payment terms must not be overlooked. There are some criteria that may be used to select the best supplier and improve the relationship with them.

- **Quality**

The cost of poor quality extends much further than the carrying cost of safety stock to ensure supply can meet demand. If a component of your product has been outsourced and that part is defective, your customer will associate the poor quality with your product. Not only will your organization have to pay to replace or repair the item, but it will also affect the perceived quality of your brand, further reducing future sales opportunities.

- **Lead Time**

Lead time is the time between placing an order and delivery of the product. The longer the lead time, the higher the cycle inventory and safety stock must be to meet demand. This higher inventory translates to higher costs to maintain these inventories and must be taken into account when evaluating the "best price" from each supplier.

- **Delivery Reliability**

While this may be difficult to evaluate, especially for a new supplier, it is worth investigating from past or current customers. For example, a large supplier may place your order on a lower priority when they are busy if you are one of their smaller customers. This means you will receive your order late, which again may mean having to carry extra stock. It is much better to have a reliable delivery at the expense of a longer lead time as other operational activities may be planned in advance to reduce costs.

- **Flexibility**

Since forecasts are almost always wrong, a flexible supplier should be able to quickly respond to changing market needs. For example, what mechanisms exist for a rush delivery? What costs are involved? Will the lead time be the same as for a regular delivery, or will it be shorter?

- **Transportation Costs**

The transportation costs associated with delivering the product to your location is part of the total purchase cost. In some cases this cost is buried in the product's unit cost, while in others it is shown as a separate line item. For local suppliers, it may be possible to arrange a pick-up using your own trucks, reducing transportation costs further. Distance and mode of transportation (truck, rail, and air) are key drivers that affect transportation costs.

- **Pricing Terms**

Suppliers typically offer quantity discounts for larger batch sizes, however extra holding costs for inventory should be factored in if the

batch size is significantly larger than what your requirements are. Some supplier offer additional discounts for early payment. For example, a two percent discount may be applied if payment is made within 10 days. This may be beneficial for your organization depending on what other options it has to utilize its working capital.

- **Technological Capability**

Although this is more qualitative, the ability of your supplier to provide you with accurate, timely information will help with planning and increase customer service in the event of a stock-out situation. Web-enabled suppliers that track your order status enable you to make adjustments as well as to inform your customers of changes to their order. Using the phone to track down the supplier and wait for an answer may not be good enough for some of your customers who demand instant updates for their order status.

3) Improving Supplier Relationship

Effective purchasing management and professional buying works better when a good

strategic framework exists. Commonly, relationships between suppliers and customers are driven by personalities, or the needs of the moment, whereas relationships and purchasing strategy should ideally be based on a combination of factors reflecting the nature of each purchasing area, including: risk, complexity, value, the market and basic matters of supply and demand.

In the business world, our organizations are both customers and suppliers. The emphasis in day-to-day transactions is on customer satisfaction and much improvement has resulted from this focus. In many cases, suppliers automatically are blamed for problems that occur with products and services. The customer talks, the supplier listens, the customer gets upset, and the supplier changes in response to the customer's reaction. The changes may or may not be in the best interest of the ultimate end user, but they appease the customer and preserve the business relationship.

In a typical customer-supplier relationship, the supplier is expected to meet the customer's standards. If problems occur, the customer

rushes in to fix the supplier. In a true customer-supplier relationship, however, there is much to be gained from adopting a more two-sided approach. The purpose of these relationships is to share ideas, to listen to each other, and be willing to take steps together to create mutual benefit-while maintaining end user satisfaction. Because customers have the ultimate power in these relationships, they must create an atmosphere that makes it easy for the supplier to speak candidly.

Profitability and efficiency in purchasing and supply management is increasingly being driven by good relationship management – working closely with suppliers and internal clients to achieve the best end result.

Managing strategic relationships and ensuring suppliers are handled with respect and in an ethical manner is a specific skill set that increasingly the purchasing profession is demanding from individuals. Strong relationships can help drive innovation as it is often the supplier that can identify opportunities for improving processes or providing new materials.

Increasingly, relationship management is being seen as a softer skill, however, it must not be over-looked and that in a purchasing context it is much more than this; the softer 'relationship' aspect of this skill is key, but so is the management of it and that is where perhaps the more strategic approaches are needed.

As a buyer, the purpose of investing time in a relationship with a supplier is to ensure the performance of that supplier always operates to the best of its ability, or perhaps if it hasn't been performing as desired, to try and improve the performance.

Just like any relationship, supplier relationships will vary in intimacy, all depending on what is deemed necessary for the relationship to work, the people involved and perhaps even the history of the relationship.

A relationship for example could be deliberately kept at arms- length but still remain very cordial – this could be because it is deemed that there will be no immediate business benefit for it to be any different. This may be the case when the items being supplied are relatively low

value, infrequently required and pose very little risk to the organization should the security of that supply ever break down.

Moving to the other extreme is the long-term close relationships that may be operated as a partnership. This will often be the case when items are high risk, high value and integral to organizational operation.

However, there is word of caution here for some sectors. Scarcity of some raw materials such as steel, which is currently a situation faced by many manufacturers, can potentially change the dynamics of a relationship and put the suppliers in the driving seat – another element of relationship management that the professional purchaser must consider.

This is a situation Japanese car manufacturer Nissan found themselves in 2004 year, when it had to close three of its Japanese car plants for five days because it ran out of steel. This meant Nissan, Japan's second largest car manufacturer, lost production of 25,000 cars.

Although this may be an extreme case, steel is a major commodity and it does highlight the

need for purchasers to keep such issues at the forefront of their minds when working with suppliers – especially for high-risk items. It also highlights the need for flexibility within supplier relationships. The key issue for purchasers is to try and ensure that key suppliers don't go elsewhere.

One factor for the purchaser to consider is how much knowledge they have of the market place within which the organization operates. Purchasers must be aware of issues that may affect their global supply chain, both on a political and an economic front.

Well managed global sourcing, outsourcing, risk management and supplier relationship management are just some of the core components that will help organizations achieve success in years to come.

Suppler Selection and Evaluation Process

Every organization knows it should be assessing supplier performance. Most are deploying some sort of supplier performance measurement, whether it is a couple of rudimentary key performance indicators or

more sophisticated data gathering and on-site assessment programs. But few purchasing and quality professionals are likely to answer "yes" when asked whether they are satisfied with their supplier assessment capabilities and results.

With increased reliance on suppliers for one's own ability to meet customer requirements and expectations, and even, in some cases, to comply with legal and regulatory requirements, organizations arc under increasing pressure to avoid supplier problems and to attract and retain the high performers, particularly among their strategic suppliers or long-term partners.

How can an organization turn thought into action and effectively use internal resources to improve the performance of these key suppliers and, at the same time, produce results and a return on investment?

The seven steps comprise a process for developing and deploying supplier selection and evaluation:

1. Align supplier performance goals with organizational goals and objectives.

2. Determine an evaluation approach.

3. Develop a method to collect information about suppliers.

4. Design and develop a robust assessment system.

5. Deploy a supplier performance assessment system.

6. Give feedback to suppliers on their performance.

7. Produce results from measuring supplier performance

1. Align performance goals

Determining what performance your organization wants from its supply chain cannot be done in a vacuum. You must first have in place a supplier strategy that relates to overall organizational goals and objectives.

Many organizations are pursuing continuous improvement programs and methodologies such as Six Sigma, lean enterprise, lean sigma, continuous improvement, operational excellence and total quality management. Typically, organizations trying to get to the next level of

excellence need to have key suppliers aligned with their own organizational direction.

If a company is pursuing lean and just-in-time deliveries, key suppliers need to be on a lean journey themselves, because the lack of synchronization can adversely impact cost, quality and delivery. If a company is committed to Six Sigma and has developed a fact-based culture, then the company will require a similar approach to performance improvement from its important suppliers.

Alternatively, if a company has not articulated an enterprise improvement strategy, the drive to allocate the resources to measure and improve supplier performance will be less strong. It is difficult to ask suppliers to "do what I say and not what I do." Additionally, commitment of resources from upper management to such a program may be difficult if continuous improvement is not valued within the culture.

2. Choose evaluation approach

The aspects of supplier performance that companies may wish to evaluate include:

* Financial health;

* Operational performance metrics;
* Enabling behaviors or cultural factors; and
* Risk factors.

- Financial health

Financial health is most important for key suppliers or long-term partners. Typical indicators of financial strength include factors such as sales, profitability and liquidity. Financial data can be obtained via Dun & Bradstreet or other credit reports, banks and trade references. Data are, of course, more accessible for publicly traded companies than for privately held ones. So, sometimes the best way to get financial information is to ask suppliers directly.

- **Operational performance metrics**

Operational performance metrics can cover many areas, such as on-time delivery, quality, lead times, responsiveness (rescheduling, order status), inventory turns and customer service call response time.

There are several ways to obtain these metrics: extract them from your own enterprise system, get reports from the supplier or conduct

internal supplier satisfaction surveys of the end user at the customer.

Business processes and practices can be reviewed to see how a supplier runs its business and provides a product or service at the best value, on time and exactly as required for its customers. This information is typically best practice based and qualitative, focused on processes and inherently independent of any vertical business sector bias. Business processes and practices information can be obtained through questionnaires or surveys or during site visits to suppliers. Evaluating business processes and practices can help get at the root causes of supplier problems. Traditional quantitative metrics can highlight a problem or negative trend but cannot get at the root cause.

- **Enabling behaviors or cultural factors**

At the heart of high performance business models such as Six Sigma, the Malcolm Baldrige National Quality Award criteria and lean are enabling behaviors, such as customer focus, agility, continuous improvement and teamwork.

If, for example, a supplier does not have a continuous improvement culture, it is unlikely that supplier will be in sync with the demands of a customer that values continuous improvement methodologies and expects the same drive to improve in its supply base.

- **Risk factors.**

An important aspect of evaluating suppliers is to understand and then mitigate risk. You can uncover risk factors in financial health, operational performance environment, business processes and practices, and enabling behaviors or cultural factors. Risk cannot be determined solely by using past performance to predict the future.

Financial risk factors may be the most obvious area many companies focus on. The operational performance environment includes risk from dealing with foreign suppliers, such as trade relations, shipping and currency exchange. The business processes and practices a supplier has in place are also critical. Another risk factor is the leadership in place at a supplier. A leadership committed to investing in the

workforce and enabling employee empowerment and input has a greater chance of success and overcoming business adversity as it arises. A culture lacking teamwork and continuous improvement indicates higher risk to the customer, as the chances of a supplier being responsive to systemic problems and getting to root causes of problems and correcting them are slimmer.

3. Develop information collection method

The challenge is the coverage problem how to collect any of the above information for a large portion of your supply base using current resources. Methods include paper questionnaires, web-based questionnaires, extracts from current systems, site visits and third-party standard certification.

Outputs of the various can include:

- Reporting on survey results.
- Supplier performance metrics such as KPIs derived from internal surveys or internal management systems.
- Supplier assessment reporting, which can be qualitative and quantitative.

- Ultimately, and ideally, supplier performance scorecards containing a rollup or summary view of all results.

4. Design a robust assessment system

Organizations need to choose an approach to evaluating suppliers. Approaches may include:

- Accepting a third-party standard, such as ISO 9001 and its sector specific derivatives or good manufacturing practices.
- Benchmarking performance against industry leaders.
- Measuring performance against best practices, such as the Malcolm Baldrige National Quality Award criteria.
- Developing KPIs and scorecards based on system data or internal customer feedback.
- Developing your own certification or evaluation and measuring performance against it.

5. Deploy the system

One of the biggest difficulties in assessment systems is deployment. For systems that require data extraction and massage, IT may need to

develop and then link information from disparate systems. For questionnaire-based systems, the questionnaires themselves can become unwieldy and difficult for both internal and supplier participants to respond to. As for on-site evaluations or audits, they require training of personnel, preferably a crossfunctional team, and are resource intensive to properly deploy. Subject matter expertise, survey instrument development expertise and knowledge of IT are needed to avoid the pitfalls in deploying all these approaches.

6. Give actionable feedback

Many organizations send performance report cards to their suppliers. Suppliers often bristle at the term "supplier management" because it implies one organization managing another. Customer companies need to have a real dialogue with their important suppliers on performance and work on the critical issues of the relationship. This requires a two-way flow of information.

If the results of performance measurement and supplier assessment are not actionable or

expectations of actions are not communicated, those actions will not occur. This is a difficult piece of the supplier performance puzzle because many supplier organizations may have competencies in some areas that exceed those of their customers.

7. Produce results

Measuring supplier performance is about understanding, communicating and then improving supplier performance. If all the important components of a good supplier assessment system are in place and you and your supplier are getting relevant, actionable results, then the suppliers can take the next step of improving their performance.

Supplier performance measurement can lead to supplier development, and supplier performance improvement has the potential to impact the customer financially and competitively.

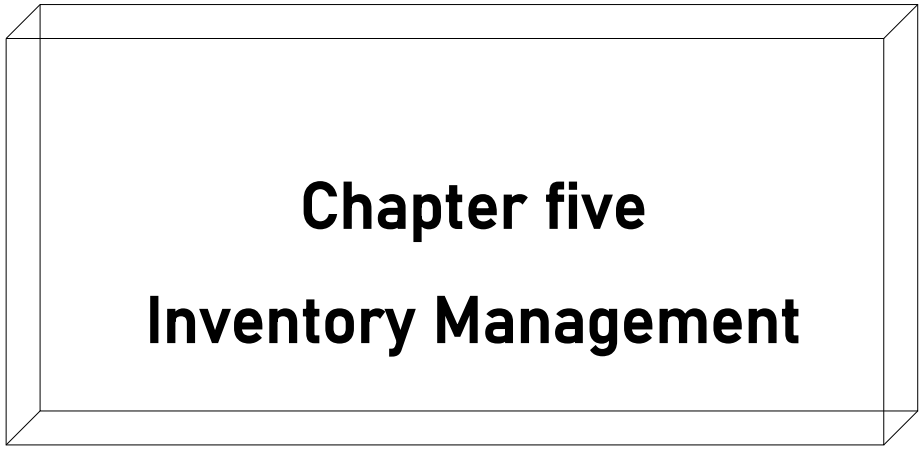
Companies need to work with suppliers to develop action plans as a result of assessments. They should then track performance to these plans to close the loop and realize the full

benefits from the supplier performance measurement process.

4) Questions

1. Discuss the criteria that may be used to select the best supplier and improve the relationship with them.
2. Discuss the steps comprise a process for developing and deploying supplier assessment.
3. Write short notes in each of the following:
    a. Pricing as one of the criteria of selecting the best supplier.
    b. Lead time as one of the criteria of selecting the best supplier.
    c. Financial health as the most important for key suppliers or long-term partners.
    d. The importance of sending performance report cards to suppliers.
4. Summarize the aspects of supplier performance that company may wish to evaluate.

5. Write briefly about risks related to suppliers' performance.



Chapter five

Inventory Management

Chapter Five

Inventory Management

1) Introduction

An inventory is a stock or store of goods. A typical firm has about 30 percent of its current assets and as much as 90 percent of its working capital invested in inventory. Because inventories may represent a significant portion of total assets, a reduction of inventories can result in a significant increase in return on investment (ROI), a ratio of profit after taxes to total assets.

Inventory in the supply chain is critical to ensure high customer service levels. However, it is also a very costly asset to maintain. Having the right amount of inventory to meet customer requirements is critical.

