Demand planning
A professional guide on forecasting and managing demand levels
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An essential guide on forecasting and managing demand levels
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Section 1: Introduction and definition

Demand planning, which forms part of an overall management strategy and affects many individuals and functions within an organisation, is just one element - albeit an important one - within demand management.

Demand planning is the management process within an organisation which enables that organisation to tailor its capacity, either production or service, to meet variations in demand or alternatively to manage the level of demand using marketing or supply chain management strategies to smooth out the peaks and troughs.

Demand drives the entire supply chain from suppliers to manufacturing, marketing, inventory, distribution and service to customers. An organisation needs to be able to forecast demand accurately but to do this needs to understand demand patterns, and how factors such as new products, competition, and changing market conditions affect these patterns. This understanding can, however, only be reached by a free and plentiful flow of information up and down the chain as illustrated below:

Section 2: Forecasting demand

Before an effective system of inventory control can be implemented it is essential to analyse, from records of usage, what has been the trend of demand for a given item of stock over an approximate period of time with a view to forecasting future requirements. The two most common approaches are detailed below:

a) Moving averages. A moving average is an artificially constructed time series in which each annual (or monthly, daily, etc) figure is replaced by the average or mean of itself and values corresponding to a number of preceding and succeeding periods. There is no precise rule about the number of periods to use when calculating a moving average. The most suitable, obtained by trial and error, is that which best smoothes out fluctuations. A useful guide is to use the number of periods between consecutive peaks and troughs.

For example the usage of a ‘dongle’ for six successive periods was 83,85,90,86,102 and 108. If a five period moving average is required, the average of the first term will be:

\[
\frac{83 + 85 + 90 + 86 + 102}{5} = 89.2
\]

The average for the second term will be:

\[
\frac{85 + 90 + 86 + 102 + 108}{5} = 94.2
\]

b) The exponentially weighted average method (EWAM). This average method has been largely discarded for inventory applications since it has a number of disadvantages:

- a large number of separate calculations are required
- a true forecast cannot be made until the required number of time periods have elapsed
- all data are equally weighted, but in practice, the older the demand data, the less relevant it becomes in forecasting future requirements
- the sensitivity of a moving average is inversely proportional to the number of data values included in the average.
Section 3: Types of demand planning

There are two types of planning: a) structured analytical planning such as time series analysis and moving monthly averages (based on historical data) and b) gut feeling. Both have their advantages and uses and it is not possible to say that one is right or wrong, and while the less structured intuitive approach may be more suited to a small or entrepreneurial business, both approaches can go hand in hand.

One key question which needs to be asked is: why bother with a plan or forecast at all? Quite often the structured analytical planning will result in a forecast which is a projection of patterns of past events into the future. Forecasts can enable a company to have a more reliable idea about future demand than might otherwise be the case. The selection and application of an appropriate forecasting technique can facilitate a route more accurately than a competitor or other person taking a less suitable approach. A plan, carefully produced and subsequently well managed, can help an organisation function more effectively, as well as improving production, minimising waste, reducing costs and improving profitability. It allows an organisation to analyse options and to draw up a strategy to achieve its objectives.

A plan can be affected by a wide range of factors, including for example:

- economic situation
- world events
- changing business environment
- regulatory and or environmental, social or cultural influences
- market trends
- marketing strategies
- seasonal influences
- competition both in the marketplace, and between suppliers
- technology (ie is there new technology available or is current technology old, unreliable and liable to cause problems?)
- delivery dates and lead times
- economic order quantities (EOQ)
- social changes
- changes in taste or fashion (usually consumer tastes but fashion could also apply to commercial/public sector organisations).

These difficulties are overcome by using an exponential series of weights with decreasing values which converge at infinity to produce a total sum of one. Such a series is known as an exponential series.

The actual demand for a ‘dongle’ during the month of January was 680 against a forecast of 600. Assuming a weighting of 0.2, the average demand forecast for February can be worked out as follows:

\[
0.2(680) + (1-0.2)(600) \\
= 136 + 480 \\
= 616
\]

*Detail and example adapted from: Purchasing and Supply Chain Management, K Lysons and B Farrington, Prentice Hall 2006*
Section 4: Independent and dependent demand

Demand may be either independent or dependent.

1) Independent demand for an item is influenced by market conditions and not related to production decisions for any other item held in stock. In manufacturing, only end items, i.e., the final product sold to the customer, have exclusively independent demand.

