Segment 3: Managing Goods in Transit and in Storage

Segment Description:
Topic 3.1 begins with a general discussion of how to manage inventory. Next, topic 3.2 presents an implementation viewpoint of how to balance the demands of distribution and logistics within domestic and international supply chains. Topic 3.3 presents an implementation viewpoint of the different viewpoints of producers and suppliers through the use of EOQ problems.

Learning Outcomes for the Segment:
Upon completing the segment and assignment, students should be able to:

- Understand the various tools available for managing inventory
- Be aware of the various tradeoffs in terms of distribution and transportation requirements in a global supply chain.
- Have insights into how concepts such as JIT have different impacts on large firms as opposed to small suppliers.

Segment Topics:
- Topic 3.1 – Inventory Management
- Topic 3.2 – Distribution, Transportation and Material Handling within the Supply Chain
- Topic 3.3 – EOQ Problem Set: A Microscope into Supply Chain Tradeoffs.

Reference Reading:


Segment Overview

To start, we refer back to figure 1 which describes the topics we address in this course. This segment covers the categories of Make and Deliver.

This sub-segment, inventory management, covers the basics of Make while the next sub-segment covers distribution management which provides the delivery requirements of a firm. The final segment will illustrate how SCM requires a team approach through the use of EOQ examples.
Sub-Segment 3.1 Inventory Management

Introduction
It is very important for a company to successfully manage their inventory and use all techniques that they see fit for their type of business. By doing this they can lower overhead and cost and increase their customer satisfaction by having goods available when the customer demands them. Both Physical and Logical inventory needs to be assessed and managed in a way where the information is true and accurate so that there is no overstocking yet minimal shortage. Good inventory control also means having accurate forecasting and accurately timed replenishments.

Ensuring that the data and technology are up to par, a company can achieve a good inventory control plan. Managed and organized information leads to better forecasting, improved returns lower cost and identification of crucial products. A company may face difficulties in their system due to an indifference attitude towards inventory control but a company should recognize the added benefits of paying close attention.

This segment discusses the concept of inventory management and its importance, followed by the current tools and techniques for inventory management including the technologies that support inventory management.

History
It has been said that war brings with it atrocities; however, sometimes great progress is achieved out of the mechanics of war. World War II was the principle creator of the science of operations research. O.R. development began in the United Kingdom and later spilled over to the US, where in the early 1950’s industrial operations grew. With this growth, inventory policies took a central stage within an organization due to constant problems within various departments of the organization. The production department wanted uninterrupted production runs, which meant large inventory of goods in process as well as finished goods. Marketing wanted to give immediate delivery of goods,
therefore demanded a large and diverse inventory. Finance wanted minimum inventory to reduce capital blockage and to stabilize labor which required goods to be produced for inventory at slack periods. These issues gave rise to a major question: What inventory policy is best for the organization? To address such questions, organizations needed a way to balance the overall objective of an organization as well as the objectives of individual departments. This gave birth to inventory management, a process to optimize the production and movement of raw material, semi-finished and finished products.

Solutions to dealing with problems of inventory management were developed as far back as 1915 by F.W Harris. He developed the economic-lot-size equation. This equation sought to minimize the sum of inventory carrying cost and set-up cost, when demands were certain. However, it was only in the early 1960’s that concepts such as inventory forecasting and safety stock were introduced to help deal with fluctuating demands.

What is Inventory Management?

Inventory Management encompasses processes that ensure product availability while reducing investment costs. For most companies, there are two forms of inventory: Physical and Logical. Physical inventory includes all the materials that are tangible and required to fabricate the final product. On the other hand, examples of logical inventory are databases, inventory tracking software, etc. Proper synchronization of these two inventories is essential for proper management of company assets. Inventory management also involves identifying the most effective source of supply for each item in each stocking location. Forecasting and replenishment are also integral to inventory management.

Why do we need Inventory Management?

Inventory is the largest and most difficult asset to manage for any distributor. Proper management of inventory is required because of:
• **Overstocking:** The excess inventory of some products lead to dead stock that reduces profitability.

• **Shortages:** It is possible that some items are not available in the inventory when order arrives. In other cases, they might be available but not traceable because of poor information controls.