The task of inventory planning can be highly complex in manufacturing environments. At the same time, it rests on fundamental principles. The system used for inventory must tie into the

operations of the firm. Inventory planning and management must be responsive to the needs of the firm. The firm should design systems, including reports that allow it to make proper business decisions.

The focus of this chapter is how inventory policy can be used to aid in establishing a competitive advantage. Hence it addresses the following subjects:

1. What is inventory?
2. Purpose of inventory.
3. Effect of Inventory Size on Cost of Operation.
4. Types of Inventory.
5. Role of Inventory Management in Working Capital.
6. The Business cycle.
7. The need for Inventory Management:
8. Inventory Management.
9. Reduce Inventory with Supplier Partnership Strategies.
10. Cost Components of Inventory.

2) What is Inventory?

Inventory is defined as a stock or store of goods. These goods are maintained on hand at or near a business's location so that the firm may meet demand and fulfill its reason for existence. If the firm is a retail establishment, a customer may look elsewhere to have his or her needs satisfied if the firm does not have the required item in stock when the customer arrives. If the firm is a manufacturer, it must maintain some inventory of raw materials and work-in-process in order to keep the factory running. In addition, it must maintain some supply of finished goods in order to meet demand.

Sometimes, a firm may keep larger inventory than is necessary to meet demand and keep the factory running under current conditions of demand. If the firm exists in a volatile environment where demand is dynamic (i.e., rises and falls quickly), an on-hand inventory could be maintained as a buffer against unexpected changes in demand.

3) Purpose of Inventory

The purpose of holding inventories is to allow the firm to separate the processes of purchasing, manufacturing, and marketing of its primary products. The goal is to achieve efficiencies in areas where costs are involved and to achieve sales at competitive prices in the marketplace. Within this broad statement of purpose, we can identify specific benefits that accrue from holding inventories.

1. **To meet anticipated demand**. These inventories are referred to as anticipation stocks because they are held to satisfy expected demand. Examples of this type of demand are stereo systems, tools, or clothing.
2. **Provide the desired level of customer service.** Customer service refers to a company's ability to satisfy the needs of its customers. There are several ways to measure the level of customer service, such as: (1) percentage of orders that are shipped on schedule, (2) the percentage of line items that are shipped on schedule, (3) the percentage of dollar volume

that is shipped on schedule, and (4) idle time due to material and component shortage. The first three measures focus on service to external customers, while the fourth applies to internal customer service.

3. **Avoiding Lost Sales:** Without goods on hand, which are ready to be sold, most firms would lose business. Some customers are willing to wait particularly when an item must be made to order or is not widely available from competitors. In most cases, however, a firm must be prepared to deliver goods on demand. Shelf stock refers to items that are stored by the firm and sold with little or no modification to customers. An automobile is an item of shelf stock. Even though customers may specify minor variations, the basic item leaves a factory and is sold as a standard item. The same situation exists for many items of heavy machinery, consumer products, and light industrial goods.
4. **Reducing Risk of Production Shortages:** Manufacturing firms frequently produce goods with hundreds or even thousands of components. If any of these are missing, the

entire production operation can be halted, with consequent heavy expenses. To avoid starting a production run and then discovering the shortage of a vital raw material or other component, the firm can maintain larger than needed inventories.

5. **Reducing Order Costs:** Each time a firm places an order, it incurs certain expenses. Forms have to be completed, approvals have to be obtained, and goods that arrive must be accepted, inspected, and counted. Later, an invoice must be processed and payment made. Each of these costs will vary with the number of orders placed. By placing fewer orders, the firm will pay less to process each order.
6. **Minimize inventory investment.** As a company achieves lower amounts of money tied up in inventory, that company's overall cost structure will improve, as will its profitability. A common measure used to determine how well a company is managing its inventory investment (i.e., how quickly it is getting its inventories out of the system and into the hands of the customers) is inventory turnover

ratio, which is a ratio of the annual cost of goods sold to the average inventory level in dollars.

7. **To smooth production requirements.** Firms that experience seasonal patterns in demand often build up inventories during off-season periods to meet overly high requirements during certain seasonal periods. These inventories are aptly named seasonal inventories. Companies that process fresh fruits and vegetables deal with seasonal inventories. So do stores that sell greeting cards, skis, snowmobiles, or Christmas trees. Inventories can facility cost-efficient operations in several ways. Inventories can provide a buffer between operations so that each phase of the transformation process can continue to operate even when output rates differ.
8. **Inventories also allow a company to maintain a level workforce throughout the year** even when there is seasonal demand for the company's output. By building large production lots of items, companies are able to spread some fixed costs over a larger

number of units, thereby decreasing the unit cost of each item.

9. **Gaining Quantity discounts**: Large purchases of inventory might qualify for quantity discounts, which will also reduce the unit cost of each item. These discounts will reduce the cost of goods sold and increase the profits earned on a sale. These benefits arise because inventories provide a "buffer" between purchasing, producing, and marketing goods. Raw materials and other inventory items can be purchased at appropriate times and in proper amounts to take advantage of economic conditions and price incentives. The manufacturing process can occur in sufficiently long production runs and with pre-planned schedules to achieve efficiency and economies. The sales force can respond to customer needs and demands based on existing finished products. To allow each area to function effectively, inventory separates the three functional areas and facilitates the interaction among them.
10. **To decouple components of the production-distribution system.** The inventory buffers

permit other operations to continue temporarily while machine breakdowns are resolved. Similarly, buffers of raw materials are used to insulate production from disruptions in deliveries from suppliers. Finished goods inventories are used to buffer sales operations from manufacturing disruptions. By recognizing the cost and space needed, companies start to realize the elimination of disruptions can greatly decrease the need for the inventory buffers decoupling operations.

11. **To protect against stockouts.** Delayed deliveries and unexpected increases in demand increase the risk of shortages. Delay can occur because of weather conditions, supplier stockouts, deliveries of wrong materials, quality problems, and so on. The risk of shortage can be reduced by holding safety stock, which are stocks in excess of average demand to compensate for variability in demand and lead time.
12. To take advantage of order cycles. Inventory storage enables a firm to buy and produce in economic lot size in order to minimize

purchasing and inventory costs without having to try to match purchase or production with demand requirements in the short run. This results in periodic orders, or order cycles. The resulting stock is known as cycle stock. In some cases, it is also practical or economical to group orders and/or to order at fixed intervals.

Effect of Inventory Size on Cost of Operation

The cost of operation is greatly affected by both excessive and insufficient inventories, as summarized in next table.

Area of Cost	Excessive Inventory	Insufficient Inventory
1.Material Cost	Greater risk of loss because of: a. Devaluation of inventory on hand due to reduction in supplier's prices. b. Inventory becomes obsolete. c. Inventory deterioration due to decrease or	Higher cost for materials and higher manufacturing costs due to increase of "small quantity" rush orders needed to maintain continuous operation.

	no usage. d. More pilferage	
2.Factory Cost	Increased cost due to the need for additional storage space, results in overcrowding in storage area causing inefficient working conditions	Increased cost due to: a. Work stoppage b. Temporary layoffs and rehiring c. Training new employees d. Additional machine set-ups e. Emergency (overtime) operation
3.Overhead Cost	Increased cost due to: a. Additional carrying cost b. Increase cost for borrowing needed money c. Outside rental of space as needed	Increased cost due to added clerical cost for extra help or overtime in purchasing, receiving, inspection, etc., as result of additional "rush orders".

4) Types of Inventory

Four kinds of inventories may be identified:

1. **Raw materials Inventory**: This consists of basic materials that have not yet been

committed to production in a manufacturing firm. Raw materials that are purchased from firms to be used in the firm's production operations range from iron or awaiting processing into steel to electronic components to be incorporated into stereo amplifiers. The purpose of maintaining raw material inventory is to uncouple the production function from the purchasing function so that delays in shipment of raw materials do not cause production delays.

2. **Stores and Spares:** This category includes those products, which are accessories to the main products produced for the purpose of sale. Examples of stores and spares items are bolts, nuts, clamps, screws etc. These spare parts are usually bought from outside or some times they are manufactured in the company also.
3. **Work-in-Process Inventory**: This category includes those materials that have been committed to the production process but have not been completed. The more complex and lengthy the production process, the larger will be the investment in work-in-process

inventory. Its purpose is to uncouple the various operations in the production process so that machine failures and work stoppages in one operation will not affect the other operations.

4. **Finished Goods Inventory**: These are completed products awaiting sale. The purpose of finished goods inventory is to uncouple the productions and sales functions so that it no longer is necessary to produce the goods before a sale can occur.

5) Inventory management performance measures

1. Customer satisfaction. Measured by the number and quantity of backorders and/or customer complaints.
2. Inventory turnover. The ratio of annual cost of goods sold to average inventory investment. It is a widely used measure. The turnover ratio indicates how many times a year the inventory is sold. The higher the ratio, the better, because that implies more efficient use of inventory. It

can be used to compare companies in the same industry.

3. Days of inventory on hand. The expected number of days of sales that can be supplied from existing inventory. A balance is desirable: a higher number of days might imply excess inventory, while a low number might imply a risk of running out of stock.

6) Effective Inventory Management

The requirements of effective inventory management are:

1. A system to keep track of the inventory on hand and on order.
2. A reliable forecast of demand that includes an indication of possible forecast error.
3. Knowledge of lead times and lead time variability.
4. Reasonable estimates of inventory holding costs, ordering costs, and shortage costs.
5. A classification system for inventory items.

7) Functions of Inventory Management

Inventory management has two broad function; (1) inventory accounting and (2) inventory control.

Inventory accounting is concerned with the book keeping aspect of inventory management. This function deals with the entry, processing, and distribution of inventory stock, which, in turn, provides a history for all inventory

transactions. This accounting will also provide information for the comparison of "book" inventory to the actual physical count of inventory stocked. Inaccurate, incomplete, or delayed inventory transaction reporting cannot be the basis for correct inventory planning or order release. Unless strict control is established and maintained, the entire inventory management system will be of no value.

Inventory control consists of planning, ordering, and scheduling the release of materials used in the manufacturing process. The inventory control manager is concerned with all types of inventory in the company, while the purchasing manager is concerned with the acquisition of materials.

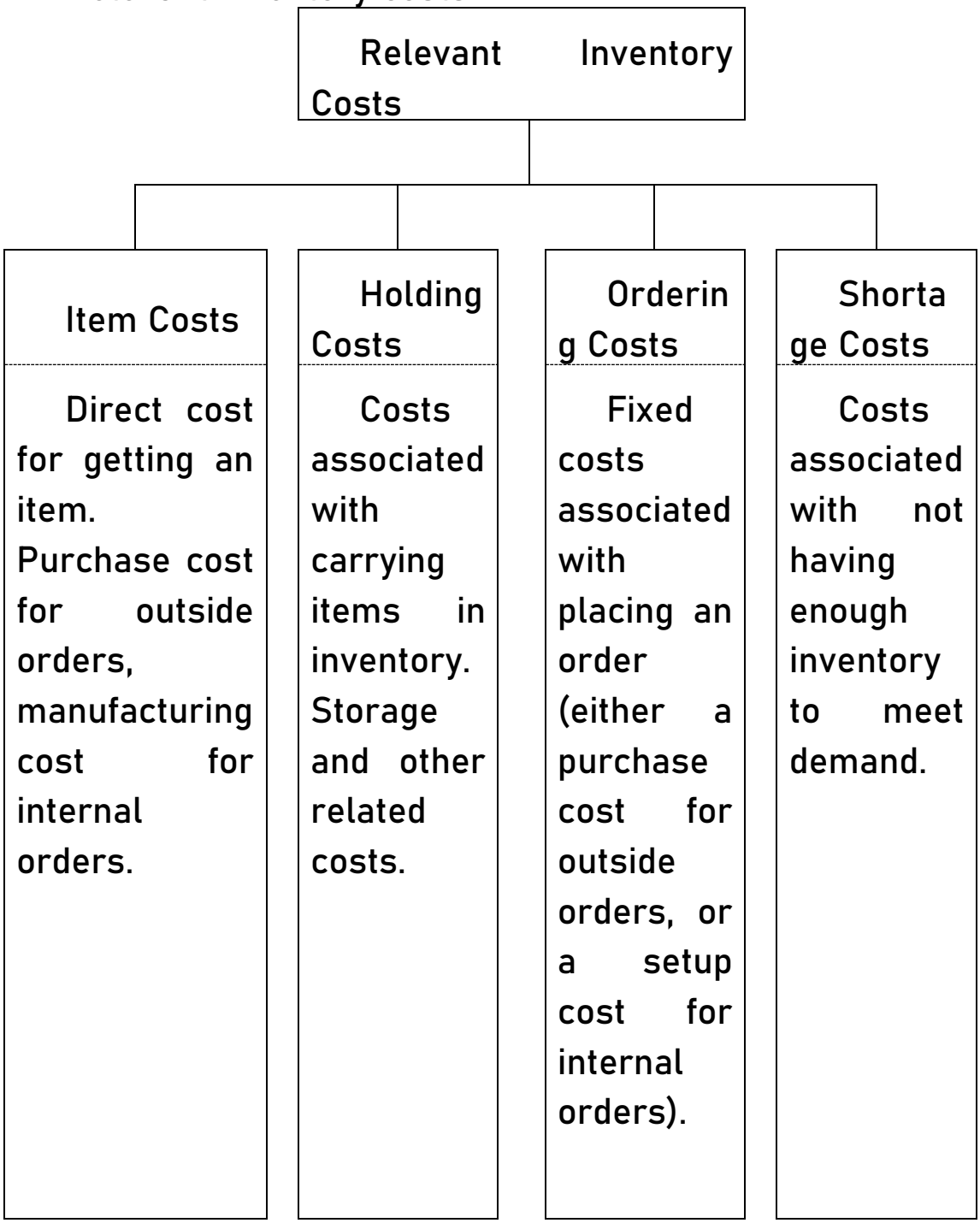
8) Cost Components of Inventory

When assessing the cost effectiveness of an inventory policy, it is helpful to measure the total inventory costs that will be incurred during some reference period of time.

Most frequently, that time interval used for comparing costs is one year. Over that span of time, there will be a certain need, or demand, or requirement for each inventory item which is simply the forecasted annual usage.

The following graph describes how the annual costs in each of the four categories will vary with changes in the inventory lot sizing decision.

Relevant inventory costs



Item costs:

How the per unit item cost is measured depends upon whether the item is one that is obtained from an external source of supply, or is one that is manufactured internally. For items that are ordered from external sources, the per unit item cost is predominantly the purchase price paid for the item. On some occasions this cost may also include some additional charges, like inbound transportation cost, duties, or insurance. For items that are obtained from internal sources, the per unit item cost is composed of the labor and material costs that went into its production, and any factory overhead that might be allocated to the item. In many instances the item cost is a constant, and is not affected by the lot sizing decision. In those cases, the total annual item cost will be unaffected by the order size. Regardless of the order size (which impacts how many times we choose to order that item over the course of the year), our total annual acquisitions will equal the total annual need. Acquiring that total number of units at the constant cost per unit will yield the same total annual cost. (This situation would be

somewhat different if we introduced the possibility of quantity discounts.)

Ordering costs:

Any time inventory items are ordered, there is a fixed cost associated with placing that order. When items are ordered from an outside source of supply, that cost reflects the cost of the clerical work to prepare, release, monitor, and receive the order. This cost is considered to be constant regardless of the size of the order. When items are to be manufactured internally, the order cost reflects the setup costs necessary to prepare the equipment for the manufacture of that order. Once again, this cost is constant regardless of how many items are eventually manufactured in the batch. If one increases the size of the orders for a particular inventory item, fewer of those orders will have to be placed during the course of the year, hence the total annual cost of placing orders will decline.