2) Dependent demand for an item derives from the product decisions for its ‘parents’. The term ‘parent’ is an item manufactured from one or more component items. A table, for example, is a parent made from a top, legs and fasteners. A component is one item that goes through one or more operations to be transformed into a parent.

There is a cyclical nature of many inventory items. They come into stock, are issued, then re-ordered on a continuous cycle. If demand were always constant (which is not realistic in an independent demand situation), the ideal inventory movement could be represented as in the saw-tooth diagram as below:

Independent demand
• can only be estimated
• although fluctuating with random market influences, usually demonstrates a continuous and definable pattern.

Dependent demand
• derives from production decisions for its parents and can therefore be forecast
• due to the practice of scheduling manufacturing in lots, is usually discontinuous and ‘lumpy’.

Contrast between continuous and ‘lumpy’ demand
Section 5: Economics of stock management

Economic aspects of stock management may be determined through an analysis of the costs incurred in obtaining and carrying inventories under the following headings:

5.1 Acquisition costs

Many of the costs arising as a result of placing an order are incurred irrespective of the size of the order. These costs typically include:

a) preliminary costs, e.g. preparing the requisition, supplier selection, negotiation
b) placement costs, such as stationery, postage etc
c) post-placement costs such as receipt of goods, materials handling, inspection, certification and payment of invoices.

In practice it is difficult to obtain more than an approximate idea of ordering costs since these will vary according to such factors as the size of company, the efficiency levels of the staff involved, and whether manual or computerised procedures are employed.

5.2 Holding costs

These are of two types:

a) Costs proportional to the value of the inventory, including:
   • financial costs, such as the interest on capital tied up in inventory
   • insurance
   • losses in value through deterioration, obsolescence and pilferage.

b) Costs proportional to the physical characteristics of inventory, including:
   • storage costs, e.g. storage space, stores rates, light, heat and power
   • labour costs relating to the handling processes involved
   • clerical costs associated with stores records and documentation.

The total costs per annum under each heading will be expressed as a percentage of the monetary values or quantity of the average stock held.

5.3 Costs of stockouts

These are the costs which arise through being out of inventory and include, for example:

• loss of production output
• costs of idle time and of fixed overheads spread over a reduced output.
• cost of action taken to deal with the stockout, such as buying from a stockist at a higher price, switching production, or obtaining substitute materials
• loss of customer goodwill through the inability to supply, or late delivery.
Section 6: The economic order quantity (EOQ)

**Definition.** The economic order quantity (EOQ) may be defined as the optimal ordering quantity for an item of stock that minimises cost.

### 6.1 Basic model

The basic (or simple) model assumes:

1) demand is uniform, ie certain, constant, and continuous over time
2) the lead-time is constant and certain
3) there is no limit on order size due either to stores capacity or other constraints. The cost of placing an order is independent of the size of the order. The delivery charge is also independent of the quantity ordered
4) the cost of holding a unit of stock does not depend on the quantity in stock
5) all prices are constant and certain. There are no bulk purchase discounts
6) exactly the same quantity is ordered each time a purchase is made.

“To calculate the EOQ a mathematical model of reality must be constructed. All mathematical models make assumptions that simplify reality. The model is only valid when the assumptions are true or nearly true. When an assumption is modified or deleted a new model must be constructed.” (Lysons)

(NB It should be noted that e-procurement can affect the cost of placing an order).

### 6.2 Basic principles

EOQ attempts to reconcile the problem of storage cost and ordering cost and to ascertain the order quantity which will minimise both. The formula used to calculate this is as follows:

\[
\text{EOQ value} = \sqrt{\frac{2 \times \text{annual anticipated demand} \times \text{cost of placing one order}}{\text{Cost of the item} \times \text{annual carrying cost interest rate}}}
\]

The cost of placing the order depends on the particular outlook of the organisation concerned and can take either a narrow view of just the cost of placing the order itself, or a broader view and include all the associate costs as well such as telephone calls, time, negotiations etc (see Section 5).

### 6.3 Example of basic EOQ formula

Assume the following figures:

- Annual demand = 1500 units
- Unit cost per item = £10
- Cost per order = £50
- Carrying cost interest rate = 20%

\[
\begin{align*}
\text{EOQ} & = \sqrt{2 \times 1500 \times 50} \\
& = \sqrt{150,000} \\
& = 387.3 \\
\end{align*}
\]

In practice, the EOQ would be increased to 300 items ordered five times yearly.

