

THE PRESENTATION OF RESEARCH FINDINGS

1 THE ANALYSIS OF QUANTITATIVE DATA

- 1.1 The result of any collection of quantitative data is likely to be a mass of raw data. For example, if 100 people were stopped in the street, asked to taste a new chocolate bar and then award it marks out of ten, the researchers would be left with a list of 100 numbers ranging from 0 to 10. The key task in quantitative analysis is therefore to reduce the raw data by summarising them so that their key features can be identified. As we will see in Sections 3 to 7 the data's key features can then be presented in some way so that they will be understood by the target audience.
- 1.2 Quantitative data can be summarised by calculating averages, performing frequency analysis or setting up a probability distribution.

Measures of location (averages)

The arithmetic mean

- 1.3 This is the best known type of average. It is calculated by the formula

$$\text{Arithmetic mean} = \frac{\text{Sum of values of items}}{\text{Number of items}}$$

For example, if three bakers sell bread, the *mean* price of a loaf of bread is the three individual prices added together and divided by three.

Example: the arithmetic mean

- 1.4 The demand for a product on each of 20 days was as follows (in units).

3 12 7 17 3 14 9 6 11 10 1 4 19 7 15 6 9 12 12 8

The arithmetic mean of daily demand is

$$\frac{\text{Sum of demand}}{\text{Number of days}} = \frac{185}{20} = 9.25 \text{ units}$$

- 1.5 The advantages of the arithmetic mean are as follows.
- (a) It is widely understood.
 - (b) The value of every item is included in the computation of the mean.
 - (c) It is supported by mathematical theory and is suited to further statistical analysis.
- 1.6 The disadvantages of the arithmetic mean are as follows.
- (a) Its value may not correspond to any actual value. For example, the 'average' family might have 2.3 children, but no family has exactly 2.3 children.
 - (b) An arithmetic mean might be distorted by extremely high or low values. For example, the mean of 3, 4, 4 and 6 is 4.25, but the mean of 3, 4, 4, 6 and 15 is 6.4. The high value, 15, distorts the average and in some circumstances the mean would be a misleading and inappropriate figure.

The mode

1.7 The mode is an average which means 'the most frequently occurring value'.

Example: the mode

1.8 The daily demand for a product in a ten day period is as follows.

<i>Demand</i> Units	<i>Number of days</i>
6	3
7	6
8	1
	<u>10</u>

The mode is 7 units, because it is the value which occurs most frequently.

1.9 The mode will be a more appropriate average to use than the mean in situations where it is useful to know the most common value. For example, when we want to know what sort of product is most in demand with customers the mode is easy to find, it is uninfluenced by a few extreme values and it can be used for data which are not even numerical (unlike the mean and median). The main disadvantage of the mode is that it ignores dispersion around the modal value, and unlike the mean, does not take every value into account. There can also be two or more modes within a set of data and it is unsuitable for further statistical analysis.

The median

1.10 The third type of average is the median. The median is the value of the middle member of a distribution or array.

1.11 The median of a set of ungrouped data is found by arranging the items in ascending or descending order of value, and selecting the item in the middle of the range.

Example : the median

1.12 The median of the following nine values:

8 6 9 12 15 6 3 20 11

is found by taking the middle item (the fifth one) in the array:

3 6 6 8 9 11 12 15 20

The median is 9.

The median of the following ten values would be the fifth item in the array.

8 6 7 2 1 11 3 2 5 2

1 2 2 2 3 5 6 7 8 11

The median is 3.

With an even number of items, we should strictly take the arithmetic mean of the two middle ones (in this example, $(3 + 5)/2 = 4$), but when there are many items it is not worth doing this.

1.13 The median is only of interest where there is a range of values and the middle item is of some significance. Perhaps the most suitable application of the median is in comparing changes in a 'middle of the road' value over time where most values inevitably fall close to the middle value. An example might be the age at which women marry: the median would show a gradual rise during the twentieth century. The median (like the mode) is unaffected by extremely high or low values. On the other hand, it fails to reflect the full range of values, and is unsuitable for further statistical analysis.

Frequency analysis

- 1.14 If a large number of measurements of a particular variable is taken (for example the number of items purchased per customer per week) some values may occur more than once. A frequency distribution (or frequency table) is obtained by recording the number of times each value occurs.