• **Inaccurate Information in Logical Inventory:** This inaccuracy can lead to inaccurate forecasting as well as not being able to locate inventory that is actually available.

• **ROI is Not Satisfactory:** Inventory control (managing excess inventory) may overshadow the profits earned.

_How does Inventory Management help us?_

The following are benefits of proper management of inventory:

• **Better Forecasting:** Accurate inventory information improves forecasting capabilities. This in turn can improve customer service and can reduce instances of overstocking or shortage of certain products.

• **Improved Financial Returns by Reduced Costs:** Inventory control activities are costly. Properly managed inventory reduces these costs. There are several different costs involved:
  - Cost of stocking and distributing materials
  - Rent and utilities expenses of warehouse
  - Insurance and taxes on physical inventory
  - Money invested in inventory.

• **Identification of Crucial Products:** Better management can help distinguish items that are a must to maintain throughput of production process.
• **Ability to support Just In Time “JIT”:** Properly managed inventory can be as effective as JIT inventories.

**Factors Affecting Inventory Management**

Despite the extensive coverage afforded to asset decisions in financial management literature and education, there tends to be one glaring shortcoming--inventory management--. The management of cash, physical capital assets, and, to a somewhat lesser extent, receivables is dealt with extensively. This omission cannot be defended by claiming that inventory is a relatively insignificant asset. On the contrary, even in this time of service industry domination, inventory remains a force in the U.S. economy.

There are some major factors that have an impact on the management of inventory. Some of these overlooked factors are cost, quality, control, order size and plant capacity.

• **Cost:** Commodity prices can vary dramatically over a relatively short period of time. A strong expectation of rising prices could lead to an immediate, above-normal inventory buildup of the affected raw material. On the other hand, a strong expectation of falling prices might lead to an above-normal inventory stock reduction. A purchasing manager should compare the incremental carrying costs of larger inventory stocks to the expected price increase. The probability of error in all price expectations must, of course, also be kept in mind.

• **Order Size:** There are various costs incurred each time an order is placed with a manufacturer, including delivery charges, handling costs, and paperwork expenses. It behooves a distributor to minimize the frequency of placing orders in order to hold down ordering costs. However, infrequent ordering necessitates large order sizes, thereby leading to greater inventory stocks and an increase in carrying costs. Manufacturing firms also place orders for goods, particularly raw materials, and parts for use in production. By placing large orders, a manufacturer can, in essence, utilize inventory to minimize ordering costs. But again, inventory
carrying costs must be incorporated into such a decision. It is the tradeoff between ordering cost and carrying cost.

- **Forecasting:** The forecasting function seeks to predict demands in the future. Forecasting is important in determining capacity, tooling and personnel requirements. There are two types of forecasting, long range and short range. Both kinds of forecasts are input to the intermediate level function of Demand management.

- **Capacity Planning:** Capacity planning is at the top of the plant planning capacity and has major impact on all other production planning issues. Demands have to be anticipated: How far into the future should we go? The size of the capacity increment depends on the flexibility of the equipment we choose: Should we add capacity by expanding an existing facility, or should we build a new one? It is often more expensive to build a new facility then to expand an existing one, but a new facility can often lead to other efficiencies.

- **Production Scheduling:** An important factor in inventory management relates to production scheduling. Continuous process manufacturers often produce a mix of products, one at a time, using the same equipment and facilities. Each time a different product is to be produced, it is necessary to stop the production process and make adjustments before proceeding. The costs of shutdown and adjustments, which are referred to here as changeover costs, can be rather high. Production time is lost while the facilities are closed down, and labor costs must be expended to make the necessary adjustments. As a consequence of the changeover costs, businesses try to find ways to minimize the number of changeovers. One of the principle ways of achieving this goal is through the use of inventory. Simply put, a company can choose to make many short production runs on each product in the mix, thereby incurring many changeovers and having smaller lots in inventory, or it can opt for long production runs and very few changeovers and increasing inventory lots.
Tools and Techniques of Inventory Management

Strategically, stores management must manage the overall supply chain efficiently and effectively. Reducing levels of stock in manufacturing is an internal and external matter (relationships with suppliers). Production demands and the management of supplies are linked strategically and operationally. There are many mathematical models for inventory control that can be used.

