

1. Inventory management

10.1 Introduction

The importance of proper inventory management is evident when one considers that inventories have led to the demise of many a business. The downfall of some companies results from the fact that they are simply unaware of, or do not consider, the cost of inventory.

Inventory is generally considered as a safety factor, the lubrication between different parts in the supply chain that enhances the smooth functioning of the total chain. In recent times, however, inventory has come to be considered more and more as a liability. Yet the basic function of inventory, namely saving in other areas and providing 'insurance', cannot be denied. The challenge is to balance the need for inventory against the cost of carrying inventory.

1.2 The purpose of inventory

There are various reasons why businesses on different levels in the supply chain hold inventory.

The functions of inventories can be classified into the following broad categories:

- Decoupling
- Balancing supply and demand
- Buffering against uncertainties in supply and demand
- Geographical specialisation
- Preventing the cost of a stockout

1.2.1 Decoupling

Decoupling provides maximum operating efficiency in a logistics environment by keeping inventories at different stages or different locations in the supply chain. Holding inventory at different stages may lead to economies of scale.

1.2.2 Balancing supply and demand

Inventory is necessary to reconcile supply with the demand for a product. Balancing is concerned with the elapsed time between consumption and manufacturing and links the economies of manufacturing with variations in consumption.

The balancing function of inventory is most prominent in seasonal supply and/or demand. This seasonality can take two forms:

- Seasonal production, but year-round consumption
- Seasonal consumption, where supply must meet peak demand

1.2.3 Buffering against uncertainties in supply and demand

The buffering function of inventory involves protecting the business or supply chain against three types of uncertainty:

- Uncertainty of future demand. This type of uncertainty results from the fact that demand usually fluctuates from period to period; causing a probability that demand may be more than the forecast. The more that demand varies from period to period, the more the uncertainty and the more difficult it becomes to forecast demand accurately.
- Lead-time uncertainty. Lead time refers to the elapsed time from order placement to order receipt. This type of uncertainty results from variability in the lead time that may be due to unforeseen delays in order processing or transportation.
- Uncertainty in supply. This refers to uncertainty about whether a specific product will be available at the time it is needed from the supplier. For example, raw materials in excess of those required for manufacturing can result from speculative purchases made because of the possibility of a strike or the unavailability of natural resources.

1.2.4 Geographical specialisation

A major function of inventory in the supply chain is to provide for geographical specialisation of members of the supply chain. The economic location of factories is often based mostly on the availability and cost of the factors of production, such as land, power, materials, water and human resources.

1.2.5 Preventing the cost of a stockout

The most important function of inventories is to ensure the availability of products – either materials, semi-finished goods or final products. If these are not available the result is the cost of a stockout.

There are three possible costs attached to a stockout. In order of severity, these are:

- The cost of a backorder
- The cost of a sale
- The cost of a lost customer

1.3 Types of inventory

An understanding of the purpose of inventory, as discussed in Section 10.2, reveals that there are various types of inventories. These can be classified in terms of either the position of the inventory in the supply chain or in terms of the purpose that it serves in the supply chain.

1.3.1 Classification of inventory based on its position in the supply chain

Inventory can be classified in terms of where it is held in the supply chain. The more it moves downstream from the factory towards the final consumer, the higher the value of the inventory.

1.3.1.1 Raw material

This is inventory of the material required to manufacture either components or the final product; it is usually low in value and high in volume. Iron ore, water, crude oil and sugar cane are examples of raw materials.

1.3.1.2 Work-in-process

Inventory of WIP is usually held to support manufacturing. It may consist of semi-finished goods between different stages of the manufacturing process or components that are used during the manufacturing process.

1.3.1.3 Packaging material

Inventory of packaging material plays a similar role to WIP. In many operations it forms part of the manufacturing process.

1.3.1.4 Finished goods inventory

The final product may be held in inventory at various locations throughout the supply chain, including a finished goods warehouse at the factory, a central distribution warehouse, field warehouse, wholesaler or retailer.

1.3.2 Classification of inventory based on its purpose

It is evident from Section 10.2 that inventory can be classified in terms of the purpose the products serve.

1.3.2.1 Cycle stock

From a manufacturing perspective, cycle stock is often defined as the amount of stock that is produce in an average production run.

1.3.2.2 Transit inventory

Transit inventory is inventory that is en rout (either moving or awaiting movement) from one location to another.

1.3.2.3 Safety (buffer) stock

Safety stock is held over and above the cycle stock to make provision for the uncertainties mentioned in Section 10.2.3. The level of safety stock would depend mostly on the severity of these uncertainties as reflected in the extent to which they vary.