Example: a frequency distribution

- 1.15 The number of items purchased by 20 customers during one week was as follows.

65	69	70	71	70	68	69	67	70	68
72	71	69	74	70	73	71	67	69	70

- 1.16 If the number of occurrences is placed against each purchase quantity, a frequency distribution is produced.

Items purchased	Number of customers (frequency)
65	1
66	0
67	2
68	2
69	4
70	5
71	3
72	1
73	1
74	1
	<u>20</u>

- 1.17 The number of customers corresponding to a particular volume of purchases is called a frequency. When the data are arranged in this way it is immediately obvious that 69 and 70 units are the most common volumes of purchases per customer per week.

Percentages

- 1.18 Percentages are used to indicate the *relative* size or proportion of items, rather than their absolute size. For example, if one car salesman sells ten Fords, six Vauxhalls and four Renaults, the *absolute* values of car sales and the *percentage* of the total sales of each type would be as follows.

	Fords	Vauxhalls	Renaults	Total
Absolute numbers	10	6	4	20
Percentages	50%	30%	20%	100%

Proportions

- 1.19 A proportion means writing a percentage as a proportion of 1 (that is, as a decimal).

100% can be thought of as the whole, or 1. 50% is half of that, or 0.5. Consider the following.

Question: There are 14 women in an audience of 70. What proportion of the audience are men?

Answer: Number of men = $70 - 14 = 56$

$$\text{Proportion of men} = \frac{56}{70} = 0.8 = 80\%$$

- (a) $\frac{56}{70}$ is the *fraction* of the audience made up by men.
- (b) 0.8 is the *proportion* of the audience made up by men.
- (c) 80% is the *percentage* of the audience made up by men.

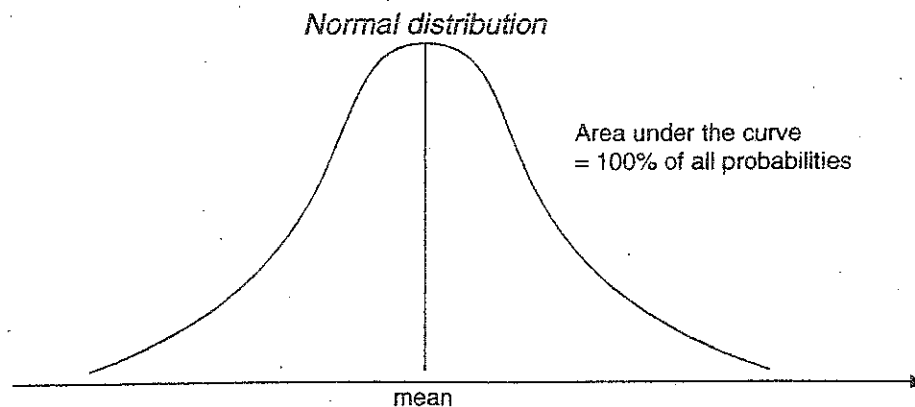
Note that $\frac{56}{70}$ is not very meaningful to most people. It can be simplified to four-fifths. A scientific calculator or a spreadsheet will do this for you.

Probability distributions

- 1.20 A frequency distribution gives an analysis of the number of times each particular value occurs in a set of items. A probability distribution simply replaces actual numbers (frequencies) with proportions of the total.

The Normal distribution

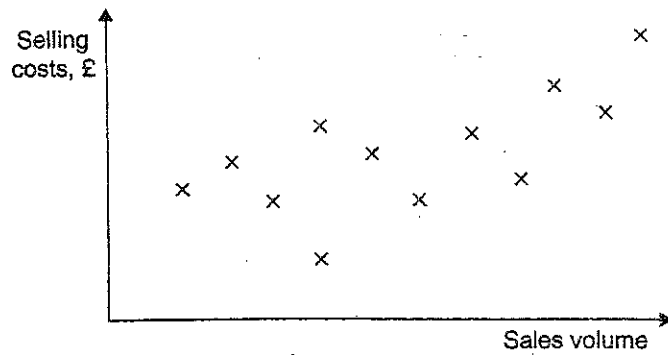
- 1.21 The Normal distribution is probably the best known and the most widely used of all the probability distributions which apply to *continuous variables* (variables which can take on any value, at least within a certain range). It can also apply to *discrete variables* which can take on many values. For example, the volume of sales, in units, of a product might be any whole number in the range 100 - 5,000 units. There are so many possibilities within this range that the variable is, for all practical purposes, continuous.
- 1.22 The graph of a normal distribution is a bell-shaped curve.