Some of oldest & simplest models include Economic Order Quantity (EOQ), and Wagner-Whitin Procedure. But today most of the industries are using techniques like Material Requirement Planning (MRP II), its predecessor was MRP I; Just in Time (JIT) and Enterprise Resource Planning (ERP), which is the next generation MRP II.

The **Economic Order Quantity (EOQ)**, as it is known in purchasing, is the amount at which the combination of order costs and inventory carrying costs is minimized. It is the most cost effective quantity to order. The EOQ model is applicable if demand for an item has a constant rate and the entire quantity ordered arrives in inventory at one point in time. EOQ calculations are frequently used in business, both by production, purchasing and inventory managers. This tool provides everything it takes to make reliable calculations. In addition, it automatically computes the reorder point (= the amount of inventory at which new orders must be placed) and order cycle time in days, both if there is a leadtime (= period between the placement of an order and its receipt in inventory) or none. An automatically generated chart based on input data can be directly exported to any presentation.

The EOQ determines the order quantity, or the amount of inventory that will be purchased or produced with each replenishment. It also determine the reorder point, or the inventory level at which a replenishment will be triggered.
The inventory level set to trigger an order of a specific item is the **Reorder point** and is generally calculated as the expected usage (demand) during the lead time plus safety stock.

The **Wagner-Whitin Procedure** assumes deterministic demand and deterministic production. We will not go into detail of this here; the goal is only to make you aware of it. In most cases, this technique is better suited for purchasing than a production system.

The **Material Resource Planning II** is used in most industries. It is an improvement over MRP I. Benefits of this is tremendous time saving due to the elimination of duplication of work. Goods cannot be accepted if there is no P.O. Quantity accepted cannot exceed quantity ordered. Use of the MRP module in conjunction with the BOM can forecast materials requirements on a lot basis. The Production Analysis can be used to track actual production versus scheduled production.

**Enterprise Resource Planning (ERP)** combines all departmental information together into a single, integrated software program that runs off a database so that the various departments can easily share information and communicate with each other. This integrated approach can have a big payback if companies install the software correctly. The advantages of ERP are consistent user interface, integrated databases, unified architecture, tool set and product support.

**Just in Time (JIT)** inventory, as the word states, works on a real time working environment basis. It is based on zero defects, small lot size, reduce set ups and breakdowns, as well as minimized lead time. JIT is based on timely delivery so there is control on inventory. It controls WIP level, observes throughput and is rate driven.

In most manufacturing systems, a small fraction of purchased parts represent a large fraction of the purchasing expenditures. Because of this manufacturing firms use **ABC**
Classification for purchased parts and materials. A category parts are 5 to 10 percent of the parts accounting for 75 to 80 percent of total annual expenditures. B category parts take next 10 to 15 percent, accounting for 10 to 15 percent of total annual expenditures. C category items take the bottom 80 percent, accounting for only 10 percent of total annual expenditures.

These are some of the techniques for inventory control management. However, in today’s world ERP & JIT tend to be the most widely used.

Focus on Practice

As a matter of practice and implementation, there are many firms that have used MRP for years. However, because of upper management pressure, they are now moving to JIT. This brings up the issue of how to move employees and production systems from an MRP environment that has become ingrained. The simplest approach is to continue to use MRP, but move from large fixed order quantities to smaller quantities, the goal being a lot size of 1. Continue this process until you have moved all MRP lots to a Lot for Lot (LFL) strategy. After LFL has been used for a period of time, congratulate your employees are their embracing of JIT concepts (which is basically what they have been doing). At this point, it is much easier to transition to a true JIT environment, than an all-or-nothing approach.