In conclusion, safety stock is determined mainly by the following factors:

- Demand uncertainty
- Lead-time uncertainty
- Duration of the lead time
- Service level policy of the business
- Order quality

1.3.2.4 Speculative stock

Speculative stock is inventory held for reasons other than satisfying normal day-to-day demand (and the safety stock to provide for uncertainties in this demand). **Business may purchase merchandise in volumes larger than necessary for the following reasons:**

- To qualify for quantity discounts
- When a price increase in goods is expected
- When a shortage of the goods is expected
- To protect against a strike
- To provide for the promotion marketing campaign) of a certain item
- To provide for seasonal sales

1.3.2.5 Dead stock

Dead stock is items for which there has been no demand for a specified in effective inventory management. This section describes the major concepts that are crucial for understanding the planning of optimal inventory levels.

1.4 Important inventory concepts

A though understanding of certain inventory related concepts is essential in effective inventory management. This section describes the major concepts that are crucial for understanding the planning of optimal inventory levels.

1.4.1 Availability

Reference has been made above to availability and its importance in the level of safety stock.

1.4.1.1 Stockout frequency

A stockout occurs when demand exceeds availability. Stockout frequency refers to the probability that a stockout will occur and measures how many times the demand for a specific product exceeds availability.

1.4.1.2 Fill rate

While the stockout frequency refers to the probability of a stockout, the fill rate measures the magnitude or impact of stockouts over time.

1.4.1.3 Order shipped complete

Orders shipped complete (or order fill) is the strictest measure of availability. It is a measure of the number of times that a business can supply all the items ordered by a customer from the available stock.

1.4.2 Average inventory

Average inventory consists of the materials, WIP, components and finished products that are typically held in inventory. Average inventory include cycle stock, safety stock and transit inventory components.

1.4.3 Inventory turnover

Inventory turnover (or stock turnover) is a measure of how many times during a year the average stock is used up and can be expressed as follows:

Inventory turnover = total annual sales ÷ average inventory.

1.5 Inventory costs

Total inventory costs consist of purchasing costs, ordering costs and carrying costs (also termed holding or maintenance costs).

1.5.1 Ordering costs

Ordering costs consist typically of administration, communication and handling costs, which are associated with order placement, processing and receiving.

1.5.2 Carrying costs

Inventory-carrying costs are the associated with holding products in stock. Together with transport costs, these are regarded as one of the major components of logistics costs.

For example, assuming carrying costs of 25 per cent, the annual inventory cost for a business with R1 million in average inventories is calculated as follows:

Inventory-carrying costs

= Value of average inventory × carrying cost %

= R1 000 000 × 25%

= R250 000

Inventory-carrying costs can be broadly categorised as follows:

- Capital costs on inventory investment
- Insurance
- Inventory risk costs:
 - Obsolescence
 - Damage
 - Shrinkage
- Storage costs

1.5.2.1 Capital cost

Money used to purchase goods that are kept in inventory could have been used for other types of investment.

1.5.2.2 Insurance

Inventory needs to be insured against theft and fire. Insurance cost is not proportional to the level of inventory since it is incurred to cover a certain value of product for a specified time.

1.5.2.3 Inventory risk costs

Inventory risk costs typically consist of obsolescence, damage and shrinkage. Obsolescence refers to the deterioration of products and is not covered by insurance.

1.5.2.4 Storage costs

Storage costs refer to the use of warehouse space for storing products in inventory. These costs are not related to the value of the product, but rather to the size of individual products, which determines the storage space required.

1.5.3 Impact of carrying-cost percentage on financial records

Unlike other logistics cost elements, such as transport and warehousing, inventory-carrying costs are not apparent in the financial statements of a business.

1.5.4 Impact of carrying-cost percentage on logistics decisions and strategies

It is evident from the discussion in Section 10.5.2 that there is some discretion in determining the carrying-cost percentage. Some businesses may use a low percentage based on the argument that the appropriate capital cost is their internal cost of funds, which is lower than external costs.

1.6 Inventory planning

Inventory planning involves the setting of optimum inventory levels in the supply chain, with due consideration for the lowest total logistics costs and uncertainty in demand and supply.

1.6.1 Cycle stock

The planning of cycle stock to ensure optimum inventory levels involves answering two crucial questions:

- How many should we order?
- When should we order?

1.6.1.1 The review level (reorder point) system

How much to order

The question of how much to order can be answered by calculating the economic order quantity (EOQ) for a specific item.

EOQ adjustment for volume transport rates

As a general rule, the larger the order, the lower the transport cost per unit because the transport cost is spread over more units. One could, therefore, expect that lower transport rates can be negotiated for larger order quantities.

EOQ adjustment for quantity discounts

When buying large quantities, discounts can also be taken into account by adjusting the EOQ.