### 6.4 Disadvantages of the EOQ Process

All inventory control systems suffer from a number of weaknesses. These may be summarised as follows:

- they are based on historical data, which may or may not be a reliable guide to future demand
- they assume that the demand for an item is independent of the demand for any other item
- they assume that stock is issued at a smooth/constant rate
- stock levels and re-order points become inaccurate and less realistic over time and as such need to be frequently revised.

### 6.5 Stock service levels

Ultimately, planning demand accurately will help to reduce high levels of stock service with the minimum of stock investment. The trick is to get the balance between minimising carrying costs and carrying enough stock to ensure there is enough stock to meet demand without any significant risk of stockouts.
Section 7: Materials requirements planning (MRP) systems

Dependent demand items are those for which demand depends ultimately on the demand for the end product. Independent demand items are not correlated to the demand for the end product - MRO supplies for example. An MRP system can be described as a system for supplying the number of components required to produce a known quantity of finished assemblies.

The MRP process starts with a master production schedule which schedules the end-products to be completed week by week during the planning period. It is based on customer order levels, sales forecasts and manufacturing policy. The master production schedule is exploded to produce a bill of materials.

The MRP system calculates the gross requirements, adjusted at each level for stock on hand and orders due in. These net requirements are then offset by anticipated lead times to provide dates by which orders should be placed to ensure that they are available by the time required.

The following illustrates a simplified summary of the stages of MRP:

1) Sales forecast - updated with latest actual sales information
2) Sales forecast, customer orders and production policy used to produce the Master Production Schedule (MPS)
3) MRP program calculates how many of each component and raw materials are needed by exploding end product requirements into successively lower levels in the product structure
4) Net requirements calculated utilising inventory status file (that is, stocks and current orders deducted to give net requirements)
5) Net requirements adjusted by lead times to determine order release profile
6) Purchasing department places order
7) Goods received.

7.1 Manufacturing resource planning (usually known as MRPII)

MRPII is an extension of MRP in that it is a closed-loop MRP system. Various functions in production planning and control (capacity planning, inventory management and shop floor control) have all been integrated into a single system. Financial systems can also be included in the operation of MRPII. There are a number of operational advantages over MRP.

1) Planning can be prioritised - rush jobs can be brought forward in time and others put back with the necessary adjustment being made to material delivery schedules.

2) Integrated functions into the systems (in particular, capacity planning, inventory management and shop floor control) allows feedback from them, making sure that the production plan is constantly kept up to date.

3) There is feedback from vendors, the production shop and stores when a problem arises in implementing the production plan which enables adjustment to be made to overcome these problems without delay.

4) As it is a company-wide system and covers all aspects of the business and includes purchasing, inventories, production, sales, engineering and cash flows, all departments can operate with the same data. The interactions across the business are captured by the system, with, for example, the values of inventories, work in progress, and finished goods are known at all times.

5) If financial systems are included not only is it an operational and financial system, but it can be used for simulations.
Section 8: Just in time (JIT)

Demand planning should not be confused with JIT, which can be described as a continuous flow production. Demand planning is certainly a necessary component of JIT, where materials and services are provided or generated in the exact quantities and just at the right time, with the obvious effect of keeping inventory down to a minimum and reducing costs. Demand planning is appropriate for all organisations, not just those who subscribe to the JIT philosophy.

JIT takes the view that inventory is not an asset but a liability and should be eliminated wherever possible. Hence stocks of production materials and components are kept to a bare minimum, as are stocks of work in progress (WIP). Supplies arrive when they are required, hence the expression Just In Time. MRP or MRPII should not be confused with JIT. MRP systems are for coordinating, ordering, scheduling and inventory, whereas JIT is a system for inventory reduction. The main difference between the two is that JIT requires the smoothing ie fairly fixed quantities at regular intervals of the product mix so the same mix of the end products is produced at regular intervals. MRP on the other hand is very sensitive to items in demand, which are reflected in the updating of the master production schedule (MPS). In many industries an MRP system is developed alongside a JIT approach.

The principles central to JIT philosophy can be summarised as follows:

• quality is built into the product to ensure rework times are kept as short as possible; the goal is zero defects
• inventory is not an asset but a liability to be eliminated if at all possible
• set-up times are reduced to the level where they become insignificant.