Intensification in Inventory Management use:

Retailers continue looking for an optimal blend of art and science to conduct inventory management activities. They have spent time, money and resources instituting fundamental techniques, establishing inventory control and aligning their assortments. The marketplace continues to become increasingly competitive and executing the basics compared with your rivals may no longer be enough. For that reason, more inventory management techniques and practices are still being used and expect to grow. This
growth is corroborated in a survey performed by Bearingpoint Inc. in 2003 on retail industries in the US including Department, Big Box, Specialty, Drug, and Home improvement stores (http://www.bearingpoint.com). They found that 51% of the participants generate more than $500 million or more in annual sales and operate 100 stores or more.

In the mentioned survey, it was reflected how the communications and shared information between retailers and their vendor partner was increased by 18% over 2002. This is seen in figure 1 below.

The percentage that shared inventory information was 76%. For that reason, the retailers achieved higher profit margin from their vendor base because the increase in maintained margin and inventory turn. In the same survey, it is important to mention that the most three used methods between retailers for managing product inventory are category management (management of product categories as strategic business units), automatic replenishment and model stock level with 67%, 61% and 59% respectively (see figure 2 below)
Regarding the major obstacles faced by retailer in maintaining inventory integrity in a scale from 1 to 10 (rating of 10 signifies as “extremely dramatic impact”), the result was that the three major obstacles are receiving, selling and physically inventory counting error, all with values of more than 6.5. This is detailed in figure 3.
Figure 4 Obstacles in Maintaining Inventory Integrity

Almost all retailers agree that in order to reduce those errors they need to apply better employees training on policies and procedures, organization education, continue implementation in barcode scanning, establishing specialty measurements in terms of accuracy. (See figure 4)
Figure 5 Ways to Eliminate Obstacles

**Mini-Case Examples of Implementation:**

Companies around the world have been successful implementing Inventory management practices and techniques.

**Wal-Mart**

Wal-Mart’s success is not just due to offering lower prices to the customer it is also contributed to applying inventory management. By only having in stock what people wanted. By electronically linking to their suppliers (EDI) and their cross-docking strategy, Wal-Mart and their suppliers gain advantages due to "just-in-time" inventory control. They gain advantages due to the elimination of paperwork from the stock re-ordering process, and the consequent elimination of processes associated with sorting, mailing and storing of paper-based transactions. Approximately, Wal-Mart savings are
around 180 Million by reducing its inventory and the annual cost of carrying that inventory.

**Home-Depot**

The Home Depot formula for success is warehouse stores that feature everyday low pricing, extraordinary customer service, quality products and a very large assortment of items. The price is a critical factor and sourcing, procurement and inventory management play important roles in the company’s overall strategy. Home Depot moves over 85 percent of its merchandise directly from supplier to store, avoiding warehouse altogether. In addition, Home Depot developed a forecasting system internally that uses two years’ of point-of-sale (POS) data and provides replenishment planning functions, so that inventory threshold-levels can be set and vendor lead times accounted for. Their profit rose more that 15% for all the improvements.

**Littlewoods Stores in the UK**

Littlewoods Stores operates more than 250 locations across the United Kingdom. The retail clothing industry is very competitive and for that reason Littlewoods began initiatives to improve their supply chain and specifically to deal with their overstocking problem. They implemented a data warehouse system, DSS and other software that transformed all the business and put the company back on track to success. The results include 20% inventory reduction, 2 percent increase in margins, improve liquidation of stock, 40% increase in staff productivity and 59 to 85% increase in cross-docking percentage.

**7-Eleven**

The 7-Eleven is the nation’s number 1 convenience-store chain in sales and they rolled out an inventory management and sales data system that not only made the most of its limited shelf space and product assortment, but also moved new products into stores and improved its position with its supplier. Using sales and inventory data, they hand over
two dozen new products to store managers weekly including fresh and perishable food and were able to optimize sales and improve their inventory. 7-Eleven has grown to $10 billion in U.S. sales and $33 billion worldwide with all improvements.

**Arizona Public Service (APS)**

APS is the largest utility company in Arizona, serving 705,000 customers and generating $1.7 billion in revenues annually. APS decided to scrutinize its supply chain for ways to increase efficiency and invest in new technology to support management of materials and services. They developed an electronic system that enables buyers and other company personnel to buy products and services through the streamlined processes of three online software modules (material Catalog, description buy and express buy). The time spent on improving supply chain permitted APS to trim inventory by 25%, and reduce purchasing cost by 5%. In turn, APS reduced the consumer electric rate by 5%.