- 1.23 As you can see, the normal curve is symmetrical. The left hand side of the area under the curve (to the left of the mean) is the mirror image of the right hand side.
- 1.24 The shape of the bell tells us how spread out or dispersed around the mean the values of the variable are. A tall thin curve would indicate that most of the values are fairly close to the mean whereas a long flat curve would indicate that the values cover a wide range.

Correlation

- 1.25 Suppose that, as well as asking the 100 chocolate bar tasters to give marks out of ten, the researchers had also made a note of the taster's age. One way of analysing this data would be to assess whether there was any correlation (or relationship) between the taster's age and the mark awarded. For example, younger tasters might award high marks and older tasters low marks. This would indicate a correlation between age and mark awarded.
- 1.26 Examples of other variables which might be correlated are as follows.
- (a) A person's height and weight
 - (b) The distance of a journey and the time it takes to make it
- 1.27 One way of assessing the correlation between two related variables is on a scattergraph or scatter diagram, plotting a number of pairs of data on the graph. For example, a scattergraph showing monthly selling costs against the volume of sales for a 12 month period might be as follows.



This scattergraph suggests that there is some correlation between selling costs and sales volume, so that as sales volume rises, selling costs tend to rise as well.

Degrees of correlation

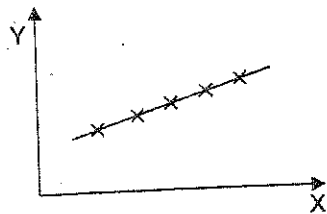
1.28 Two variables can be one of the following.

- (a) Perfectly correlated
- (b) Partly correlated
- (c) Uncorrelated

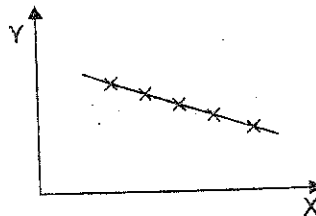
These differing degrees of correlation can be illustrated by scatter diagrams.

1.29 *Perfect correlation*

(a)



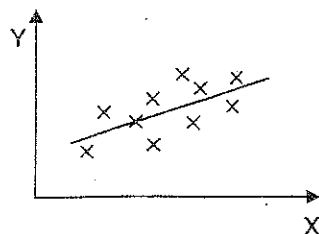
(b)



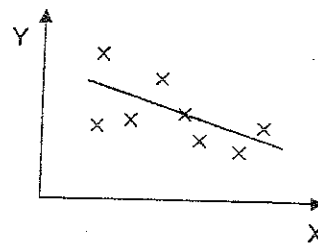
All the pairs of values lie on a straight line. An exact linear relationship exists between the two variables.

1.30 *Partial correlation*

(a)



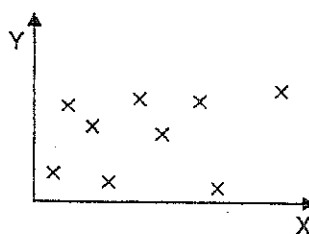
(b)



In (a), although there is no exact relationship, low values of x tend to be associated with low values of y , and high values of x with high values of y .

In (b) again, there is no exact relationship, but low values of x tend to be associated with high values of y and vice versa.

1.31 No correlation



The values of these two variables are not correlated with each other.

Positive and negative correlation

1.32 Correlation, whether perfect or partial, can be positive or negative.

1.33 Positive correlation means that low values of one variable are associated with low values of the other, and high values of one variable are associated with high values of the other.

Negative correlation means that low values of one variable are associated with high values of the other, and high values of one variable with low values of the other.

2 THE ANALYSIS OF QUALITATIVE DATA

2.1 We saw in Chapter 7 that collecting qualitative data meant the recording of words, phrases, sentences and narrative which explained or described people's thoughts, feelings and intentions. The key task in analysis is to *summarise* what the people said. It is then possible to classify responses into categories, analyse them to some extent using statistics, interpret the results and present the findings.