Traditional methods of production attempt to achieve long production runs and large lot sizes. This requires large amounts of capacity, large inventories and WIP in a short period of time but can result in queues, delays and plants standing idle. The basic operating principle is to start with raw materials and components with the emphasis on pushing work through the plant. This is costly in terms of working capital tied up and ultimately the rate of return on capital is reduced. In the JIT approach the emphasis is on pulling work through the system; nothing is produced for which no demand exists at the next stage. Hence, stocks of materials/components and WIP are effectively eliminated.
Section 9: Information flows

Forecasts, schedules and call-offs show all demand-related information in the supply chain. In 1958 Jay W. Forrester developed the concept of demand amplification, sometimes known as the ‘Forrester Effect’.

Demand amplification occurs when the demand for a product is overestimated further down the supply chain causing what is known as the “bullwhip effect” (see diagram below). This is due to the following reasons:

### Causes of the bullwhip effect

- **Demand signalling**
  - No visibility of end demand
  - Multiple forecasts
  - Long lead times
  - High order cost
  - “Full truck load” economies
  - Random or correlated ordering
- **Order batching**
  - High-low pricing
  - Delivery and purchase synchronised
- **Fluctuation in prices**
  - Proportional rationing scheme
  - Ignorance of supply conditions
  - Unrestricted orders and free returns policy
- **Shortage or rationing scheme**

Inventory is often a substitute for information, as any kind of uncertainty is covered by inventory. However, adding in safety stocks can send out false signals and encourage suppliers to also compensate for uncertainty by similarly building in safety stocks. The key to success lies in passing real time sales data down the supply chain and smoothing out order frequencies and quantities where possible.

### Sources of demand

From the viewpoint of the typical organisation, demand can arise from several sources.

- to satisfy the production process
- to satisfy service/spares requirements
- to satisfy customer requirements
- to satisfy internal (non-production) requirements
- to satisfy political or regulatory requirements.
Section 10: Variety reduction

This technique can, by standardising and where possible reducing the range of products and materials in stock, achieve considerable savings. Advantages of this approach include:

- reduced stockholding costs
- release of financial resources tied up in stocks
- easier specification when ordering
- narrower range of inventory
- smaller supplier base.

It can take two forms.

Reactive

Can be undertaken on a periodic basis by a specially appointed team of interested parties to establish:

- the intended use of each item of stock
- percentage of stock items serving an identical, or near-identical, purpose
- what range of sizes is essential
- how frequently each item in the range is used
- what items can be eliminated.

Proactive

Using this approach, variety reduction can be achieved by using, so far as possible, standardised components and subassemblies to make a range of end products which, although dissimilar in appearance and performance, use only a few basic components. Pro-active approaches to variety reduction can also apply when considering capital purchases. By ensuring compatibility with existing machinery the range of spares carried to insure against breakdowns can be substantially reduced.

Whichever of these approaches is adopted the need to maintain a satisfactory customer service level needs to be borne in mind.

(Source: Purchasing and Supply Chain Management. K Lysons and B Farrington Prentice Hall, 2006)

Section 11: Developing the marketing mix

When a company has decided on its overall competitive marketing strategy it must begin planning the details of the marketing mix, which may be defined as the set of controllable tactical marketing tools that the company blends together to produce the response it seeks in the target market.

The marketing mix consists of everything the company can do to influence the demand profile for its product. The many possibilities may be categorised as 'the four Ps', as follows:

<table>
<thead>
<tr>
<th>Product</th>
<th>Promotion</th>
<th>Price</th>
<th>Place</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variety</td>
<td>Advertising</td>
<td>List price</td>
<td>Channels</td>
</tr>
<tr>
<td>Quality</td>
<td>Promotions</td>
<td>Discounts</td>
<td>Coverage</td>
</tr>
<tr>
<td>Design</td>
<td>Personal</td>
<td>Allowances</td>
<td>Assortments</td>
</tr>
<tr>
<td>Features</td>
<td>Selling</td>
<td>Payment</td>
<td>Locations</td>
</tr>
<tr>
<td>Brand name</td>
<td>Publicity</td>
<td>Period</td>
<td>Inventory</td>
</tr>
<tr>
<td>Packaging</td>
<td>Warranties</td>
<td>Credit terms</td>
<td>Transport</td>
</tr>
</tbody>
</table>

An effective marketing programme is able to blend the elements of the marketing mix into a co-ordinated overall strategy.