Numerous other companies such as General Motors, Toyota (the leader in JIT), Kmart, JCPenny, US Department of Defense, etc are applying inventory management to improve customer service level, warehouse capacity and the overall profit. In the big picture, American business has succeeded in Lean manufacturing. US. Department of commerce showed that from 1981 to 2000, inventory as a percentage of GDP fell 46%, from 8.3 to 3.8%.

The greatest challenge, by far, involves getting associates in different parts of the supply chain to work together. That’s because many organizations still operate in a functional cost manner, where managers are rewarded for improving performance only within their own internal group.
Trends in Inventory Control

Companies are now seeing that collaboration between supplier and vendors is key to making the supply chain successful. This idea of working together in a healthy relationship is driving what is being developed for the future of inventory management.

Electronic Data Interchange (EDI) is helping a lot of business in sharing data. It involves the transfer of data between different companies using a network. EDI helps with buying, selling and sharing information. A supplier can access their customers inventory data and know when their inventory needs replenishing and can adjust their near term manufacturing forecast plan to this information. When a company needs to place an order, they can do this through an EDI system and avoid a paper trail of purchase orders because the system will automatically save the information. It provides faster communication from one entity to another and companies can access real time data.

Vendor Managed Inventory (VMI), is now being more readily used. Using a VMI program, a company outsources its inventory control to their supplier while only needing to handle sales and forecasting data. VMI allows manufacturers to respond to customer demand and goods are only sent when needed from VMI locations that are run by the manufacturer. VMI programs can result in inventory reduction due to the supplier handing inventory tracking and replenishment planning and collaboration.

Scan Based Trading (SBT) is mainly used by supermarkets. This concept uses daily point of sale scanner data to manage payment and replenishment of goods. The system allows for a perpetual inventory count; when an item is scanned at checkout the program picks it up and adjusts the inventory accordingly. The difference in this system compared to other perpetual inventory control is that the supplier still owns the goods until the item is scanned and payment is made at that time to. The supermarket acts like a warehouse storage for the manufacturer. The supplier gets real time information on when their
products are bought and can schedule their deliveries based on how much of an item remains in the store. SBT can reduce inventories, cut labor costs, streamline distribution, maintain the optimal amount of inventory and save money for both the supplier and store.

**Collaborative Planning, Forecasting and Replenishment** (CPFR) combines EDI and VMI. It is different because it allows more shared information between two entities and increases collaboration. It links the supply and demand of a product so that the retailer is more involved in the supply chain because both companies will be able to see the entire supply chain from one end to the other. The final retailer will be able to be involved from the manufacturing of raw materials to the final product. All the suppliers that are involved in the process of making an item are linked together and can get information about the other. This helps to determine short comings of material of any manufacture in the chain so that companies can plan accordingly.

Due to the heightened responsibility of both the supplier and vendor, both have had to accommodate each other. This relationship is becoming much more important and as such, the customer experience is trying to be elevated. This is being done by having in-store KIOSKS or a detailed web site where customers can get information and order products, some companies have gone as far as to let the customer personalize their products to fit their needs. By doing this the vendor is better to track the interest of the product with what is actually being ordered.

A technology that has started to emerge to help with inventory management is **Radio Frequency Identification** or RFID. RFID uses a computer chip and reader to let the user know when an item has arrived at an entrance and when it leaves an exit. Wal-Mart first started to use this back in 2000 for individual items but dropped the study and decided it would be better to track pallets of goods. RFID is still new and not all suppliers have been acquainted with RFID due to the non-compatibility between different systems. A new company set up in September 2004 is trying to create a universal reader for all RFID chips to standardize the technology and give it a chance to thrive and maybe perhaps replace the barcode.
All the programs are used to keep real time data on inventory. A company and its supplier will know when it is running short on inventory which means that the cycle time in ordering is becoming shorter, more frequent with smaller lots. This type of situation helps both parties involved. It creates a continuous steady flow of work for the supplier instead of having major peaks and lows and a retailer will know that its inventory is being taken care of.

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