For the most part ordering cost is primarily the labor associated with processing the order however you can include the other costs such as

the costs of phone calls, faxes, postage, envelopes, etc.

Example:

Suppose the cost per order is $100 and the company uses 1200 units of a material during the year. The size of the order and the total ordering costs to be incurred by the company are given below.

- Size of order (units) 100, 150 and 200
- Number of orders in a year in each case of size of order unites:

= 1200/ 100 = 12

= 1200/150 = 8

= 1200/200 = 6

- Total ordering costs @ $ 100 / order

= 12 × 100 = $1200

= 8 × 100 = $800

= 6 × 100 = $600

From the above example, it can be easily seen that a company can reduce its total ordering costs by increasing the order size which in turn will reduce the number of orders.

However, reduction in ordering costs is usually followed by an increase in carrying costs to be discussed now.

Holding costs (also called carrying costs):

Any items that are held in inventory will incur a cost for their storage. This cost will be comprised of a variety of components. One obvious cost would be the cost of the storage facility (warehouse space charges and utility charges, cost of material handlers and material handling equipment in the warehouse). In addition to that, there are some other, more subtle expenses that add to the holding cost. These include such things as insurance on the held inventory; taxes on the held inventory; damage to, theft of, deterioration of, or obsolescence of the held items. The order size decision impacts the average level of inventory that must be carried. If smaller quantities are ordered, on average there will be fewer units being held in inventory, resulting in lower annual inventory holding costs. If larger quantities are ordered, on average there will be more units

being held in inventory, resulting in higher annual inventory holding costs.

By and large, carrying costs are considered to be a given percentage of the value of inventory held in the warehouse, despite some of the fixed elements of costs which comprise only a small portion of total carrying costs. Approximately, carrying costs are considered to be around 25 percent of the value of inventory held in storage. The greater the investment in inventory, the greater the carrying costs.

In the example considered in the case of ordering costs, let us assume that the price per unit of material is $40 and that on an average about half-of the inventory will be held in storage. Then, the average values of inventory for sizes of order 100, 150 and 200 along with carrying cost @ 25 percent of the inventory held in storage are given below.

- Size of orders (units): 100, 150 and 200
- Average value of inventory:
    1. when size of orders (units) 100

= 40 × 100/2 = $2000

2. when size of orders (units): 150

= 40 × 150/2 = $3000

3. when size of orders (units): 200

= 40 × 200/2 =$4000

- Carrying cost @ 25 percent of above:

1. When average value of inventory $2000:

= 25% ×2000 = $500

2. When average value of inventory $3000:

= 25% ×3000 = $750

3. When average value of inventory $4000:

= 25% ×4000 = $1000

From the above calculations, it can be easily seen that as the order size increases, the carrying cost also is increasing in a directly proportionate manner.

Shortage costs:

Companies incur shortage costs whenever demand for an item exceeds the available inventory. These shortage costs can manifest

themselves in the form of lost sales, loss of good will, customer irritation, backorder and expediting charges, etc. Companies are less likely to experience shortages if they have high levels of inventory, and are more likely to experience shortages if they have low levels of inventory.

The order size decision directly impacts the average level of inventory. Larger orders mean more inventories are being acquired than is immediately needed, so the excess will go into inventory. Hence, smaller order quantities lead to lower levels of inventory, and correspondingly a higher likelihood of shortages and their associated shortage costs. Larger order quantities lead to higher levels of inventory, and correspondingly a lower likelihood of shortages and their associated costs. The bottom line is this: larger order sizes will lead to lower annual shortage costs.

These costs have both quantitative and qualitative dimensions. These are, in the case of raw materials, the loss of production due to stoppage of work, the uneconomical prices associated with `cash' purchases and the set-up

costs, which can be quantified in monetary terms with a reasonable degree of precision.

As a consequence of this, the production department may not be able to reach its target in providing finished goods for sale. Its cost has qualitative dimensions as discussed below:

When marketing personnel are unable to honor their commitment to the customers in making finished goods available for sale, the sale may be lost. This can be quantified to a certain extent. However, the erosion of the good customer relations and the consequent damage done to the image and good will of the company fall into the qualitative dimension and elude quantification.

Even if the stock-out cost cannot be fully quantified, a reasonable measure based on the loss of sales for want of finished goods inventory can be used with the understanding that the amount so measured cannot capture the qualitative aspects.

The important costs are the ordering cost, the cost of placing an order, and the cost of carrying or holding a unit of inventory in stock. All other

costs such as, for example, the purchase cost of the inventory itself, are constant and therefore not relevant to the Economic Order Quantity model.

9) Reduce Inventory with Supplier Partnership Strategies

Here are three inventory reduction strategies that are a result of supplier partnerships. Each strategy requires closer relationships with suppliers in addition to web-enabled information systems to track and monitor product movement and create better forecasts. Issues to consider when considering these strategies include confidentiality and inventory ownership.

- **Quick Response Strategy**

This strategy has been successfully used in the grocery retailing industry. Using this strategy, suppliers have links to the retailer's Point of Sale (POS) data, which is essentially sourced from cash register terminals from all retail locations. Suppliers use this information to optimize their production and inventory levels using actual demand. The retailer is still

responsible for ordering, however the supplier is better able to manage its inventory and reduce lead times as it improves its forecast.

- **Continuous Replenishment Strategy**

As with the Quick Response strategy, retailers must share their POS data with the supplier. An agreement is then made on the delivery frequency and inventory levels with both parties. The result is increased inventory levels. Typically, the supplier gradually reduces inventory levels further while maintaining service levels.

- **Vendor Managed Inventory (VMI)**

The supplier takes on more responsibility with this initiative, as it determines both the inventory levels and delivery frequency to maintain agreed-upon in-stock levels. Wal-Mart, in conjunction with Proctor and Gamble significantly increased inventory turns when they first piloted this initiative and they have rolled-out this concept to many of their suppliers using their in-house Retail-Link information system. This system tracks past sales history, trends, out-of-stocks and other

performance data going back two years to help reduce inventories while maintaining service levels.

Issues to Consider:

- **Confidentiality**

By far the most important consideration is the sharing of competitive information with suppliers. The development of a high level of trust is a prerequisite before undertaking such a partnership. In the VMI case, the retailer is relying on the supplier to have an appropriate level of stock at their locations. Failure to do so would mean lost sales for the retailer.

- **Information Systems**

Advanced information systems are necessary to facilitate the transfer of data to/from the retailer and supplier. The system should be web-enabled and use bar-coding or even better, RFID technology to ensure data accuracy. The system may either be developed in-house, or outsourced to a B2B e-commerce provider.

- **Inventory Ownership**

The ownership of inventory is dependent on the level of the supplier relationship described above. Who decides on the replenishment of inventory will determine who is responsible for the inventory. Under the VMI agreement, Walt-Mart does not pay for the inventory until after it sells it to its customer. This greatly reduces inventory costs for the retailer, pushing them back to the supplier. Ultimately, in order to have a sustainable partnership it is important to calculate inventory cost reductions and share the savings between both partners.

10) Steps to Develop a Partnering Strategy:

1. Agree on and draft a contract that details performance measurements, inventory ownership and required service levels.
2. Determine what the information systems requirements are to drive the process and invest in the appropriate technologies.
3. Monitor and track inventory reductions and share the savings as agreed upon.

11) Questions

1. Write short notes in each of the following:
    a. Purpose of inventory.
    b. The effect of inventory size on the cost of operation.
    c. Types of inventory.
    d. The role of inventory management in working capital.
    e. The importance of inventory management.
    f. Functions of inventory management.
2. Discuss the different types of cost related to inventory.
3. The different inventory reduction strategies that are the result of supplier partnerships.

Chapter Six

Inventory Control System

Chapter Six

Inventory Control Systems

1) Introduction:

Inventory represents a significant investment of capital for most companies. Inventory management is fundamental to establish a long-term competitive advantage. It involves the control of assets being produced for the purposes of sale in the normal course of the company's operations. This chapter addresses issues related to the inventory control. It focuses on the following subjects:

1. Inventory Catalog
2. ABC Analysis
3. Other Inventory Control Systems
4. Reorder Point
5. Safety Stock
6. Stockless Buying Just In Time System

2) The Inventory Catalog

An inventory catalog is a type of data storage that holds inventory data for the products and variants for single or multiple product catalogs. One of the first steps in organizing an effective inventory control system is to know something about each item stocked. An analysis, tabulation, and classification of the characteristics of commodities are made and listed in a catalog, which is issued to all departments so that all know what items are carried in stock.

The catalog should list all items, completely described and identified by manufacturer's product number and cross referenced to the company's own stock number. This will also serve to reduce the number of duplicate items (same item from several suppliers with their stock number).

3) ABC Analysis System

The **A-B-C** approach classifies inventory items according to some measure of importance, usually annual dollar usage (i.e., dollar value per unit multiplied by annual usage

rate), and then allocates control efforts accordingly. Typically, three classes of items are used: A (very important), B (moderately important), and C (least important).

The actual number of categories varies from organization to organization, depending on the extent to which a firm wants to differentiate control efforts. With three classes of items, A items generally account for about 15 to 20 percent of the number of items in inventory but about 60 to 70 percent of the dollar usage. At the other end of the scale, C items might account for about 60 percent of the number of items but only about 10 percent of the dollar usage of an inventory.

This type of inventory analysis is known by several names, the most common being the ABC analysis system (next tables).

ABC analysis system

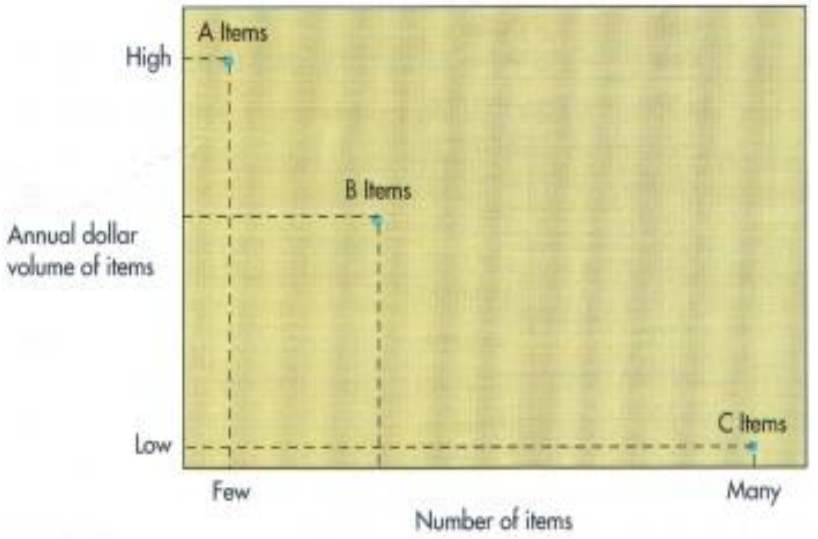
Inventory Item Number	Annual Usage	Value Per Unit	Annual Dollar Usage
1	25,000	$3	75,000
2	5,000	$4	20,000
3	1,000	$10	10,000
4	10,000	$2	20,000
5	4,000	$5	20,000
6	70,000	$10	700,000
7	25,000	$5	125,000
8	5,000	$1	5,000
9	3,000	$5	15,000
10	2,000	$5	10,000

ABC analysis system

Item mber	Annual $ Usage	% of Items	Cumulative % of Items	% of Value	Cumulative % of Value	ABC Class*
6	$700,000	10%	10%	70	70	A
7	$125,000	10%	20%	12.5	82.5	A
1	$75,000	10%	30%	7.5	90	B
2	$20,000	10%	40%	2	92	C
4	$20,000	10%	50%	2	94	C
5	$20,000	10%	60%	2	96	C
9	$15,000	10%	70%	1.5	97.5	C
3	$10,000	10%	80%	1	98.5	C
10	$10,000	10%	90%	1	99.5	C
8	$5,000	10%	100%	.5	100	C
Total	$1,000,00					

*When classifying the items as A, B, or C items, it can be somewhat subjective as to where the lines are drawn.

With the unrealistically small demonstration above, the first 20% of the inventory items constitute 82.5% of the inventory value, so these items (Items 6 and 7) will be designated as A items. On the other extreme, 70% of the items constitute only 10% of the inventory value, so these items (Items 2, 4, 5, 9, 3, 10, and 8) will be designated as C items. Finally, 10% of the items constitute 7.5 % of the inventory value, so this item (Item 1) will be designated as a B item.



The purpose of the ABC:

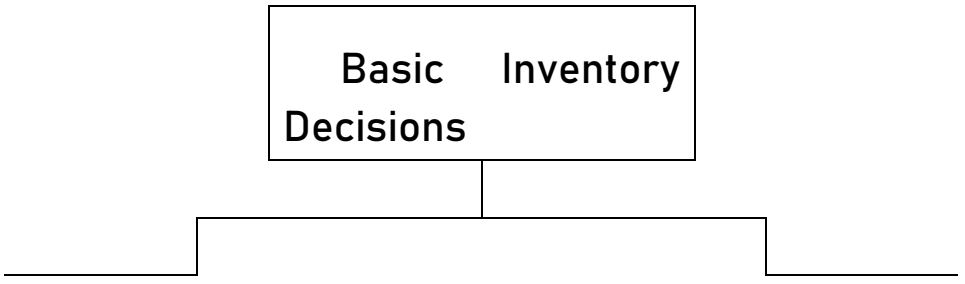
The ABC system is one of the keys to inventory control. The purpose of the ABC classification was to separate the "important few" from the "trivial many" so that the appropriate level of control can be assigned to each item. A items should receive close attention through frequent reviews of amounts on hand and control over withdraws, where possible, to make sure that customer service levels are attained. The C items do not need very close scrutiny, and the B items should have controls that lie between the two extremes.

Note that C items are not necessarily unimportant; incurring a stockout of C items

such as the nuts and bolts used to assemble manufactured goods can result in a costly shutdown of an assembly line. However, due to the low annual dollar volume of C items, there may not be much additional cost incurred by ordering larger quantities of some items, or ordering them a bit earlier

4) Other Inventory Control Systems

There are two basic decisions that must be made for every item that is maintained in inventory. These decisions, as shown in the next figure, have to do with the timing of orders for the item and the size of orders for the item. To accomplish this, the inventory manager must know the need and application for each item stocked, whether the item is a "dependent-demand" or an "independent-demand" item.



