2 Dimensions of and strategies for production planning

This chapter covers Unit 2, Module 1, Sections 3, 4 and 5.
On completion of this chapter you should be able to:

- understand what a production plan is
- identify and explain the main dimensions or features of a production plan
- understand different methods of sales forecasting and recognise the importance of sales forecasts
- explain key features of product design planning
- explain different types of layout for a production process
- revise the scheduling techniques of critical path and decision trees and understand PERT
- outline the benefits of using simulation techniques

Dimensions of production planning
Production planning involves creating a detailed account of how a business intends to design and produce the goods and services to satisfy forecast demand. It involves taking decisions on the design of the product, how many to make, the processes to use and the production capacity required. A production plan will require forecasts to be made about future demand levels for the product.

Forecasting
A production plan contains details of how many units are planned to be produced to meet demand. This requires predictions or forecasts of future demand to be made. There are six main methods of sales forecasting.

1 Sales force composite
This is a method of sales forecasting that adds together all of the individual predictions of future sales of all of the sales representatives working for a business.

Sales force representatives have the task keeping in contact with customers – usually not the final consumers but the retail businesses that purchase and stock the product for sale to consumers. They promote the products of the business, take orders for new deliveries and deal with any queries regarding product specification, delivery dates and so on. By having this frequent contact with customers, sales representatives are able to develop a real insight into market trends and potential demand for the future. By asking all sales staff they have contact with for their estimates of future sales to the customers and then adding these estimates together a total sales forecast can be arrived.

This method has the advantage of being quick and cheap to administer. It does have limitations, however. Sales representatives may not be aware of macro-economic developments of competitors actions that could have a substantial impact on future sales. Customers may over-estimate the number of products that they hope to sell in the future in the hope of gaining a more favourable arrangement with the supplying business. It is not based on an assessment of existing final consumer tastes or needs and how these might change in the future.

2 Time-series analysis
This method of sales forecasting is based entirely on past sales data. Sales records are kept over time and when they are presented in date order, they are referred to as a 'time series'.

(a) Extrapolation
The most basic method of predicting sales based on past results is termed extrapolation. Extrapolation means basing future predictions on past results. When actual results are plotted on a time-series graph, the line can be extended, or extrapolated, into the future along the trend of the past data; see Figure 2.1.
(b) Moving averages

This method is more complex than simple graphical extrapolation. It allows the identification of underlying factors that are expected to influence future sales. These are:

- **The trend.** This is the underlying movement in a time series.
- **Seasonal fluctuations.** These are the regular and repeated variations that occur in sales data within a period of 12 months.
- **Cyclical fluctuations.** These variations in sales occur over periods of time of much more than a year and are due to the trade cycle.
- **Random fluctuations.** These can occur at any time and will cause unusual and unpredictable sales figures. Exceptionally poor weather or negative public image following a high-profile product failure are two examples.

Examination questions will be mostly concerned with the identification of the trend and seasonal variations. The moving-average method is used to analyse these in Table 2.1 on ice cream sales. Once they have been identified, then short-term sales forecasts can be made.

Points to note are:

- The moving-average method involves calculating moving totals from a number of sales figures. Each total in Table 19.1 is made up of four results. This is why the total is called a four-quarter moving total. A four-period moving total was used because the data clearly vary consistently over this length of time. For example, sales are always highest in the summer quarter. If other data were used, perhaps daily sales figures, then a seven-period total would have been used, because the regular variation in sales would have been over seven days. Monthly sales data may require the use of a 12-period moving total.
- If this four-quarter moving total was divided by 4, in order to calculate the average, this result would not lie alongside any one quarter.

This would not make sense – to have a result which does not 'belong' to any one time period. The problem is overcome by 'centring' the average so that it lies alongside one actual quarter. This is done by adding two four-quarter moving totals together. This gives an eight-period moving total. This is divided by 8 to give the moving average.

- The moving average is known as the trend of the data. The underlying movement of the data has been identified by averaging out the regular seasonal fluctuations.
- The difference between the actual sales and this trend must have been largely due to seasonal fluctuations. These can then be calculated as shown in Table 2.2.

Seasonal variation (Col. 7) = Actual result (Col. 3) – Moving average (trend)(Col. 6)

Make sure you obtain the correct plus or minus sign for your results. If the result is negative, it means that in that quarter sales are usually below the trend or average for seasonal reasons.