Other adjustments to the EOQ

There may be other situations for which the basic EOQ solution can be adjusted. These include:

- Production lot size. These refer to the most economical quantities from a manufacturing perspective.
- Multiple-item purchase: more than one product is bought at the same time and transport and quantity discounts may come into play.
- When capital is limited: budget restrictions prevent purchasing all product lines at the EOQ. Multiple product orders must frequently be made within budget limitations.
- Specialised (dedicated) transport can influence order quantities. Since the vehicle cannot be used for other products, purchases should be made fully utilise the available space on the vehicle.
- Unitisation: case or pallet sizes need to be considered.

When to order

Once the order quantity is established the question of when to order can be addressed. The reorder point (ROP) defines the time when a replenishment order should be initiated.

Worked example

Assume daily demand of 50 units and a lead time of ten days. The ROP in this case would be 500 units (50 x 10).

1.6.1.2 Target stock level system

Often circumstances make the use of the review level system inappropriate. Sometimes, suppliers encourage orders at fixed intervals.

1.6.2 Safety stock

Certainly seldom prevails, if ever, in business, planning optimum inventory levels must, therefore, include planning for safety stock.

It can be statically proven that in a normal distribution:

- 68,27 per cent of all events would fall within one standard deviation either side of the mean;
- 95,45 per cent of all events would fall within two standard deviations either side of the mean; and
- 99, 73 per cent of all events would fall within three standard deviations either side of the mean.

1.6.2.1 Demand uncertainty

When applying probability theory and the normal distribution to demand history, it can be estimated that in approximately 68 per cent of occasions demand would be within plus or minus one standard deviation from the mean; that in approximately 95 per cent of occasions demand would be within two standard deviations either side of the mean; and in 99 per cent of occasions, demand will be within three standard deviations either side of the mean.

1.6.2.2 Lead time uncertainty

The provision for safety stock due to inconsistent lead times is calculated in the same way as for variations in sales.

1.6.2.3 Combined effect of lead time and demand uncertainty

A business is typically confronted with both demand and lead time uncertainty.

1.6.2.4 Calculating fill rate

While the probability theory determines the probability of a stockout, the fill rate gives an indication of the magnitude of a stockout.

1.6.2.5 Conclusion on safety stock

Due to increased competition and the need for greater efficiency, businesses worldwide are searching for ways to reduce inventories without compromising service levels.

1.6.3 Logistics requirements planning

1.6.3.1 Definition and scope of logistics requirements planning

Logistics requirements planning (LRP) is a scheduling technique which ensures that the right goods are available at the right place, at the right time and in the right quantities.

1.6.3.2 The logistics requirements planning process

The important LRP planning tool is the schedule, which integrates and coordinates requirements across the supply chain for a specified planning period.

The procedure involves using the above variables according to the following steps:

- Step 1:** Start with distribution (independent demand)
- Step 2:** Do demand forecasting covering periods as short as possible. (Most LRP applications forecast weekly demand.)
- Step 3:** Calculate how long (e.g. number of days or weeks) the current stock will last.
- Step 4:** Deduct the safety stock requirement. (There should always be provision for uncertainty. The projected inventory on hand, therefore, should never fall below the required safety stock level.)
- Step 5:** Add stock that may be in transit.
- Step 6:** Calculate the date when safety stock will be reached – this is the date on which a new batch should arrive.
- Step 7:** Calculate the date of shipment, allowing for lead time between placing and receiving the order for finished products.
- Step 8:** Place production via the master productions schedule.
- Step 9:** Calculate the delivery date of raw materials.
- Step 10:** Calculate the date of shipment, allowing for lead time between placing and receiving the order for materials.

A practical example of the implementation of LRP is explained in the next section.

1.6.3.3 Practical application of LRP

Consider a distribution network for a certain product (a single SKU) with a central warehouse in Johannesburg (close to the factory) and regional distribution warehouses in Windhoek, East London, Cape Town, Bloemfontein and Durban.

1.6.4 Just-in-time

1.6.4.1 General approach and features of just-in-time

Just-in-time (JIT) is one of several approaches to inventory management that have special relevance to supply chain management (other being MRP and DRP).

The main features of a JIT system are:

- Zero or minimum inventory;
- Short lead times;
- Small, frequent replenishment quantities; and
- High-quality or zero defects.

1.6.4.2 Difference between conventional and JIT systems

Table 10.13 shows the major differences between conventional and JIT inventory management.

1.6.4.3 Application possibilities

The application of JIT systems is not possible in all situations and is more appropriate to certain stages of the supply chain than others.