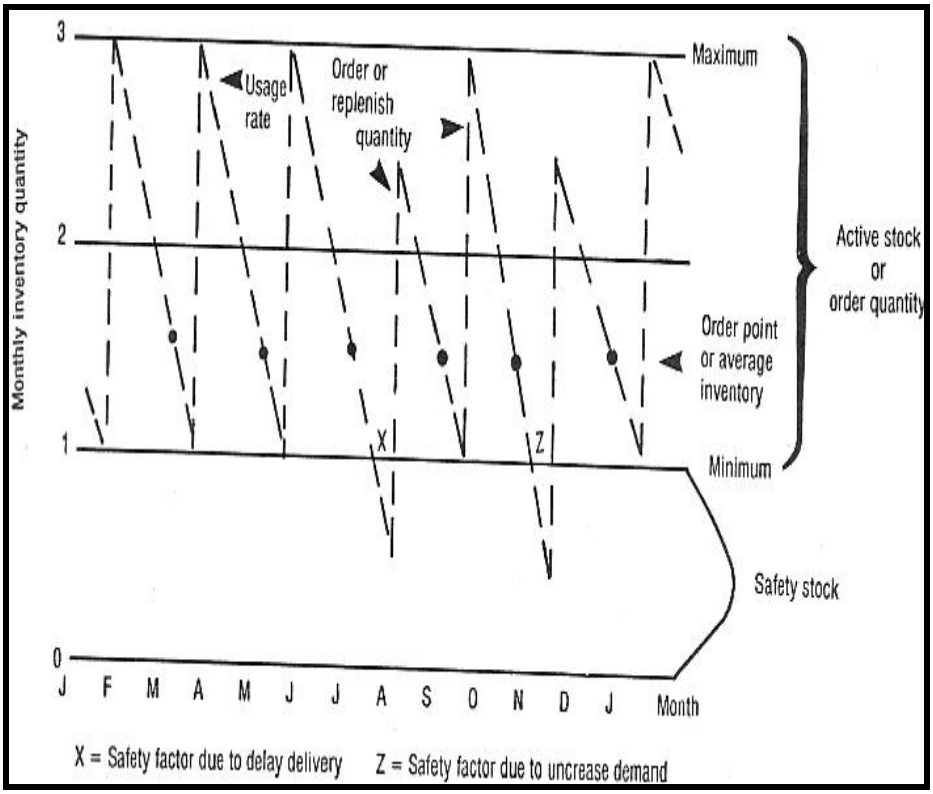
How much?	When?
Lot sizing decision Determination of the quantity to be ordered.	Lot timing decision Determination of the timing for the orders.

- ***A dependent demand*** **item**, also known as an internal-demand item, is that item whose use is directly related to or derived from the demand of other items or end product. Demand for a car translates into demand for four tires, one engine, one transmission, and so on. The items used in the production of that car are the dependent demand items.
- ***An independent demand*** **item**, also called external-demand item, is an item that is unrelated to the demand of items entering the finished product. The demand for lubricating oil for machine operation is independent from the demands of items entering the manufacturing process itself.

Other inventory control systems include:

- The ***cyclical ordering system*** is a **time-based system** and relies upon scheduled periodic review of stock levels for initiating a purchase request if stock is below a certain level. Its disadvantage is that not all items have the same usage rate and not reordering in time makes this system inefficient and can cause production problems
- The ***fixed-order quantity system,*** which is based on the order quantity factor rather than the time factor, operates smoothly when the items exhibit stable usage and lead time. When these factors change, a new order quantity is again predetermined.
- The ***two-bin system,*** which, as the name implies, has inventory stocked in two bins, and when one bin is emptied and the second begun – an order is placed for one bin of material.
- The ***maximum-minimum system***. This system is used when the items are comparatively standard in character and used in steady quantities and there is an

established minimum level, maximum level, and fixed-order point. Theoretically, the minimum level would be reached when the last unit was used and new shipment arrives. This makes the minimum level at zero and the quantity delivered as the maximum level. However, this theoretical policy becomes inoperative when there are unforeseen contingencies, such as a sudden increase in demand, late delivery, or receipt of non-conforming goods.



In the real world, manufacturers maintain a safety reserve to take care of any contingency that may arise. The amount of safety reserve or safety stock depends on the rate of consumption, importance of the time to production, and the lead time to obtain replacement. Safety stock is essential to prevent production interruption or loss of revenue.

The order quantity should take into consideration the maximum and minimum levels of the active stock plus the safety stock. In the previous figure, we have the following facts:

1. The normal use is 100 units per month;
2. The maximum level is 300 units, representing three months' supply (200 units for active stock and 100 units safety stock);
3. The order point is at the average inventory stock level of 150 units, with the reorder quantity of 200 units (the active stock quantity); and
4. The lead time is one half month. If the production rate is steady, using 100 units

per month the safety factor could be reduced or entirely eliminated. That is, when the last unit of the active stock is at its minimum level (at zero), the new stock arrives to boost the stock level to its maximum, and there is no need for safety stock.

5. The constant threat of that unknown contingency, however, demands that we carry a **safety stock**.

- **The effect of delay in delivery:** In the previous figure, see that in July there was a contingency due to delay in delivery, and without the safety factor there would have been a temporary slowdown, or even a shutdown, causing loss to the company.
- **The effect of Increase in demand:** We also see that during October there was a sudden increase in demand, and the November delivery would not arrive in time to meet this increased demand. Again the safety stock prevented disruption of the manufacturing process. The safety factor is a safeguard against such occurrences.

Hence **Safety Stock is** the quantity of stock held to satisfy unexpectedly high requirements in the stocking-up period. The purpose of the safety stock is to prevent a material shortage from occurring.

In order to determine the safety stock level, you must first specify the risk of a material shortage and also the desired service level. Usually the safety stock will not be used in production. More discussion of the safety stock will be addressed at the end of this chapter.

The active inventory stock is that portion of the total inventory supply intended to meet normal expected requirements for the material. This is directly related to the order quantity. Calculation of the **economic order quantity** is the expected annual requirements divided by the number of purchase orders per year, which proves to be the most economical quantity based on the cost of acquisition, the cost of carrying the inventory and total costs. The next chapter will address the economic order quantity in details.

The above mainstays of conventional inventory control systems have always been subject to review and reevaluation. This restoration of inventory to the maximum level was to have inventory always available when needed. This maximum level for inventory is the exact opposite of what top management wanted from inventory management. They want the lowest capital investment in inventory with sufficient stock available for continuous operation.

5) Reorder Point and Lead Time

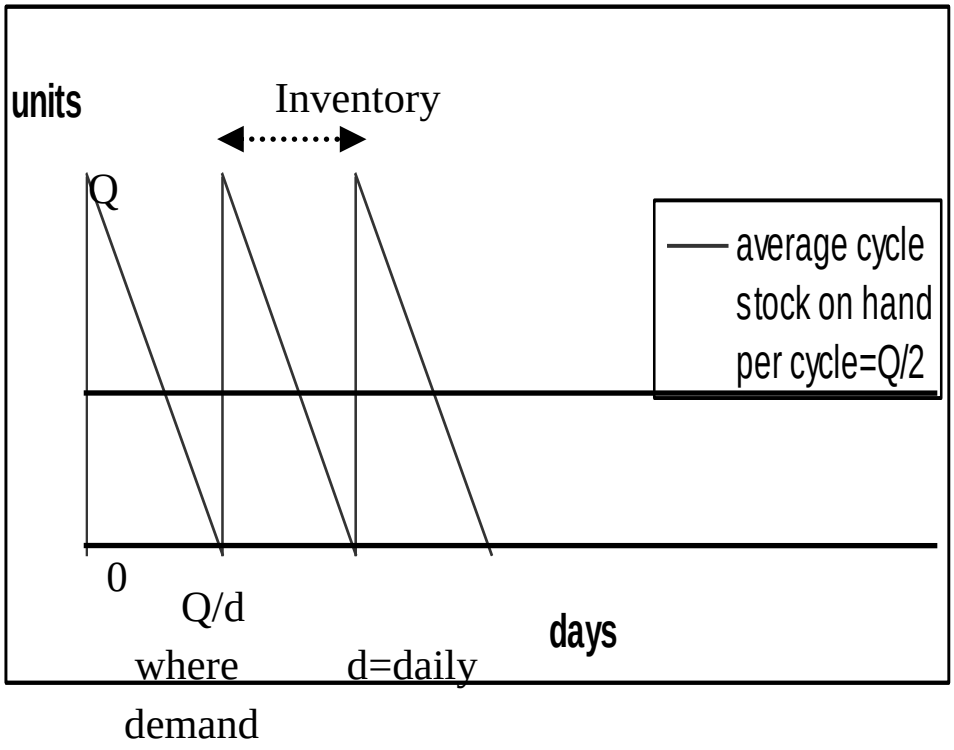
Reorder point is Inventory level of an item which signals the need for placement of a replenishment order, taking into account the consumption of the item during order lead time and the quantity required for the safety stock. Also called reorder level, reorder quantity, or replenishment order quantity.

Inventory System with No Lead-Time

If we assume that the lead-time for procuring material is zero. Consequently, the reorder point for replenishment of stock occurs

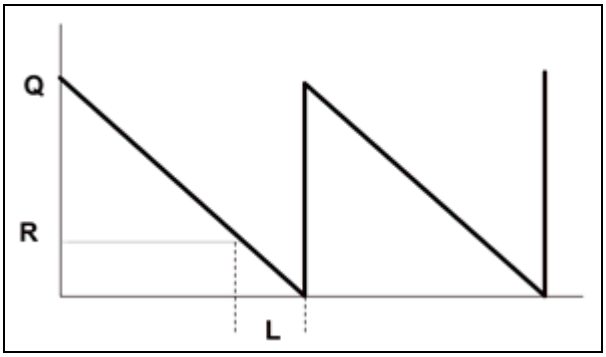
when the level of inventory drops down to zero, see the next graph.

Consider drawing a horizontal line at Q/2 in the above diagram. If you were to draw this line then it is clear that the times when stock exceeds Q/2 are exactly balanced by the times when stock falls below Q/2. In other words we could equivalently regard the above diagram as representing a constant stock level of Q/2 over time.



Inventory System with No Lead-Time

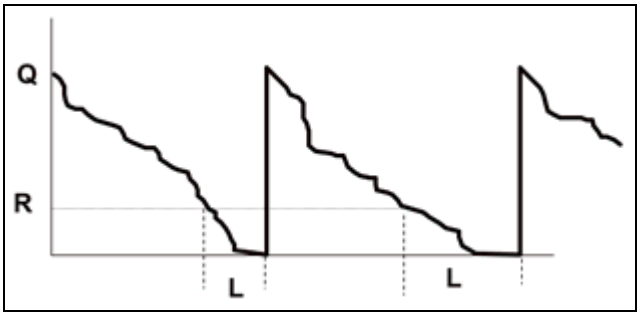
In view of instantaneous replenishment of stock the level of inventory jumps to the original level from zero level. In real life situations one never encounters a zero lead-time. There is always a time lag from the date of placing an order for material and the date on which materials are received.



Reorder point

As a result, as the above figure show, the reorder level is always at a level higher than zero, and if the firm places the order when the inventory reaches the reorder point, the new goods will arrive before the firm runs out of goods to sell. Sometimes the usage rate or lead time varies, hence the reorder point and lead time behavior can be as shown in the next figure.

The decision on how much stock to hold is generally referred to as **the order point problem**, that is, how low should the inventory be depleted before it is reordered.



Reorder point with different lead time and usage rate

The two factors that determine the appropriate order point are the procurement or delivery time stock which is the Inventory needed during the lead time (i.e., the difference between the order date and the receipt of the inventory ordered) and the safety stock which is the minimum level of inventory that is held as a protection against shortages.

Reorder Point:

= Normal consumption during lead-time + Safety Stock.

Several factors determine how much delivery time stock and safety stock should be held. In summary, the efficiency of a replenishment system affects how much delivery time is needed.

Since the delivery time stock is the expected inventory usage between ordering and receiving inventory, efficient replenishment of inventory would reduce the need for delivery time stock. And the determination of level of safety stock involves a basic trade-off between the risk of stock-out, resulting in possible customer dissatisfaction and lost sales, and the increased costs associated with carrying additional inventory.

Another method of calculating reorder level involves the calculation of usage rate per day, lead time which is the amount of time between placing an order and receiving the goods and the safety stock level expressed in terms of several days' sales.

Reorder level:

= Average daily usage rate × lead-time in days + safety stock level

From the above formula it can be easily deduced that an order for replenishment of materials be made when the level of inventory is just adequate to meet the needs of production during lead-time.

Example

There is no safety stock.

Demand = 10,000 unit/year

Store open 311 days/year

Daily demand = d = 10,000 / 311

= 32.154 unit /day

Lead time = L = 10 days

Reorder point = R = (d × L) + safety stock = (32.154) (10) + 0 = 321.54 units

Example

Suppose there is no safety stock. If the average daily usage rate of a material is 50 units and the lead-time is seven days, count the reorder level.

Reorder level

= Average daily usage rate x Lead time in days + safety stock level

= (50 units x 7 days) + 0 = 350 units

When the inventory level reaches 350 units an order should be placed for material. By the time the inventory level reaches zero towards the end of the seventh day from placing the order materials will reach and there is no cause for concern.

Safety Stock

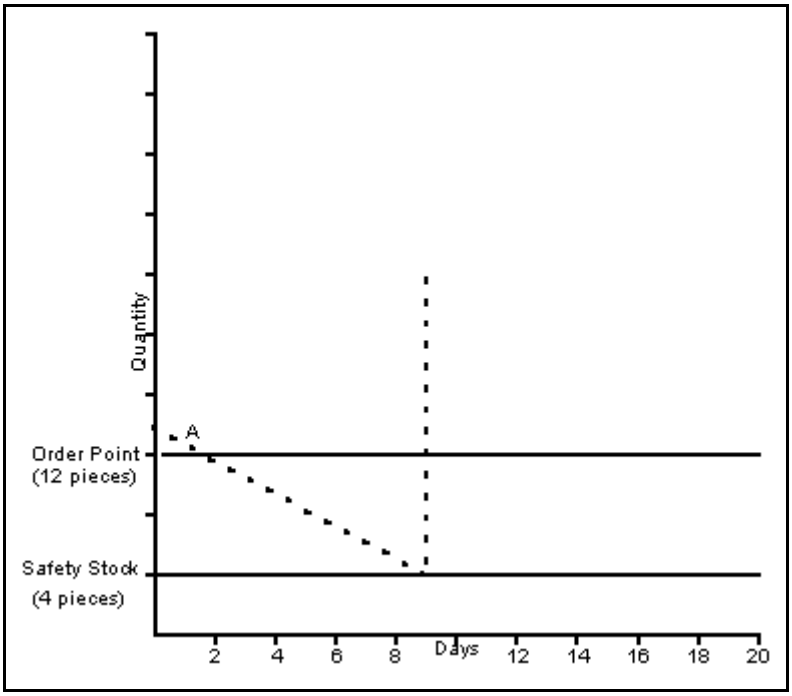
As has been discussed before the order point formula contains one element which is the safety stock. Safety stock provides protection against running out of stock during the time it takes to replenish inventory. Why is this protection necessary?

- Demand is a prediction based on past history, trend factor(s), and/or known future usage of a product. The item's actual usage will probably be more or less than this quantity. Safety stock is needed for those occasions when actual usage exceeds forecasted demand. It is "insurance" to help ensure that you can fulfill customer requests for a product

during the time necessary to replenish inventory.

- The anticipated lead time is also a prediction, usually based on the lead times from the last several stock receipts. Sometimes the actual lead time will be greater than what was projected. Safety stock provides protection from stock outs when the time it takes to receive a replenishment shipment exceeds the projected lead time.

The following diagrams illustrate how safety stock is used. The dotted line in the graph represents the available quantity (On-Hand – Committed) of the item. A replenishment order is placed on the first of the month as the available quantity available reaches the order point ("A" in the graph). In this example, there is none of the product currently on incoming replenishment orders. Therefore, at point "A," the item's available quantity equals its replenishment position.