- The average seasonal variation smooths out the actual seasonal variations. This is obtained by
<table>
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<th>Year</th>
<th>Quarter</th>
<th>Sales revenue</th>
<th>Four-quarter moving total</th>
<th>Eight-quarter moving total</th>
<th>Quarterly moving average (Trend)</th>
<th>Seasonal variation</th>
<th>Average seasonal variation</th>
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<tr>
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<td>4</td>
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<td>580</td>
<td>1170</td>
<td>146.25</td>
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<td>590</td>
<td>1170</td>
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<td>-20</td>
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<td>610</td>
<td>1200</td>
<td>156.25</td>
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<tr>
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<td>670</td>
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<td>167.5</td>
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<td>-42.5</td>
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<td>1550</td>
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</table>

Table 2.2 Moving averages for ice cream sales (£'000s)

Adding up all of the seasonal variations for each separate quarter and then dividing by the number of results. For example, Quarter 3 seasonal variations are:

\[43.75 + 52.5 + 58.75 = 155/3 = 51.67.\]

**Forecasting using the moving-average method**

The results from Table 2.2 can now be used for short-term forecasting. You will need to:

1. Plot the trend (moving average) results on a timeseries graph (Figure 2.2).
2. Extrapolate this into the future – short-term extrapolations are likely to be the most accurate.

![Forecasting future-trend sales figures](image-url)
3. Read off the forecast trend result from the graph for the period under review, e.g. Quarter 2 in Year 2007.
4. Adjust this by the average seasonal variation for Quarter 2.

Thus, for Quarter 2 in the year 2007:
- The actual forecast will be the extrapolated trend forecast for this quarter, £208,000, plus the average seasonal variation of – £4,600 = £203,400.

**Moving-average method – an evaluation**

The advantages are:
- It is useful for identifying and applying the seasonal variation to predictions.
- It can be reasonably accurate for short-term forecasts in reasonably stable economic conditions.
- It identifies the average seasonal variations for each time period and this can assist in planning for each quarter in future.

On the other hand, the disadvantages are:
- It is a fairly complex calculation.
- Forecasts further into the future become less accurate as the projections made are entirely based on past data.
- Forecasting for the longer term may require the use of more qualitative methods that are less dependent on past results.

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**Activity**

Read the case study below and tackle the exercises that follow.

**Case study**

The sales of Sodhi's convenience store were recorded over a four-week period. The shop is only open five days per week. The owner of the store has started to undertake a short-term forecasting exercise and has asked you to help.

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<th></th>
<th>Sales</th>
<th>Moving total (5 period)</th>
<th>Moving average</th>
<th>Daily variation</th>
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<td></td>
<td></td>
</tr>
<tr>
<td>Tues</td>
<td>32</td>
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<tr>
<td>Weds</td>
<td>38</td>
<td></td>
<td></td>
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<tr>
<td>Thurs</td>
<td>40</td>
<td></td>
<td>43</td>
<td>–3</td>
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<tr>
<td>Fri</td>
<td>50</td>
<td></td>
<td>44</td>
<td>6</td>
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<tr>
<td>Sat</td>
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<td>Tues</td>
<td>37</td>
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<tr>
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<td>224</td>
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<td>Fri</td>
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<td></td>
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<td>Sat</td>
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<td>Sat</td>
<td>72</td>
<td></td>
<td></td>
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</tbody>
</table>

(30 marks, 40 minutes)

1. Why has the shop owner used a five-period moving total? Is he right to do so? (4)
2. Copy out the table above and complete the columns for the moving total, moving average and daily variation. (8)
3. Plot the moving average (trend) line on a graph and extrapolate this to the fifth week. (6)
4. For each day that the shop is open, calculate the average daily variation in sales. (2)
5. Use your graph, the extrapolation of the trend and the average daily variation in sales to forecast sales for each day of the fifth week. (2)
6. Evaluate the usefulness of this method for forecasting sales from the store in ten months’ time. (8)
3 Consumer surveys
These are a form of market research and the questions may either be quantitative in nature – e.g. asking for likely future levels of demand – or qualitative – e.g. asking for reasons behind future demand choices. For greater accuracy the sample of consumers selected must be large enough to be as fully representative of the total number of consumers for a product as possible. Such surveys may be conducted by the business itself but this takes up management time and requires a detailed awareness of research techniques, questionnaire construction and statistical analysis of results. The other option is to hire a specialist market research agency to undertake the surveys. This can be expensive but is likely to lead to a more accurate demand forecast than many ‘in-house’ surveys.

Below are two examples of questions asked in a survey of shoppers:

‘How many foreign holidays did you take last year?’
‘What do you look for in an ideal foreign holiday?’

The first question is designed to obtain quantitative data which can be presented graphically and analysed statistically. The second question is designed to find out the key qualitative features of a holiday that would influence consumer choice.