The typical features of the ideal company for JIT concepts to be applied can be summarised as follows:

- Narrow product range
- Manufacturer
- High volume
- Stable market
- Influential business
- Good-quality management
- Local suppliers of goods and services
- Dependent and reliable suppliers of goods and services
- Fast-cycle processes
- Personal commitment by management and operators

1.6.4.4 Requirements for JIT

The requirements for JIT system can be summarised as follows:

- Short timescale/short lead time: processes are suitable for JIT if the timescale is in hours rather than days.
- Long-term agreement with suppliers in respect of throughput levels, quality management and commitment.
- Suppliers should be treated as an intrinsic part of the organisation.
- Local suppliers. (Many suppliers locate to the vicinity of a major customer.)
- More frequent deliveries from suppliers.

- Close cooperation and liaison with suppliers of distribution services as well as of goods. (Longer-term, higher-volume commitments with suppliers can result in reduced prices.)

1.6.4.5 Benefits of JIT

A JIT system may bring about several benefits, the most important being a saving in logistics costs due to a reduction in inventory requirements.

The most significant savings are in the following areas:

- Reduction in warehousing costs because less space is required.
- Reduction in average inventory values due to a smaller investment in inventory.
- Operational cost savings, particularly in manufacturing, due to fast changeovers. (For example, a change in production setup from one brand to another provides an opportunity for less inventory. Furthermore, there is less stock that needs to be counted and controlled.)
- There could be a reduction in delivery costs even though delivery quantities means smaller. Smaller delivery quantities means smaller loads, allowing for different transport methods (for example, parcel post instead of a truck load). In addition, frequent fixed route deliveries enable a carrier to have a base load upon which to build other business; frequent deliveries on fixed routes do not require planning and management effort once set up; discounts can be negotiated on contracts based on regularity of service; standard-pack quantities and containers are smaller and less expensive, while recycling is also faster.

Additional costs usually occur because methods have not been changed to suit JIT, for example information systems and agreements with suppliers.

1.6.5 Collaborative inventory initiatives

There are several concepts or methods for collaborative inventory replenishment. Most are based on sound relationships and joint planning among supply chain participants, with the purpose of rapidly replenishing inventory.

6.6.5.1 Collaborative planning, forecasting and replenishment

Collaborative planning, forecasting and replenishment (CPFR) is probably the most widely used collaborative effort between supply chain participants.

6.6.5.2 Quick response

Quick response (QR) involves the sharing of retail sales information among supply chain participants.

6.6.5.3 Vendor-managed inventory

Vendor-managed inventory (VMI) is very similar to QR, but eliminates the need for the downstream customer to place a replenishment order.

6.6.5.4 Profile replenishment

Profile replenishment (PR) is an extension of QR and VMI, whereby the supplier anticipates future demand based on overall knowledge of the market for a specific product category.

1.7 Inventory control

1.7.1 The purpose of inventory control

The purpose of inventory control is to optimise three objectives:

- Superior customer service
- Relatively low inventory costs
- Lowest possible total operating costs

1.7.2 ABC analysis (Pareto analysis)

1.7.2.1 The Pareto Principle

In a study of the distribution of wealth in Milan during the 18th century, economist Vilfredo Pareto found that 20 per cent of the people controlled 80 per cent of the wealth.

1.7.2.2 ABC analysis using the Pareto Principle

Pareto analysis forms the basis of inventory control and is an important management tool that can be used to minimise effort and obtain the best results.

1.7.2.3 Policy and control based on ABC classification

As shown in Table 10.16, different systems of control can be used for the different classes of inventory.

1.7.3 Stock cover

Inventory control aims to drive stock towards appropriate levels. These levels are determined by supply and demand factors. Balance is important in ensuring the maximum service is offered with the minimum inventory-carrying costs.

1.7.4 Setting stock targets based on ABC

Stock cover should not be used for determining reorder levels, but for control purposes to reduce stock levels.

Stock cover ratios can be used to calculate the broad ranges of week's cover for each inventory category. An allowable stock cover range can be set for ABC inventory categories in a ration which is theoretically 1:3:7.

Acceptable ranges could be as follows:

- A class: between one and four weeks
- B class: between two and eight weeks
- C Class: between three and twenty weeks

1.8 Conclusion

Together with transport costs, inventory costs constitute probably the most significant portion of total logistics costs. Many supply chain decisions are based on the cost of holding inventory. The effective management of inventory throughout the supply chain is therefore of paramount importance.

These reasons can be summarised as follows:

- To allow for operating efficiency through economies of scale.
- To balance supply and demand, particularly when seasonality of products occurs.
- To buffer against uncertainties in demand and supply.
- To allow for geographic specialisation.
- To prevent the cost of a stockout.