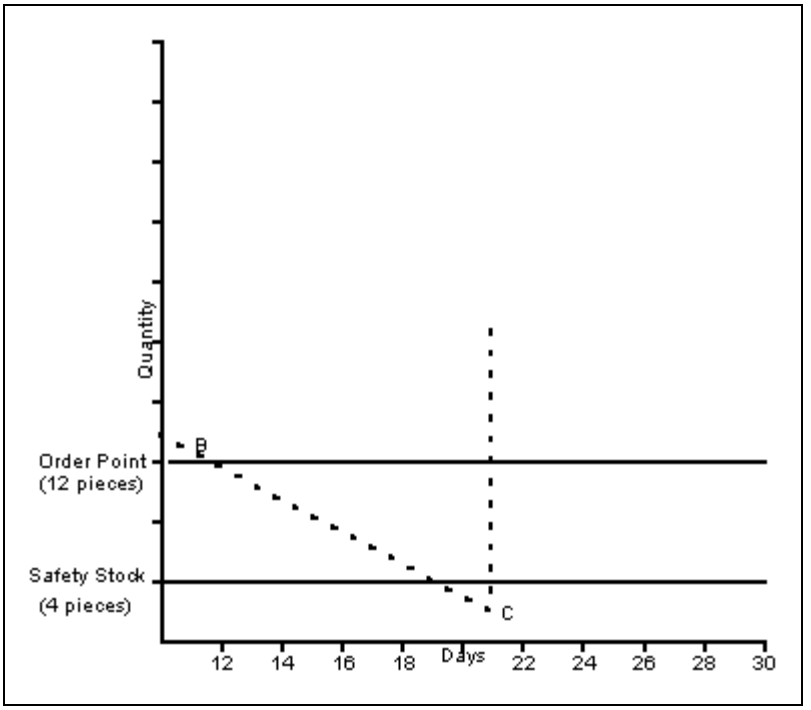
Projected Lead Time = 8 Days

Demand = 1 piece/day

On Order with Vendor = 0

The actual usage of eight pieces during the lead time is consistent with projected demand. The shipment arrives on the 9th of the month. As the stock receipt is processed, the available quantity on the shelf is equal to the safety stock quantity. The protection provided by the safety stock was not needed.

The product again reaches the order point on the 11th of the following month ("B" in the following graph):



Projected Lead Time = 8 Days

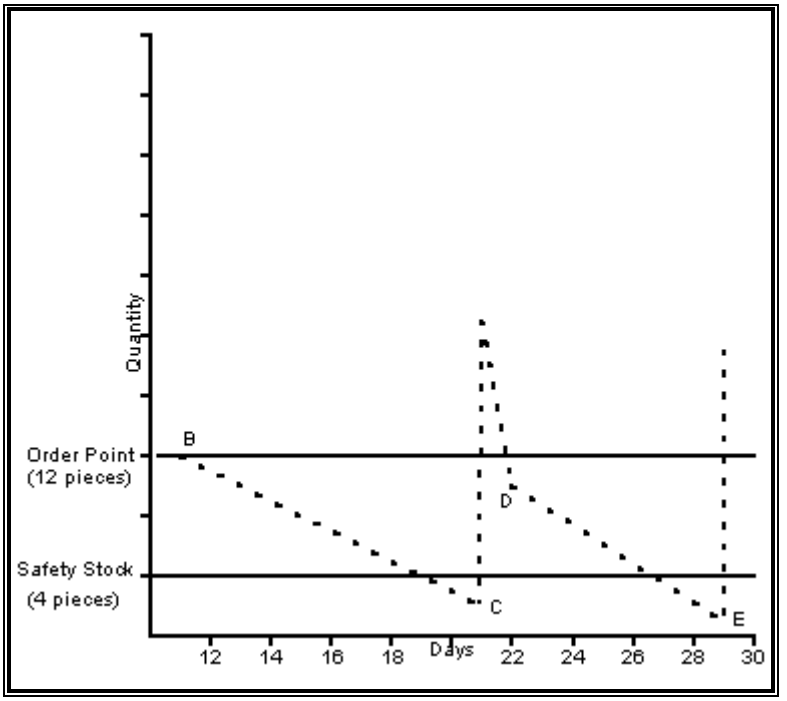
Demand = 1 piece/day

On Order with Vendor = 0

Another order is placed with the supplier. But the vendor is temporarily experiencing manufacturing problems and the shipment arrives two days late ("C" in the graph). If it were not for the safety stock, we would have run out of the product.

Shortly after the shipment arrives, a customer orders 10 pieces of the product. You experience more than a week's usage in just one day. The available quantity falls to "D" in the following graph. A replenishment order is issued that day, but the available quantity is already below the order point.

The safety stock quantity allows you to satisfy customer demand for the product until the replenishment shipment arrives from the supplier on the 29th of the month ("E" in the graph). Again, safety stock prevented a stock out.



Example:

Average daily demand = 50 units per day

Operating year contains 300 days of operation

Ordering cost S = $3 per order

Holding cost H = $1 per unit per year

Lead time = 1 day

EOQ = 300 units per order.

- Count the number of orders and reorder point.

Computations:

D = 15,000 units per year

Resulting number of orders per year = D/Q = 15000 units / 300 units = 50 orders per year

Reorder point = (the average number of units demanded during the 1 day lead time) = 50 × 1 = 50 units

Additional Data:

If the demand is not always a constant 50 units per day. There is variability in daily demand according to the following table of demands and probabilities:

Daily Demand	0	0	0	0	0	0	0	0	0
Probability	01	04	05	.2	.4	.2	05	04	01

The previous table suggests that if you waited until you had 50 units left in inventory before placing an order for 300 more units, you would be O.K. if the demand during the 1 day lead time was 10, 20, 30, 40, or 50.

However, if the demand during the 1 day lead time was 60, 70, 80, or 90 you would have had a shortage. The size of the shortage would

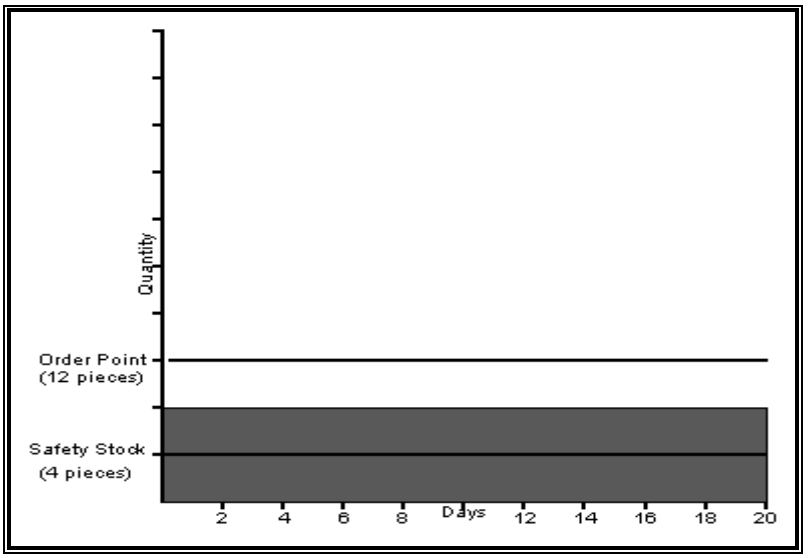
depend upon how many units were demanded during the lead time, but the maximum possible shortage would have been 40 units (if demand was the largest possible value of 90). You can prevent shortages by providing safety stock when there is uncertainty in demand.

If you wanted to guarantee that you would never have a shortage in this situation, you would need 40 units of safety stock at the bottom of the graph to "dip into" if demand spiked to higher than average values. But, adding 40 units of safety stock really means that you have elevated your reorder point. You are not waiting until there are only 50 units in inventory to place your order. You are ordering when there are 90 units in inventory. (And, of course, 90 units is sufficient to cover the worst case scenario for this problem.)

How Much Safety Stock Do You Need?

Take a look at the next graph. When a replenishment shipment arrives, the available quantity is usually somewhere in the shaded area of the graph. Notice that the safety stock quantity is in the middle of the shaded area. Half

the time you will use some or all of the safety stock before the replenishment shipment arrives. The other 50% of stock receipts will arrive before you use any of the safety stock. On average, the full safety stock quantity is always on the shelf when the replenishment shipment arrives. It is, on average, "non-moving" inventory.



A distributor puts inventory in his warehouse to sell it to customers. Profits from these sales are necessary to pay the distributor's expenses and provide a return on his investment. With this thought in mind, it seems as though it would not be a good idea for

a distributor to intentionally have non-moving inventory in stock.

On the other hand, keep in mind the goal of effective inventory management:

"Effective inventory management allows a distributor to meet or exceed his (or her) customers' expectations of product availability with the amount of each item that will maximize the distributor's net profits."

Safety stock is, in reality, an expense of doing business. But it is necessary to ensure good customer service. To maximize profits, we must carefully control all expenses, including safety stock. Therefore, we want to achieve our customer service goals with the least possible amount of safety stock.

The Conventional Ways of Calculating Safety Stock

There are two common conventional methods for calculating the safety stock quantity for a product:

- Percentage of Lead Time Demand
- Days Supply

As we discuss the various methods for calculating safety stock quantities, we'll refer to two variables, "forecast demand" and "usage." Forecast demand is a prediction of how much of a product will be sold or otherwise used in a particular month, and usage is the quantity that was actually sold or used.

Percentage of Lead Time Demand

Retired inventory consultant Gordon Graham long advocated that, for most items, 50% of lead time demand provides an adequate safety stock quantity. Let's look at an example:

Demand/Day = (390/30) = 13 pieces

Projected Lead Time = 8 days

Demand During the Lead Time = (8 x 13) = 104 pieces

Safety Stock = (104 x 50%) = 52 pieces

The thirteen pieces per day is multiplied by the projected lead time of eight days resulting in a lead time demand of 104 pieces. Safety stock is half this amount, or 52 pieces. This quantity represents a four day (4 days x 13 pieces/day) reserve.

This method is easy to understand but it tends to maintain too much or too little safety stock for many items. For example:

- Products with long but very reliable lead times and with fairly consistent demand. If we use this method for an imported product with a 12-week lead time, we'll keep six weeks stock in reserve as safety stock. If we usually receive the shipment on time and demand doesn't vary substantially from month to month, we'll have too much safety stock – in other words, too much money tied up in non-productive inventory.
- Products with very short lead times and significant variations in demand from month to month. If a product had a one-week lead time, this method will keep a three or day supply of the item in reserve as safety stock. If usage tends to vary significantly from month to month, there probably won't be enough safety stock available to consistently fill customer demand and the company will experience stock outs.

Days Supply

The days supply method allows a buyer to manually specify a number of days supply of a product to hold in reserve as safety stock. Because a buyer usually does not have the time to review the safety stock parameters for every item each month, he or she will probably set the days supply to provide more than enough safety stock. After all, in the eyes of most buyers, excess inventory is usually preferable to stock outs. As a result, the days supply method often results in the accumulation of non-producing inventory.

A Better Way of Maintaining Safety Stock

Remember that the purpose of safety stock is to protect customer service from unusual customer demand during the lead time or delays in receiving a replenishment shipment. Why not base the amount of safety stock maintained for each item on the variations in demand and lead time? The greater the variation in demand and/or lead time, the more safety stock will be maintained for the item. This is referred to as the "average deviation method."

Let's look at an example. We'll consider the variation or deviation in demand as the difference between the forecast demand of a product in a month and the actual usage in the past three months (it is common to use three to six month's history in this calculation). Consider an item with the following forecast demand and usage history:

Forecast demand and usage history

	Forecast Demand	Actual Usage	Deviation
January	50	60	10
February	76	80	4
March	80	70	-10

In January, the demand forecast was 50 pieces and actual usage was 60 pieces, resulting in a deviation or difference of 10 pieces. In February, the demand forecast was 76 pieces and actual usage was 80 pieces, which produced a deviation of four pieces. The average deviation is:

(10 + 4) ÷ 2 = 7 pieces per month

Note that the deviation for March, in which demand exceeded usage, is not considered in our calculation of safety stock. Why? Because if our prediction of what customers want exceeds actual sales, we certainly don't want to add more

safety stock to inventory. We probably have more than enough on the shelf already.

Next we have to calculate the average deviation of the product's lead time. In calculating this amount, we'll just look at the last three stock receipts from the primary source of supply. Why so few? Well, a lot of things can occur over extended periods of time that will affect the lead time for an item. For example:

- Your vendor can add or shut down production lines.
- Freight carriers can use different routes.
- The availability of the raw materials needed to make the product may change.

Here are the three most recent stock receipts for the item along with the anticipated lead time for the product when the purchase order associated with the stock receipt was entered:

Date of Receipt	Anticipated Lead Time	Actual Lead Time	Deviation
June 15th	10 days	17 days	7 days
April 20th	8 days	13 days	5 days
February 2nd	8 days	6 days	-2 days

As with our analysis of demand and usage, we will not consider any stock receipt whose actual lead time was less than its anticipated lead time – in other words, any time we received the item early. The average lead time deviation of the remaining two stock receipts is six days:

(7 + 5) ÷ 2 = 6 days

The six days is multiplied by the current anticipated demand per day to determine the anticipated usage during the six-day period. Demand per day is calculated by dividing the current monthly demand by the number of work days in the month. For example, say the current

monthly demand is 90 pieces and the current month has 18 work days. The demand per day is five pieces; multiplied by the six-day deviation equals 30 pieces. The 30 pieces is added to the demand deviation to determine the total safety stock for the item:

30 + 7 = 37 pieces

As a final step in determining the safety stock quantity, we'll multiply the average deviation by a deviation multiple. The deviation multiple used is dependent on the customer service level we want to provide to our customers.

Customer service level is defined as the percentage of line items for stocked products shipped complete by the promise date.

The higher the multiple, the more safety stock we'll maintain, and the higher the customer service level. Please refer to our other articles for a complete discussion of the customer service level.

Generally we have found that the following multiples provide the corresponding level of customer service:

Deviation Multiple	Resulting Customer Service Level
2	95%
3	97%
4	99%

If our goal is a 95% customer service level, we'll multiply the average deviation by a multiple of two (37 x 2 = 74 pieces). Be careful! Using a higher deviation increases the amount of non-moving inventory on your shelf. In our example, the difference between a safety stock quantity derived using a deviation multiple of two or three is an additional 37 pieces!

Yes, this is a more involved way of calculating safety stock than the conventional methods previously discussed. But it reflects the variations in market conditions, and therefore better predicts if a particular product needs more or less safety stock. And, if your computer system calculates your replenishment parameters, you won't have to worry about performing the calculations.

However, you will have to properly assign deviation multiples to each item, in each warehouse, in order to meet your overall customer service level goals. We'll discuss that process next month.

Stockless Buying

Striving toward this goal has many purchasing agents using a stockless buying system whereby the responsibility for the inventory is shifted to the supplier. The buyer draws up a purchase agreement or contract with as many suppliers as needed for the agreement or contract with as many suppliers as needed for the many items required. When entering such program, the buyer must be extra careful in his selection of suppliers who can meet the delivery requirements of such program.

A blanket order is issued to the supplier, against which requests for shipment are made. This reduces the paperwork for the purchasing department. Carrying costs are eliminated because the supplier stocks the goods. This arrangement is of equal importance to the

supplier, for he knows what his customer will require over a specific period of time and can schedule his own production rate.