There are four important issues for market researchers to be aware of when conducting consumer surveys:

♦ **Who to ask?** Given that in most cases it is impossible or too expensive to survey all potential members of a target market (called the survey population) it is necessary to select a ‘sample’ from this population. The more closely this sample reflects the characteristics of the survey population, then the more accurate is the survey likely to be.

♦ **What to ask?** The construction of an unbiased and unambiguous questionnaire is essential if the survey is to obtain useful results.

♦ **How to ask?** Should the questionnaire be self completed and returned by post or filled in by an interviewer in a face-to-face session with the respondent? Could a telephone survey be conducted instead?

♦ **How accurate is it?** Assessing the likely accuracy and validity of the results is a crucial element of market research surveys.

4 Delphi method
This is a long-range qualitative forecasting technique that obtains forecasts from a panel of experts. The experts do not meet and they are anonymous to each other. The ‘facilitator’ collects and co-ordinates the opinions from experts who are sent detailed questionnaires asking for their judgement about possible future events – such as demand levels or technology changes that could affect consumer taste and demand levels. After each round of questionnaire results have been collected they are summarised and sent to all of the experts on the panel. A further questionnaire is then sent out to see if the experts have changed their minds after reading the results of the first round of questionnaires.

In this way the ‘extreme’ responses from the experts are often amended and moderated so that, eventually, a consensus is reached that represents the most likely ‘correct’ forecast. This may take several rounds of questionnaires to achieve.

Tests have proven that this Delphi technique – named after the all-knowing ‘Oracle of Delphi’ – is more accurate than unstructured groups of experts giving their opinions and forecasts.

5 Jury of experts
The Delphi technique uses experts not directly employed by the business. The jury of experts uses the specialists within a business to make forecasts for the future. Senior managers meet and develop forecasts based on their knowledge of their specific areas of responsibility within the business. This is quicker and cheaper than the Delphi technique but it lacks the external view of market conditions and consumer trends that the Delphi approach offers. It is sometimes referred to as ‘the jury of executive opinion’.

6 Least squares regression
In the previous section extrapolation was explained as the process of extending the trend of data into the future to obtain forecasts. This was done using a rather inaccurate ‘visual’ approach of finding a line of best fit
between data points and then extending this into the next year or so.

The least squares regression method is a mathematical approach to forecasting that extrapolates data into the future based on a correctly calculated line of best fit. The least squares regression line is obtained by calculating the gradient of the line that achieves the smallest sum of the square of differences from the data points on the line. The formula for this line can then be used to extrapolate into the future and this allows forecasts to be made.

![Figure 2.3 A calculated regression line](image)

The calculation of the least squares regression line is beyond the scope of the CAPE syllabus but students need to be aware of the principle behind it.

**Product design planning**

You are advised to return to page 6 to read again the section on value analysis as this model is the starting point for successful product design.

**Modularisation**

Much good product design is currently based around 'modular components'. These are parts of a product or sub-assemblies that can easily be added to or subtracted from a complete product to give a new product that can be marketed to customers.

*Example 1.* A mobile (cell) phone manufacturer is planning a new range of mobile phones. The product design department have been asked to develop new mobile phone products that will appeal to a range of consumer groups of different ages, income levels and so on. Instead of designing several different types of new phones, the design department develops one basic model to which can be added different features and casings for different market segments – including a camera feature, video feature, MP3 music download feature, e-mail feature. These ‘modular’ features can be added to or subtracted from the basic model depending on the specific needs of each consumer group. This modularisation approach will clearly be cheaper than designing and producing several new completely different and unrelated mobile phones.

*Example 2.* Volkswagen produce a large range of cars (over 30 models) under both the original brand name and under the names of SEAT and Skoda. Instead of each model being designed and built with its own distinct engine, gearbox, interior trim and so on, Volkswagen have designed a small range of engines and other components that will fit into all or most of these models. These ‘modular components’ give the company a huge advantage in terms of economies of scale, as well as offering the consumer a very wide range of engines and other components from which to choose.

In conclusion, modularisation offers the opportunity for 'mixing and matching' of components in modular product designs. There has to be a 'standard interface' between components for this mixing and matching to take place – i.e. the electrical and mechanical links between the modules must allow them to be easily fitted together.

Advantages of modularisation are:

1. It gives designers flexibility in meeting the needs of different market segments.
2. A wider range of products can be offered than would be possible under traditional 'standardisation' methods. See 'mass customisation' on page 9.
3. Modules or sub-assemblies, because they can be used in a wide range of applications, can be made on a very large scale, which allows for substantial scale economies.
4. Ease of design and testing means each module can be designed and tested separately before final assembly.
5. Product updating is easier. Instead of designing and producing a totally new product just one or two modules can be updated to allow the final product to be relaunched as a newer version.