2.2 Summarising the wealth of data gathered may take some time. It involves scanning over the questionnaires or discussion transcripts and picking out:

- (a) key ideas, on the grounds of novelty, excitement or conviction;
- (b) key words and phrases, which seem to sum up the attitudes of the respondents.

It will then be possible to reduce the data to a logical sequence of key points.

2.3 Alternatively, it may be possible to identify categories into which responses fall, and classify all responses into these categories. While this is a more systematic method, it may not give due weight to those results which were perceived to be important at the time of the research.

2.4 If it is possible to categorise responses then the frequencies of each can be calculated and some degree of statistical method is possible. Thus, a response with which 'nearly all' the respondents agreed has a much higher frequency than one with which very few concurred. This method is particularly useful where differences in the demographics of the groups are highlighted, such as language and humour variations between old and young.

2.5 Key words or phrases used in the research should be quoted in a report, but they must be regarded as illustrative rather than representative.

2.6 While qualitative data can generate hypotheses, researchers cannot test them easily. The conclusions which can be drawn are those to do with observing relationships, sequences and patterns, but how far these are causal would have to be tested by quantitative techniques.

3 TABLES

- 3.1 Raw data (the list of results from a survey) need to be summarised and analysed, to give them meaning. This chapter is concerned with several different ways of presenting data to convey their meaning. We will start with one of the most basic ways, the preparation of a table.
- 3.2 Tabulation means putting data into tables. A table is a matrix of data in rows and columns, with the rows and the columns having titles.
- 3.3 Since a table is two-dimensional, it can only show two variables. For example, the resources required to produce items in a factory could be tabulated, with one dimension (rows or columns) representing the items produced and the other dimension representing the resources.

Resources for production: all figures in pounds

	Product items				Total
	A	B	C	D	
Resources					
Direct material A	X	X	X	X	X
Direct material B	X	X	X	X	X
Direct labour grade 1	X	X	X	X	X
Direct labour grade 2	X	X	X	X	X
Supervision	X	X	X	X	X
Machine time	X	X	X	X	X
Total	X	X	X	X	X

- 3.4 To tabulate data, you need to recognise what the two dimensions should represent, prepare rows and columns accordingly with suitable titles, and then insert the data into the appropriate places in the table.

Guidelines for tabulation

- 3.5 The table in Paragraph 3.3 illustrates certain guidelines which you should apply when presenting data in tabular form. These are as follows.
- The table should be given a clear title.
 - All columns should be clearly labelled.
 - Where appropriate, there should be clear sub-totals.
 - A total column may be presented; this would usually be the right-hand column.
 - A total figure is often advisable at the bottom of each column of figures.
 - Tables should not be packed with too much data so that reading the information is difficult.

Rounding errors

- 3.6 Rounding errors may become apparent when, for example, a percentages column does not add up to 100%. Any rounding should be to the nearest unit and the potential size of errors should be kept to a tolerable level by rounding to a small enough unit (for example to the nearest £10, rather than to the nearest £1,000).

4 CHARTS

- 4.1 Instead of presenting data in a table, it might be preferable to give a visual display in the form of a chart.
- 4.2 The purpose of a chart is to convey the data in a way that will demonstrate its meaning or significance more clearly than a table of data would. Charts are not always more appropriate than tables, and the most suitable way of presenting data will depend on the following.
- (a) What the data are intended to show. Visual displays usually make one or two points quite forcefully, whereas tables usually give more detailed information.
 - (b) Who is going to use the data. Some individuals might understand visual displays more readily than tabulated data.

Pictograms

- 4.3 A pictogram is a statistical diagram in which quantities are represented by pictures or symbols.

Example: pictograms

- 4.4 A pictogram showing the number of employees at a factory would represent the quantities of employees using pictures of people.



In this example, each picture represents ten employees, and to represent a smaller quantity, a part-picture can be drawn. Here, there were 45 men employed in 19X6.