Then there is on-consignment inventory, which is another stockless buying method. In this situation, the supplier ships goods to your plant, at no charge when shipped, for you company to provide secured storage space with the expectation that your company will eventually use the product, whereby such action becomes a "sale of goods" for which you pay. You are acting as someone who is holding property in trust for some purpose. This method is used primarily by retailers. Suppliers want to expose their product to the customer. The retailer does not want to invest in a new product, but will handle such product without investment. Some non-profit hospitals have entered into such on-consignment agreements.

Just in Time Inventory Management System

6) Overview of Just-in-Time

Just-in-time is a movement and idea that has gained wide acceptance in the business

community over the past decade. As companies became more and more competitive and the pressures from Japans continuous improvement culture, other firms were forced to find innovative ways to cut costs and compete.

The idea behind JIT, or lean manufacturing, is to have the supplies a firm needs at the exact moment that they are needed. In order to accomplish this goal a firm must constantly be seeking ways to reduce waste and enhance value.

As previously stated, one of the key components of JIT is to reduce waste and add value. There are several activities that a company must monitor as targets for reducing waste. Among these are, excessive waste times, inflated inventories, unneeded people or material movement, unnecessary processing steps, numerous variability throughout a firm's activities and any other non-value adding activity.

The layout and inventories that are part of a JIT strategy may seem the most logical steps to reduce waste and increase value. By simply

redeveloping the layout of certain facilities a firm can reduce the time it takes for supplies to get to the next step in process and cut costs associated with that movement.

One way to do this is to have work-in-progress close to the next station in the manufacturing chain. Couple this with lowering inventories and a powerful combination is formed to reduce costs. In lowering inventories a firm can reap numerous benefits; batch sizes, set-up times and safety stock are all reduced, ergo costs are trimmed and value is added. But in order to achieve these things a firm must be willing to accept the problems that these actions can either uncover or create.

Going hand-in-hand with maintaining Just In Time inventory levels is JIT scheduling. By working to reduce inventory to the lowest possible working levels, a firm must constantly be adjusting its schedule of ordering and delivering.

In doing so, communication both up and down the supply chain is critical. Frequent orders are placed for supplies and small production runs

are constantly being initiated. In order to achieve this breakneck pace of order/production schedule, a firm must constantly be making small changes to orders/production and recognize that Kanbans are of incredible importance.

The Kanban system is used to ensure that parts or materials are available when needed. The Kanban system is an information system that controls production by using markers or cards. It is responsible for ensuring that the necessary products are produced (or acquired) in the necessary quantities at the necessary time. It is the heart of the JIT system.

The basic Kanban system uses three cards: a withdrawal Kanban, a production Kanban, and a vendor Kanban. A withdrawal Kanban specifies the quantity that a subsequent process should withdraw from the preceding process. A production Kanban specifies the quantity that the preceding process should produce. Vendor Kanbans are used to notify suppliers to deliver more parts

Possibly the single piece of JIT that has the most relevance to a study of supply chain management is the partnerships that are essential to making JIT truly work. A firm cannot implement a JIT system by itself; it must have the complete cooperation of its entire supply chain.

The sheer amount of information that is needed for a JIT system to operate well demands partnerships to be formed and nurtured, almost to the point at which an entire supply chain operates as one firm.

Examples of these kinds of partnerships are everywhere in today's business world. XYZ-Company allows its key suppliers to work directly at their manufacturing sites and place orders as needed for the parts that that supplier supplies. By example Dell has its suppliers store raw materials directly at the manufacturing plants.

Other concepts of Just In Time also need to be introduced in order to have a discussion about what truly makes Just In Time a worthy endeavor. By the 1980s the Japanese had

achieved manufacturing greatness by practicing continuous improvement, in that a firm is constantly working to improve in every facet of its business functions.

To do this a firm must always increase quality, look for innovative ways to solve problems and increase focus on the quality of its suppliers. All of these are cornerstones of a modern JIT system.

Lastly, getting the workforce to buy into a JIT lean manufacturing system is important because without the dedication of the workforce, any endeavor is sure to fail.

There are several ways to achieve workforce commitment. A simple way is to cross train the workforce members outside of their normal business function and help increase an employee's problem solving ability.

In doing so a firm is empowering its workforce to think about their function in a new way while looking for ways to improve and giving them an overall view of the entire firm, not just their single job. When this is coupled with the support of management, an increase in

resources to solve problems, and an increase in employee roles and responsibility, a workforce will feel empowered and work to make Just In Time a success for the business.

Strengths of JIT

There is a lot of strength in incorporating JIT lean manufacturing in a company. The traditional approach to inventory management (just-in-case system) assumes that inventories are needed. The just-in-case theory provides various reasons to justify the need for inventories. Increased competition based on product diversity, quality, specialized features, and shorter life cycles have led many firms to reject the traditional EOQ model in favor of the just-in-time (JIT) model. JIT can offer greater cost efficiency and more flexibility to respond to customer demands.

The next table compare between the traditional systems and JIT systems. JIT makes production operations more efficient, cost effective and customer responsive. JIT allows manufacturers to purchase and receive components just before they're needed on the

assembly line, thus relieving manufacturers of the cost and burden of housing and managing idle parts.

Traditional systems:

1. Balance setup and carrying costs
2. Satisfy customer demand
3. Avoid manufacturing shutdowns
4. Take advantage of discounts
5. Hedge against future price increases

JIT systems:

1. Drive setup and carrying costs to zero
2. Use due-date performance
* 3. Use total preventive maintenance
* 4. Use total quality control
* 5. Use the Kanban system

* Rather than holding inventories as a hedge against plant shutdowns, JIT attacks the plant shutdown problem by addressing these issues.

The benefit of carrying smaller amounts of inbound, in-process, and finished goods inventory exists regardless of the firm's operating context (size, production technology, etc…). Just In Time appeals to many companies because it helps prevent manufacturers from being stuck with inventory that may become obsolete.

JIT was initially developed and justified based on cost reduction and quality improvement dimensions. Now, companies view JIT as providing an approach to achieving excellence in the elimination of waste (thought of as all things that do not add value to the product), as well as making the company more responsive to short-term customer demand patterns.

JIT manufacturing can be a real money-saver for a company. Companies are not only more responsive to their customers, but they also have less capital tied up in raw materials and finished goods inventory, allowing companies to optimize their transportation and logistics operations (UPS, 2003).

Overall, JIT manufacturing results in lower total system costs and improved product quality. With JIT, some plants have reduced inventory more than fifty-percent and lead time more than eighty-percent (Droge, 1998). JIT is lowering costs and inventory, reducing waste, and raising the quality of products.

We can conclude that the benefits of JIT system are:

1. JIT reduces the costs of acquiring inventory to insignificant levels by:
    a- Drastically reducing setup time.
    b- Using long-term contracts for outside purchases.
2. Carrying costs are reduced to insignificant levels by reducing inventories to insignificant levels.
3. Lead times are reduced so that the company can meet requested delivery dates and respond quickly to customer demand. Lead times are reduced by:
    a- Reducing setup times.
    b- Improving quality.

c- Using cellular manufacturing.

4. The JIT approach avoids shutdowns by:
   a- Utilizing total preventive maintenance to reduce machine failures.
   b- Utilizing total quality control to reduce defective parts.
   c- Cultivating supplier relationships to ensure availability of quality raw materials and subassemblies.
   d- Using the Kanban system.
5. JIT deals with discounts and price increases through:
   a- Careful supplier selection.
   b- Long-term contracts with suppliers.
   c- Prices are stipulated (usually producing a significant savings).
   d- Quality is stipulated.
   e- The number of orders placed is reduced.

Weaknesses of JIT

Just as JIT has many strong points, there are weaknesses as well.

1. “In just-in-time, everything is very interdependent. Everyone relies on everybody else” (Greenberg, 2002). Because of this strong interdependence with JIT, a weakness in the supply chain caused by a JIT weakness can be very costly to all linked in the chain.
2. JIT processes can be risky to certain businesses and vulnerable to the supply chain in situations such as labor strikes, interrupted supply lines, market demand fluctuations, stock outs, lack of communication upstream and downstream in the supply chain and unforeseen production interruptions.
3. Labor strikes, stock outs, and port lockouts can quickly disrupt an entire supply chain while JIT processes are in place. “Adhering to the just-in-time concept can be expensive in times of emergency such as at ports” (Greenburg, 2002). When a ship arriving from Asia full of supplies cannot make it to shore, the company using JIT generally has very little inventory to compensate for the emergency. This lack

of inventory is exactly what makes JIT so great to companies in reducing costs, yet making it risky as well by in some cases not having enough buffer inventories to react and keep the supply chain moving.

4. Every year markets experience seasonal demand fluctuations as well as fluctuations due to demand from disasters or other unforeseen events. “Just-in-time delivery leaves retailers and manufacturers with little inventory as the holiday season approaches” (Greenberg, 2002).
5. Relying solely on JIT systems would leave supply chains in shock due to the overwhelming seasonal market demand at different times of the year for seasonal products. Not all products should be produced with JIT systems in place. Custom made items will not work well with JIT as JIT systems respond best to mass produced and highly automated production items.
6. Communication is king in a JIT rich supply chain. There is a risk involved with JIT

when there is a communication breakdown and the company cannot get the right amount of supplies needed to keep the just-in-time system running smoothly.

7. Technology is playing a big role in JIT number, however, the reliance on technology can lead to breakdowns in the IT systems that can be costly to work around and go back to the 'pencil and paper' methods of doing supply/inventory demand calculations. Companies should always have backup systems in place to help thwart the possibility of technology or communication breakdown.
8. Weaknesses in JIT systems are very important to recognize. "From Cisco routers to Dell computers to the Gap's leather pants, companies have found their just-in-time manufacturing systems have let them down" (Johnson, 2001).
9. Companies must strongly evaluate the pros and cons of implementing JIT systems. The effects and risk to their

supply chain must also be heavily considered.

Finally we have to say that although JIT has its weaknesses, in most cases, the benefits outweigh the risks to the JIT enabled company. Planning for and recognizing when things may go wrong with the JIT system are vital for the success of JIT implementation across all areas of supply chains.

7) Questions and Problems

1. Explain the ABC inventory classification system and indicate its advantages.
2. Identify specific benefits that accrue from holding inventories.
3. Distinguish between a fixed-order-quantity system and fixed-time-period system and give an example of each.
4. Describe the difference between independent and dependent demand and give an example of each for a pizza restaurant such as Domino's or Pizza Hut.
5. Discuss the strengths and weakness of JIT system.
6. Describe the difference between JIT and traditional inventory management systems.
7. Write short notes in each of the following:
    a. The system of Stockless Buying.
    b. The importance of safety stock.
    c. Methods of calculating safety stock.
    d. Lead time period.

e. Reordering point.

f. Maximum-minimum system in controlling inventory levels.

Problem 1:

Classify the inventory items as A, B, or C based on annual dollar value, given the following information:

Item	Annual Demand	Unit Cost	Annual Dollar Value
1	1,000	$4,300	$4,300,000
2	5,000	720	3,600,000
3	1,900	500	950,000
4	1,000	710	710,000
5	2,500	250	625,000
6	2,500	192	480,000
7	400	200	80,000
8	500	100	50,000
9	200	210	42,000
10	1,000	35	35,000

11	3,000	10	30,000
12	9,000	3	27,000

Problem 2

The following classification table contains figures on the monthly volume and unit costs for a random sample of 16 units from a list of 2,000 inventory items at a health care facility. Classify the inventory items as A, B, or C

Item	Unit Cost	Usage
K34	10	200
K35	25	600
K36	36	150
M10	16	25
M20	20	80
Z45	80	200
F14	20	300
F95	30	800
F99	20	60
D45	10	550
D48	12	90
D52	15	110
D57	40	120
N08	30	40
P05	16	500
P09	10	30

Chapter seven

Economic Order Quantity Model EOQ

Chapter seven

Economic Order Quantity (EOQ) Model

1) Introduction

The goal of effective inventory management is to minimize the total costs - direct and indirect - that are associated with holding inventories. However, the importance of inventory management to the company depends upon the extent of investment in inventory.

To further economize in the replenishment planning process, the most economic lot sizes or production sizes should be determined. Ordering an optimal amount helps eliminate unnecessary stock and maximize return-on investment.

There are many costs associated with the ordering process. The optimal order quantity is determined by minimizing the sum of these costs over the next year.

This chapter addresses the following subjects related to Economic Order Quantity Model:

1. What is Economic Order Quantity?
2. Assumptions of Economic Order Quantity.
3. Impact of changing assumptions of Economic Order Quantity.

Economic Order Quantity (EOQ)

Inventory is held to avoid the nuisance, the time and the cost etc. of constant replenishment. However, to replenish inventory only infrequently would necessitate the holding of very large inventories. It is therefore apparent that some balance or trade-off or compromise is needed in deciding how much inventory to hold, and therefore how much inventory to order.

The EOQ model is a technique for determining the best answers to the how much and when questions. It is based on the premise that there is an optimal order size that will yield the lowest possible value of the total inventory cost. There are several assumptions regarding the behavior of the inventory item that are central to the development of the model

How much stock should we have?

There are two extreme answers to this question:

1. A lot

- this ensures that we never run out
- is an easy way of managing stock
- is expensive in stock costs, cheap in management costs

2. None/very little

- this is known (effectively) as Just-in-Time (JIT)
- is a difficult way of managing stock
- is cheap in stock costs, expensive in management costs

We shall consider the problem of ordering raw material stock but the same basic theory can be applied to the problem of:

- Deciding the finished goods stock.
- Deciding the size of a batch in a batch production process.

The costs that we need to consider so that we can decide the amount of stock to have can be divided into stock holding costs and stock ordering (and receiving) costs as below. Note here that, conventionally, management costs are ignored here.

Holding costs - associated with keeping stock over time

- storage costs
- rent/depreciation
- labor
- overheads (e.g. heating, lighting, security)
- money tied up (loss of interest, opportunity cost)
- obsolescence costs (if left with stock at end of product life)
- stock deterioration (lose money if product deteriorates whilst held)
- theft/insurance

Ordering costs - associated with ordering and receiving an order

- clerical/labor costs of processing orders

- inspection and return of poor quality products
- transport costs
- handling costs

Note here that a stock out occurs when we have insufficient stock to supply customers. Usually stock out occurs in the order lead time, the time between placing an order and the arrival of that order.

Given a stock out, the order may be lost completely or the customer may choose to backorder, i.e. to be prepared to wait until we have sufficient stock to supply their order.

Note here that whilst conceptually we can see that these cost elements are relevant it can often be difficult to arrive at an appropriate numeric figure (e.g. if the stock is stored in a building used for many other purposes, how then shall we decide an appropriate allocation of heating/lighting/security costs).

2) Assumptions of the Basic EOQ Model

When calculating the Economic Order Quantity, be aware of the following assumptions:

1. Demand for the item is known and constant.
2. Lead time is known and constant. (Lead time is the amount of time that elapses between when the order is placed and when it is received.)
3. The cost of all units ordered is the same, regardless of the quantity ordered (no quantity discounts).
4. Ordering costs are known and constant (the cost to place an order is always the same, regardless of the quantity ordered).
5. When an order is received, all the items ordered arrive at once (instantaneous replenishment).
6. Since there is certainty with respect to the demand rate and the lead time, orders can be timed to arrive just when we would have

run out. Consequently the model assumes that there will be no shortages.

Based on the above assumptions, there are only two costs that will vary with changes in the order quantity, (1) the total annual ordering cost and (2) the total annual carrying (holding) cost. Shortage cost can be ignored because of assumption 6. Furthermore, since the cost per unit of all items ordered is the same, the total annual item cost will be a constant and will not be affected by the order quantity.