Direct involvement of purchasing

The purchasing department will have some involvement in many aspects of the above; the precise extent of such involvement varying according to circumstances.

The primary role of the purchasing department, it has been suggested, is to buy the right goods at the right time, and at the right price, in the right quantity and of the right quality. Each of the components of that ‘mission statement’ (if it can be so described) has an important bearing on demand management as a whole. Thus the purchasing professional has a responsibility to consider, for example, having an understanding of the product development cycle and life cycle. They could meet with internal customers in order to understand their business, their objectives and their concerns. To share information about his/her role with them, and to carry out purchasing research into new products and techniques.
Section 12: Developing a risk assessment strategy – the involvement of purchasing

An important aspect of the purchasing professional’s role is risk assessment, the essential principles of which should always be taken into account in the demand planning process. Specific issues and questions to be addressed include:

- whether or not a supply strategy is in place in the organisation and is widely known and understood. If not, one needs to be devised and agreed with everyone being made aware of it and the need to abide by it.

- addressing the financial implications/risk involved, including the level of investment in stock.

- critically reviewing the planning estimates given by each function within the organisation to guard against demand being inflated at each stage.

- how dependent is the organisation on particular key suppliers; are they single sourced/dual sourced/multi-sourced? This should be critically reviewed and changes implemented as necessary.

- how dependent are the suppliers on the organisation’s business? While it might be of some comfort to learn that the buyer’s organisation is their biggest customer, this is not necessarily an ideal position to be in. The buyer’s business with them, while profitable to them, may not provide a sufficient margin to fund new technology/ business re-engineering. Also, if they have other customers they may obtain new ideas from them which could be of general benefit.

- have the suppliers’ capacity and development plans been reviewed? What are their production facilities like? Are their quality control procedures satisfactory? Is their production flexible enough to meet both anticipated and unforeseen requirements? Do they have efficient transport/ delivery arrangements?

- what contingency plans do the suppliers (as well as their trading partners) have in the event that they have a problem – labour difficulties, for example?

- the suppliers’ suppliers, and the supply chain as a whole, should be kept under constant review to ensure that there are no weak links.

- contracts with suppliers should be kept under review, ensuring that the buyer’s interests are clearly represented. All contractual clauses need to be examined; for example is there a service level agreement with consequences for non-performance. Can quantities be varied and by how much, how often and is there a cost for doing so. Can the buyer suspend or cancel the agreement and in such cases does a penalty apply?

- how are suppliers selected? Specifically, is there a formal procedure and, equally important, is there a set procedure for regular reviews? Has their financial position been reviewed? Is their environmental and ethical policy acceptable, and does it align with that of the buyer’s organisation? Is their management team easy to work with and are there cross-relationships at senior levels in the two organisations to resolve problems should they arise?

- what steps can the buyer’s organisation take to compensate for ‘lumpy/irregular demand’ such as seasonal fluctuations?

The purchasing professional should remember that s/he is the link between their own organisation and the supplier. Demand planning should have been done at a corporate level with their input, but they are key to the demand management process and, with one eye on that plan at all times must be fully aware of the current situation with their own internal users working to that plan and to their suppliers delivering to the plan. S/he must not forget either that most plans are a position at a point in time, or that they will probably be altered for a variety of reasons, so that changes or fluctuations in the suppliers’ capability levels (that should have taken into consideration) can assume key significance.
Section 13: Conclusion

Successfully anticipating and planning demand can give companies a significant competitive advantage. There is a fine balance between not holding enough stock, and holding too much - holding too much stock throughout the supply chain can mean that large amounts of money are tied up in stock which is a wasteful and inefficient use of resources. Holding too little, on the other hand, can result in stockouts and losing customers to other competitors. As cost pressures increase on the supply chain, the art of successfully managing demand throughout the supply chain becomes increasingly important.

There are many blue chip ‘dinosaurs’ who have recognised the importance of having a leaner, more agile, more responsive supply chain, and the journey to get to the ultimate scenario is often a mixture of process re-engineering, effective systems, an informed and flexible supply chain, and intuitive professionals who understand the market and the high level of responsiveness of their extended supply chain.