- 4.6 The advantage of pictograms is that they present data in a simple, readily understood way. Pictograms convey their message to the reader at a glance, and are consequently often used on television and in advertisements.
- 4.7 The disadvantages of pictograms are that they can only convey a limited amount of information, and that they lack precision. Each symbol must represent quite a large number of items, otherwise a pictogram would contain too many symbols. Using portions of a symbol to represent smaller quantities gives some extra precision, but not much.



represents 1,000 men then



represents less than 1,000 men, but how many exactly? 400? 500? 600?

Pie charts

- 4.8 A pie chart is used to show pictorially the relative sizes of component elements of a total. It is called a pie chart because it is circular, and so has the shape of a pie in a round pie dish and because the 'pie' is then cut into slices. Each slice represents a part of the total.
- 4.9 Pie charts have sectors of varying sizes, and you need to be able to draw sectors fairly accurately. To do this, you need a protractor. Working out sector sizes involves converting parts of the total into equivalent degrees of a circle.

Example: pie charts

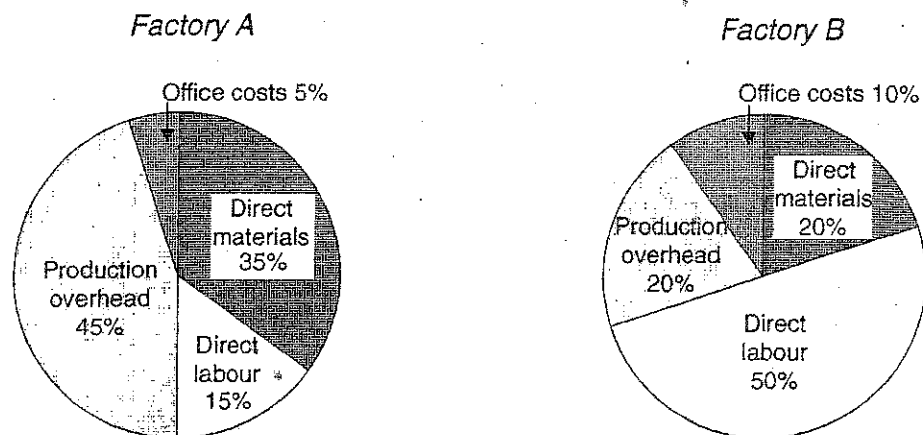
- 4.10 The costs of production at Factory A and Factory B during March 19X2 were as follows.

	Factory A		Factory B	
	£'000	%	£'000	%
Direct materials	70	35	50	20
Direct labour	30	15	125	50
Production overhead	90	45	50	20
Office costs	10	5	25	10
	<u>200</u>	<u>100</u>	<u>250</u>	<u>100</u>

Show the costs for the factories in pie charts.

Solution

- 4.11 A pie chart could be drawn for each factory, as follows. A protractor is used to measure the degrees accurately to obtain the correct sector sizes.



- 4.12 The advantages of pie charts are as follows.
- They give a simple pictorial display of the relative sizes of elements of a total.
 - They show clearly when one element is much bigger than others.
 - They can sometimes clearly show differences in the elements of two different totals. In the example above, the pie charts for factories A and B show how factory A's costs mostly consist of production overhead and direct materials, whereas at factory B, direct labour is the largest cost element.
- 4.13 The disadvantages of pie charts are as follows.
- They show only the relative sizes of elements. In the example of the two factories, for instance, the pie charts do not show that costs at Factory B were £50,000 higher in total than at Factory A.
 - They involve calculating degrees of a circle and drawing sectors accurately, and this can be time consuming.
 - It is sometimes difficult to compare sector sizes accurately by eye.

Bar charts

4.14 The bar chart is one of the most common methods of presenting data in a visual form. It is a chart in which quantities are shown in the form of bars.

4.15 There are three main types of bar chart.

- (a) Simple bar charts
- (b) Component bar charts, including percentage component bar charts
- (c) Multiple (or compound) bar charts