Total Annual Inventory-System Costs Include: 1) Carrying (holding) cost 2) Ordering cost

To see how we can decide the inventory level to adopt, consider the very simple model below.

In this basic model we have the situation where:

- our company orders from an outside supplier;
- that outside supplier delivers to us precisely the quantity we ask for; and
- we pass that stock onto our customers (either external customers, or an internal

customer within the same company (e.g. if ordering raw materials for use in the production process).

EOQ symbols:

D = annual demand (units per year)

S = cost per order (dollars per order)

H = holding cost per unit per year (dollars to carry one unit in inventory for one year)

Q = order quantity (Lot size)

We saw on the previous pages that the only costs that need to be considered for the EOQ model are the total annual ordering costs and the total annual holding costs.

Annual Ordering Cost

The annual cost of ordering is simply the number of orders placed per year times the cost of placing an order (S). The number of orders placed per year is a function of the order size. Bigger orders means fewer orders per year, while smaller orders means more orders per year. In general, the number of orders placed per year will be the total annual demand divided by the size of the orders (D/Q).

The number of orders placed per year = D/Q

Total Annual Ordering Cost = (D/Q) S

Annual Holding Cost

The annual cost of holding inventory is a bit trickier. If there was a constant level of inventory in the warehouse throughout the year, we could simply multiply that constant inventory level by the cost to carry a unit in inventory for a year. Unfortunately the inventory level is not constant throughout the year, but is instead constantly changing. It is at its maximum value (which is the order quantity, Q) when a new batch arrives, then steadily declines to zero. Just when that inventory is depleted, a new order is received, thereby immediately sending the inventory level back to its maximum value (Q). This pattern continues throughout, with the inventory level fluctuating between Q and zero. To get a handle on the holding cost we are incurring, we can use the average inventory level throughout the year (which is Q/2).

The cost of carrying those fluctuating inventory levels is equivalent to the cost that would be incurred if we had maintained that

average inventory level continuously and steadily throughout the year. That cost would have been equal to the average inventory level (Q/2) times the cost to carry a unit in inventory for a year (H). In short,

Total Annual Holding Cost = (Q/2) H

Total Annual Cost

The total annual relevant inventory cost would be the sum of the annual ordering cost and annual holding cost, or

TC = (D/Q) S + (Q/2) H

This is the annual inventory cost associated with any order size, Q.

At this point we are not interested in any old Q value. We want to find the optimal Q (the EOQ, which is the order size that results in the lowest annual cost). This can be found using a little calculus (take a derivative of the total cost equation with respect to Q, set this equal to zero, then solve for Q).

For those whose calculus is a little rusty, there is another option which is using the graph. The unique characteristics of the ordering cost

line and the holding cost line on a graph are such that the optimal order size will occur where the annual ordering cost is equal to the annual holding cost.

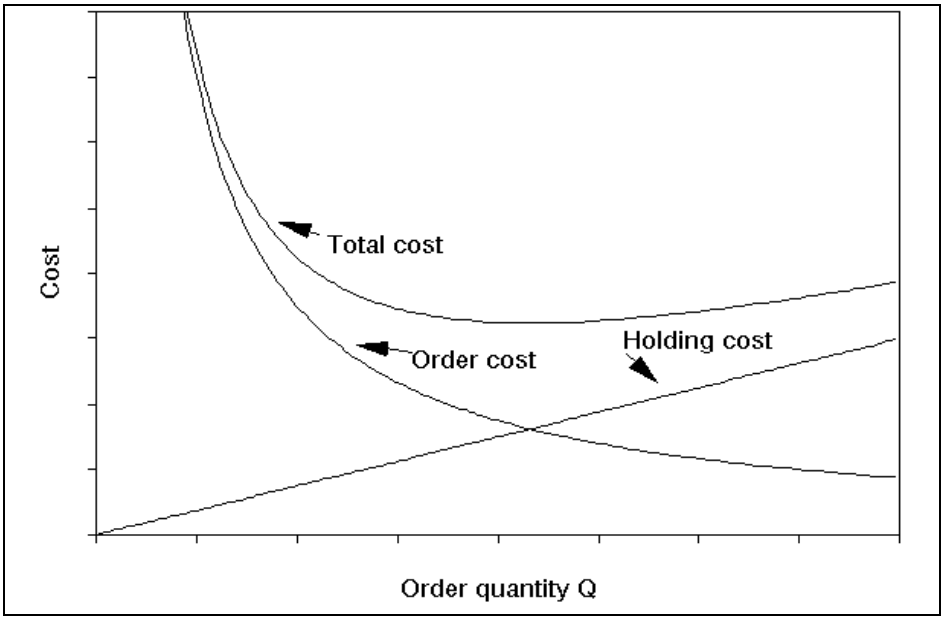
EOQ occurs when:

$(D/Q)S = (Q/2)H$

A little algebra clean-up on this equation yields the following:

$Q^2 = (2DS) / H$ and finally $Q = \sqrt{2DS / H}$

The diagram below illustrates how these two components (annual holding cost and annual order cost) change as Q, the quantity ordered, changes.



As Q increases holding cost increases but order cost decreases. Hence the total annual cost curve is as shown below - somewhere on that curve lies a value of Q that corresponds to the minimum total cost.

We can calculate exactly which value of Q corresponds to the minimum total cost by differentiating total cost with respect to Q and equating to zero.

Comments:

- This formula for the EOQ is believed to have been first derived in the early 1900's and so EOQ dates from the beginnings of mass production/assembly line production.
- To return to the issue of management costs being ignored for a moment the basic justification for this is that if we consider the total cost curve shown above, then - assuming we are not operating a policy with a very low Q (JIT) or a very high Q - we could argue that the management costs are effectively fixed for a fairly wide range of Q values.

If this is so then such costs would not influence the decision as to what order quantity Q to adopt. Moreover if we wanted to adopt a more quantitative approach we would need some function that captures the relationship between the management costs we incur and our order quantity Q - estimating this function would certainly be a non-trivial task.

Example:

A retailer expects to sell about 200 units of a product per year. The storage space taken up in his premises by one unit of this product costs £20 per year. If the cost associated with ordering is £35 per order what is the economic order quantity given that interest rates are expected to remain close to 10% per year and the total cost of one unit is £100.

We use the EOQ formula:

$$Q = \sqrt{2DS/H}$$

Here:

D=200

S = 35

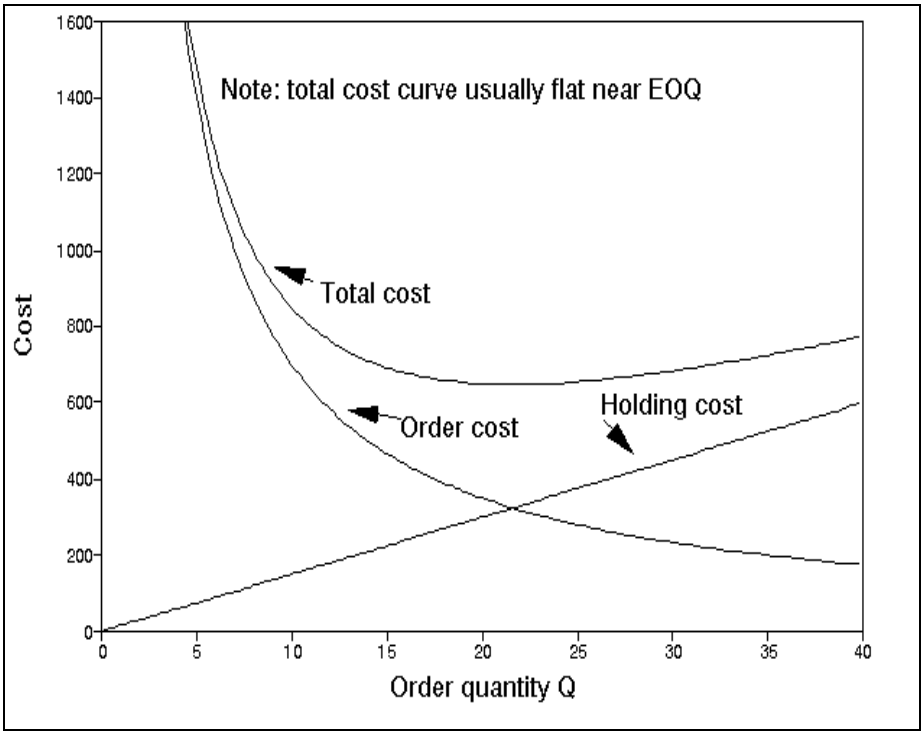
The holding cost H = £30 per unit per year

Hence EOQ = √ (2 x 200 x 35/30) = 21.602

But as we must order a whole number of units we have that:

EOQ = 22

We can illustrate this calculation by reference to the diagram below which shows order cost, holding cost and total cost for this example.



With this EOQ we can calculate our total annual cost from the equation

Total annual cost = TC = (D/Q) S + (Q/2) H

Hence for this example we have that

Total annual cost

= (35 x 200/22) + (30 x 22/2) = 318.2 + 330

= £648.2

Note: If we had used the exact Q value given by the EOQ formula (i.e. Q = 21.602) we would have had that the two terms relating to annual

holding cost and annual order cost would have been exactly equal to each other.

i.e. holding cost = order cost at EOQ point (or, referring to the diagram above, the EOQ quantity is at the point associated with the Holding Cost curve and the Order Cost curve intersecting).

i.e. $(Q/2)\ H = (R/Q)\ S$ so that $Q = \sqrt{2DS/H}$

In other words, as in fact might seem natural from the shape of the Holding Cost and Order Cost curves, the optimal order quantity coincides with the order quantity that exactly balances Holding Cost and Ordering Cost.

Note: Carrying cost is sometimes stated as a percentage of the purchase price of an item rather than as a dollar amount per unit. However, as long as the percentage is converted into a dollar amount, the EOQ formula is still appropriate.

Example: A local distributor for a national tire company expects to sell approximately 9,600 steel belted radial tires of a certain size and tread design next year. Annual carrying cost is $16 per tire, and ordering cost is $75. The distributor operates 288 days a year.

a. What is the EOQ?

b. How many times per year does the store reorder?

c. What is the length of an order cycle?

d. What is the total annual cost if the EOQ quantity is ordered?

Solution:

D = 9,600 tires per year

H = $16 per unit per year

S = $75

1. The EOQ

$$Q_0 = \sqrt{\frac{2DS}{H}} = \sqrt{\frac{2(9{,}600)75}{16}} = 300 \text{ tires}$$

2. The number of reorders per year

$$\text{Number of orders per year} : \frac{D}{Q_0} = \frac{9{,}600 \text{ tires}}{300 \text{ tires}} = 32$$

3. The length of an order cycle

$$\text{Length of order cycle} : \frac{Q_0}{D} = \frac{300 \text{ tires}}{9{,}600 \text{ tires}} = \frac{1}{32} \text{ of a year} \Rightarrow \frac{1}{32} \times 288 = 9 \text{ workdays}$$

4. The total annual cost related to EOQ

$$TC = \text{carrying cost} + \text{ordering cost}$$
$$= \frac{Q_0}{2}H + \frac{D}{Q_0}S$$
$$= \frac{300}{2}\$16 + \frac{9,600}{300}\$75$$
$$= \$2,400 + \$2,400$$
$$= \$4,800$$

Example: Piddling Manufacturing assembles security monitors. It purchases 3,600 black-and-white cathode ray tubes a year at $65 each. Ordering costs are $31, and annual carrying costs are 20 percent of the purchase price. Compute the optimal quantity and the total annual cost of ordering and carrying the inventory.

Solution:

$$D = 3{,}600 \text{ cathode ray tubes per year}$$
$$S = \$31$$
$$H = .20(\$65) = \$13$$
$$Q_0 = \sqrt{\frac{2DS}{H}} = \sqrt{\frac{2(3{,}600)(31)}{13}} = 131 \text{ cathode ray tubes}$$
$$TC = \text{carrying costs} + \text{ordering costs}$$
$$= \frac{Q_0}{2}H + \frac{D}{Q_0}S$$
$$= \frac{131}{2}13 + \frac{3{,}600}{131}31$$
$$= \$852 + \$852 = \$1{,}704$$

3) Quantity Discount Model

Quantity discounts are price reduction for large orders offered to customers to include them to buy in large quantities. If quantity discounts are offered, the buyer must weigh the potential benefits of reduced purchase price and fewer orders that will result from buying in large quantities against the increase in carrying costs caused by higher average inventories. The buyer's goal with quantity discounts is to select the order quantity that will minimize total cost, where total cost is the sum of carrying cost, ordering cost, and purchasing cost.

Quantity Discount Model Assumptions

- Same as the EOQ, except that unit price depends upon the quantity ordered.
- Adjusted total cost equation is:

$$TC_{QD} = \left(\frac{D}{Q}S\right) + \left(\frac{Q}{2}H\right) + PD$$

Where P = unit price

When the supplier is willing to offer a lower price if large quantities of an item are ordered, the total annual purchase cost line will no longer be horizontal, but will instead have step decreases in it. This will lead to a total cost curve that has breaks in its continuity (step changes) resulting in a slightly different model for determining the optimal order size.

Quantity Discount Procedure

- Calculate the EOQ at the lowest price
- Determine whether the EOQ is feasible at that price
    - Will the vendor sell that quantity at that price?
- If yes, stop – if no, continue

- Continue until you identify a feasible EOQ
- Check the feasibility of EOQ at the next higher price
- Calculate the total costs (including total item cost) for the feasible EOQ model
- Calculate the total costs of buying at the minimum quantity required for each of the cheaper unit prices
- Compare the total cost of each option & choose the lowest cost alternative

Example:

- Annual Demand = 5000 units
- Ordering cost = $49
- Annual carrying charge = 20%
- Unit price schedule:

Quantity	Unit Price
0 to 999	$5.00
1000 to 1999	$4.80
2000 and over	$4.75

Solution

Step 1

$$Q_{P=\$4.75} = \sqrt{\frac{2\times 5{,}000\times 49}{0.2\times 4.75}} = 718 \ \left(not\ feasible\right)$$

$$Q_{P=\$4.80} = \sqrt{\frac{2\times 5{,}000\times 49}{0.2\times 4.80}} = 714 \ \left(not\ feasible\right)$$

$$Q_{P=\$5.00} = \sqrt{\frac{2\times 5{,}000\times 49}{0.2\times 5.00}} = 700 \ \left(feasible\right)$$

Step 2

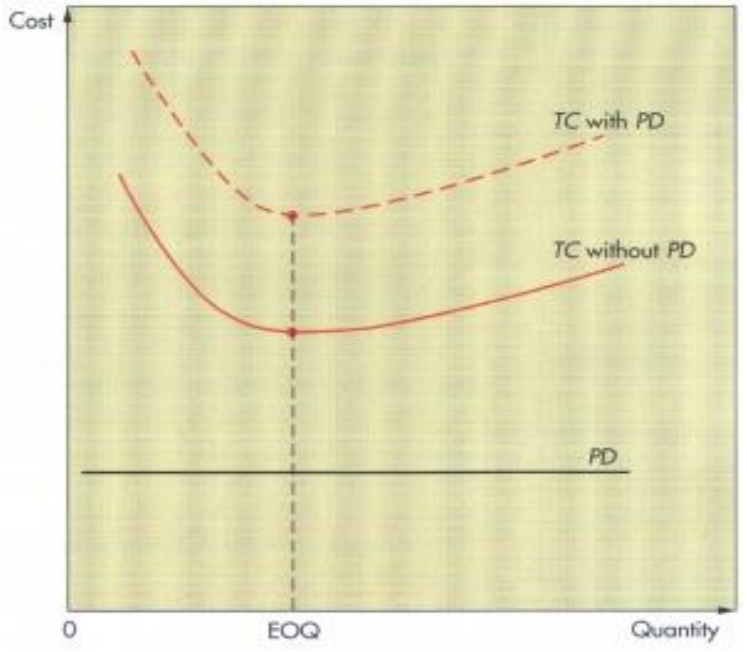
$$TC_{Q=700} = \frac{5{,}000}{700}\times 49 + \frac{700}{2}\times 0.2\times 5.00 + 5.00\times 5000 = \$25{,}700$$

$$TC_{Q=1000} = \frac{5{,}000}{1000}\times 49 + \frac{1000}{2}\times 0.2\times 4.80 + 4.80\times 5000 = \$24{,}725$$

$$TC_{Q=2000} = \frac{5{,}000}{2000}\times 49 + \frac{2000}{2}\times 0.2\times 4.75 + 4.75\times 5000 = \$24{,}822.50$$

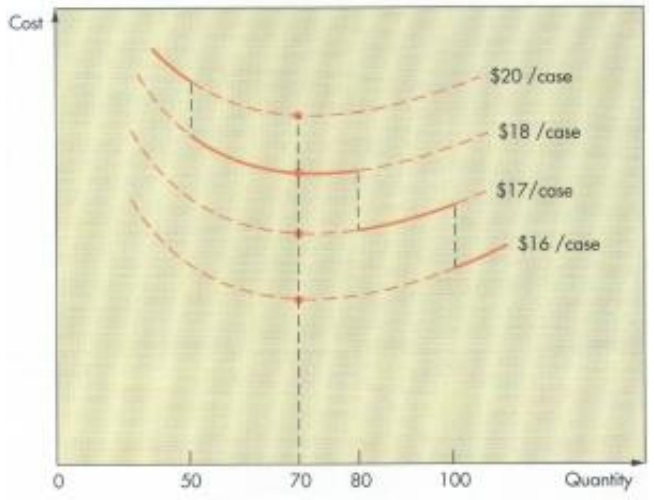
Recall that in the basic EOQ model, determination of order size does not involve the purchasing cost. The rationale for not including unit price is that the assumption of no quantity

discounts, price per unit is the same for all order sizes (when the demand, D, is known and a constant). Inclusion of unit price in the total cost computation is that case would merely increase the total cost by the amount PD, P times D. A graph of total annual purchase cost versus quantity would be a horizontal line. Hence, including purchasing costs would merely raise the total-cost curve by the same amount (PD) at every point. That would not change the EOQ curve.



Example: The maintenance department of a large hospital uses about 816 cases of liquid cleanser annually. Ordering costs are $12,

carrying costs are $4 per case per year, and the new price schedule indicates that orders of less than 50 cases will cost $20 per case, 50 to 79 cases will cost $18 per case, 80 to 99 cases will cost $17 per case, and larger orders will cost $16 per case. Determine the optimal order quantity and the total cost.



1. Compute the common EOQ: $\sqrt{\frac{2DS}{H}} = \sqrt{\frac{2(816)12}{4}} = 70 \text{ cases}$
2. The 70 cases can be bought at $18 per case because 70 falls in the range of 50 to 79 cases. The total cost to purchase 816 cases a year, at the rate of 70 cases per order, will be

$$TC_{70} = \text{carrying cost} + \text{ordering cost} + \text{purchase cost}$$
$$= \frac{Q}{2}H + \frac{D}{Q_0}S + PD$$
$$= \frac{70}{2}4 + \frac{816}{70}12 + 18(816) = \$14,968$$

Because lower cost ranges exist, each must be checked against the minimum cost generated by 70 cases at $18 each. In order to buy at $17 per case, at least 80 cases must be purchased. (Because the TC curve is rising, 80 cases will have the lowest TC for that curve's feasible region.) The total cost at 80 cases will be

$$TC_{80} = (80/2)4 + (816/80)12 + 17(816) = \$14,154$$

To obtain a cost of $16 per case, at least 100 cases per order are required, and the total cost will be

$$TC_{100} = (100/2)4 + (816/100)12 + 16(816) = \$13,354$$

Therefore, because 100 cases per order yields the lowest total cost, 100 cases is the overall optimal order quantity.

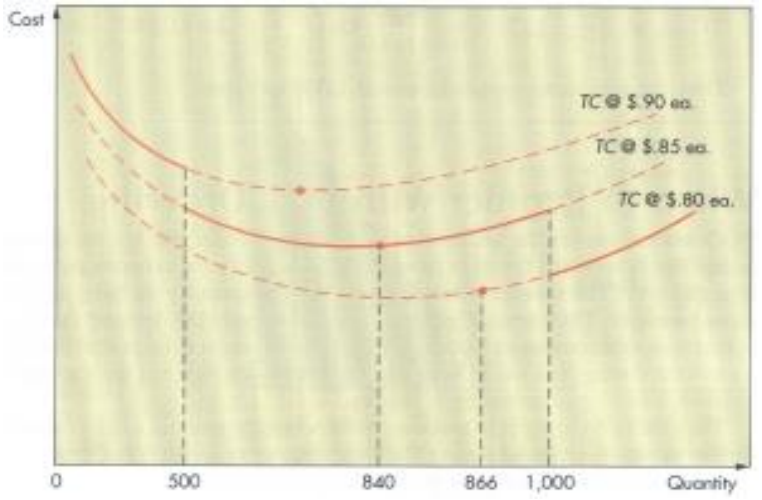
When carrying costs are expressed as a percentage of price, determine the best purchase quantity with the following procedure:

1. Beginning with the lowest unit price, compute the minimum points for each price range until you find a feasible minimum point (i.e., until a minimum point falls in the quantity range for its price).
2. If the minimum point for the lowest unit price is feasible, it is the optimal order quantity. If the minimum point is not feasible in the lowest price range, compare the total cost at the price break for all *lower* prices with the total cost of the largest feasible minimum point. The quantity that yields the lowest total cost is the optimum.

Example: Surge Electric uses 4,000 toggle switches a year. Switches are priced as follows: 1 to 499, 90 cents each; 500 to 999, 85 cents each; and 1,000 or more, 80 cents each It costs approximately $30 to prepare an order and receive it, and carrying costs are 40 percent of purchase price per unit on an annual basis. Determine the optimal order quantity and the total annual cost.

Solution: D = 4,000 switches per year, S = $30, H = .40P.

Range	Unit Price	H
1 to 499	$0.90	$0.36
500 to 999	$0.85	$0.34
1,000 or more	$0.80	$0.32



1. Find the minimum point for each price, starting with the lowest price, until you locate a feasible minimum point.

$$\text{minimum point}_{0.80} = \sqrt{\frac{2DS}{H}} = \sqrt{\frac{2(4{,}000)30}{0.32}} = 866 \text{ switches}$$

2. Because an order size of 866 switches will cost $0.85 each rather than $0.80 each, 866

is not a feasible minimum point for $0.80 per switch. Next, try $0.85 per unit.

$$\text{minimum point}_{0.85} = \sqrt{\frac{2DS}{H}} = \sqrt{\frac{2(4,000)30}{0.34}} = 840 \text{ switches}$$

This is feasible; it falls in the $0.85 per switch range of 500 to 999.

3. Now compute the total cost for 840, and compare it to the total cost of the minimum quantity necessary to obtain a price of $0.80 per switch.

$$TC_{840} = \text{carrying cost} + \text{ordering cost} + \text{purchasing cost}$$

$$= \frac{Q}{2}H + \frac{D}{Q}S + PD$$

$$= \frac{840}{2}(.34) + \frac{4,000}{840}(30) + 0.85(4,000) = \$3,686$$

$$TC_{1,000} = \frac{1,000}{2}(.32) + \frac{4,000}{1,000}(30) + 0.80(4,000) = \$3,480$$

Thus, the minimum-cost order size is 1,000 switches.

4) Single-Period Inventory Model

Sometimes a unique situation that arises is one in which there will be demand for an item in only one period, so the challenge is to determine

the order size (stock size) that will best accommodate the anticipated (and uncertain) demand. Any items stocked in excess of demand will be scrapped. Any demand in excess of what has been stocked will represent a missed opportunity for more profit. This problem is sometimes referred to as the newsboy problem, or the Christmas tree problem is used to handle ordering of perishables (fresh fruits, vegetables, seafood, cut flowers) and items that have a limited useful life (newspapers, magazines, spare parts for specialized equipment). The *period* for spare parts is the life of the equipment, assuming that the parts cannot be used for other equipment. What sets unsold or unused goods apart is that they are not typically carried over from one period to the next, at least not without penalty. Day-old baked goods, for instance, are often sold at reduced prices, leftover seafood may be discarded, and out-of-date magazines may be offered to used book stores at bargain rates. There may even be some cost associated with disposal of leftover goods.

Analysis of single-period situations generally focuses on two costs: **shortage** and **excess**.

Shortage cost may include a charge for loss of customer goodwill as well as the opportunity cost of lost sales. Generally, **shortage cost** is simply unrealized profit per unit. That is,

$C_{shortage} = C_s$ = revenue per unit - cost per unit

If a shortage or a stockout relates to an item used in production or to a spare part for a machine, then shortage cost refers to the actual cost of lost production.

Excess cost pertains to items left over at the end of the period. In effect, excess cost is the difference between purchase cost and salvage value. That is,

$C_{excess} = C_e$ = original cost per unit - salvage value per unit

If there is cost associated with disposing of excess items, the salvage will be negative and will therefore *increase* the excess cost per unit.

The goal of the single-period model is to identify the order quantity, or stocking level, that

will minimize the long-run excess and shortage costs.

There are two general categories of problems that we will consider: those for which demand can be approximated using a continuous distribution (perhaps a theoretical one such as a uniform or normal distribution) and those for which demand can be approximated using a discrete distribution (say, historical frequencies or a theoretical distribution such as the Poisson). The kind of inventory can indicate which type of model might be appropriate. For example, demand for petroleum, liquids, and gases, tends to vary over some *continuous scale*, thus lending itself to description by a continuous distribution. Demand for tractors, cars, and computers is expressed in terms of the *number of units* demanded and lends itself to description by a discrete distribution.

These discussed methods are but a few of the many variations to the basic EOQ model that are in existence. They all are designed to provide optimal answers to the how much and when questions. Choice of a model should be dictated

by the characteristics of the inventory situation that you are facing.

5) Questions

1. Describe the major cost categories used in inventory analysis and their functional relationship to each other.
2. Explain how the order quantity is determined using the basic EOQ model.
3. What are the assumptions of the basic EOQ model and to what extent do they limit the usefulness of the model?
4. How are the reorder point and lead time related in inventory analysis?
5. How must the application of the basic EOQ model be altered in order to reflect quantity discounts?
6. Explain in general terms how a safety stock level is determined.

Problems

Student Name
No.

1. A company operates 250 days per year.

   Annual demand (D) = 10,000 units per year.

   Ordering cost (S) = $75 per order.

   Holding cost (H) = $6 per unit per year.

   Lead time = 5 days.

   What is the EOQ, total annual inventory cost, number of orders placed, and time between the placements of orders?

   Results of computations

   - EOQ =
   - Number of orders placed per year =
   - Average inventory level =
   - Annual ordering cost =

- Annual holding cost =

- Total annual inventory cost =

- Time between the placement of orders =

2. Consider calculating the total annual inventory cost, ordering cost and carrying cost using the following information.

Spreadsheet Implementation of EOQ Model		
Annual Demand	D	1000
Ordering Cost	S	$5.00
Holding Cost	H	$1.25
Lead Time	L	5
Item Cost	C	$12.50

Ordering cost

Carrying cost

Total annual inventory cost

3. A firm runs a mail-order business for gym equipment. Annual demand for the product number TS10 is 16,000. The unit cost is $25, the annual holding cost per unit is $2.50 and the cost to place an order is $50. Answer the following inventory policy questions for the company.

a- Calculate the EOQ.

b- What are the total annual inventory holding and ordering costs associated with your recommended EOQ?

Total annual inventory cost = Ordering cost + Carrying cost

Q	(D/Q)*S	(Q/2)*H	TC
Order Quantity	Ordering Cost	Carrying Cost	Total Cost
10			
20			
30			
40			
50			
60			
70			
80			
90			
100			
110			
120			
130			
140			
150			
160			
170			
180			
190			

c- What do you notice about the relationship between holding cost and ordering cost?

d- Use the information in the previous table to raw a graph to illustrate the relationship between holding cost and ordering cost and point the EOQ point.

e- If the company keeps a safety inventory to cover two days delay in supply, count the safety stock.

f- Assuming 250 days of operation per year and a lead time of 5 days, what is the reorder point for the Company?

g- Draw a graph to illustrate the different levels of inventory and discuss the importance of safety stock.

4. Electronic Village stocks and sells a particular brand of personal computer. It costs the store $450 each time it places an order with the manufacturer for the personal computers. The annual cost of carrying the PCs in inventory is $170. The store manager estimates that annual demand for the PCs will be 1,200 units. Determine the economic order quantity and the total minimum inventory cost.

The economic order quantity

The total minimum inventory cost

5. Use the following information:
    - Annual demand = 12000 units
    - Cost per unit = $6.75
    - Ordering cost = $28
    - Unit holding cost = $1.35
    - Quantity each order = 461 units
    - Number of orders = 26

Calculate:

- EOQ.

- Annual holding cost.

- Annual ordering cost.

- Combined cost.

- Annual purchase cost.

- Total cost.

- Draw the levels of inventory.

- Illustrate the relationship between holding cost and ordering cost.

6. Suppose the annual demand for an inventoried item is 1,200 units. The holding cost for it is $3 per unit per year. The ordering cost is $50 per order.

   (6a) In this problem,

   D=

S =

H =

(6b) If the current order quantity is Q=100 units per order, then

(a) The total annual ordering cost = S*(D/Q) =

(b) The total annual holding cost = H*(Q/2) =

(c) The total annual inventory cost =

7. Calculate the economic order quantity, Q*, for this problem.

$$Q^* = \sqrt{\frac{2DS}{H}} =$$

8. With the economic order quantity Q* as you have just calculated,

   (a) How many orders will be placed in a year?

   (b) What is the total annual ordering cost?

   (c) What is the average inventory level?

   (d) What is the total annual holding cost?

   (e) What is the total annual inventory cost?

9. Suppose the order quantity is Q=300 units per order.

   (a) Without calculations, the total inventory cost associated with this order quantity must be _____ that with Q*, the economic order quantity.

a. higher than b. lower than c. equal to

10. The total annual inventory cost associated with the economic order quantity, Q*, is the lowest comparing to any other order quantities.

a. True b. False

11. At the EOQ, the total annual holding cost is always _____ the total annual ordering cost.

a. greater than b. smaller than c. different from

d. same as e. None of the above. It depends on specific problems

12. A large bakery buys flour in 25-lb bags. The bakery uses an average of 4,680 bags a year. Preparing an order and receiving a shipment of flour involves a cost of $4 per order. Annual carrying costs are $30 per bag.

(a) Determine the economic order quantity

(b) What is the average number of bags on hand?

(c) How many orders per year will there be?

(d) Compute the total cost of ordering and carrying flour.

(e) If annual costs were to increase by $1 per order, how much would that affect the minimum total cost?

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