Simple bar charts

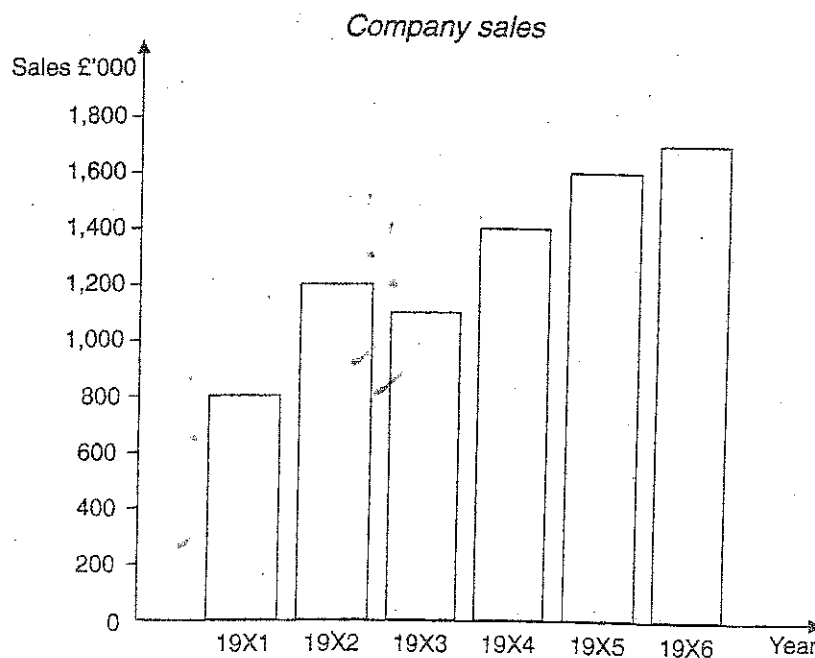
4.16 A simple bar chart is a chart consisting of one or more bars, in which the length of each bar indicates the magnitude of the corresponding data item.

Example: a simple bar chart

4.17 A company's total sales for the years from 19X1 to 19X6 are as follows.

Year	Sales £'000
19X1	800
19X2	1,200
19X3	1,100
19X4	1,400
19X5	1,600
19X6	1,700

The data could be shown on a simple bar chart as follows



4.18 Each axis of the chart must be clearly labelled, and there must be a scale to indicate the magnitude of the data. Here, the y axis includes a scale for the amount of sales, and so readers of the bar chart can see not only that sales have been rising year by year (with 19X3 being an exception) but also what the actual sales have been each year.

4.19 Simple bar charts serve two purposes.

- (a) They show the actual magnitude of each item.
- (b) They enable one to compare magnitudes, by comparing the lengths of bars on the chart.

Component bar charts

4.20 A component bar chart is a bar chart that gives a breakdown of each total into its components.

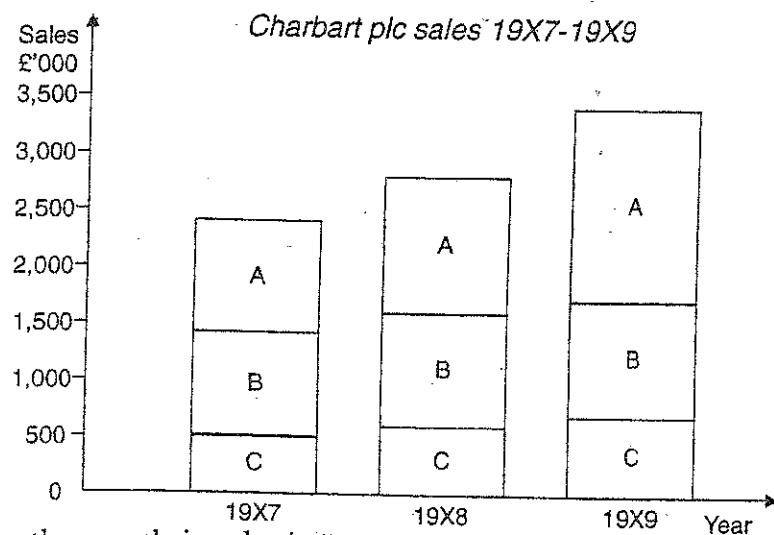
Example: a component bar chart

4.21 Charbart plc's sales for the years from 19X7 to 19X9 are as follows.

	19X7	19X8	19X9
	£'000	£'000	£'000
Product A	1,000	1,200	1,700
Product B	900	1,000	1,000
Product C	500	600	700
Total	<u>2,400</u>	<u>2,800</u>	<u>3,400</u>

4.22 A component bar chart would show the following.

- How total sales have changed from year to year
- The components of each year's total



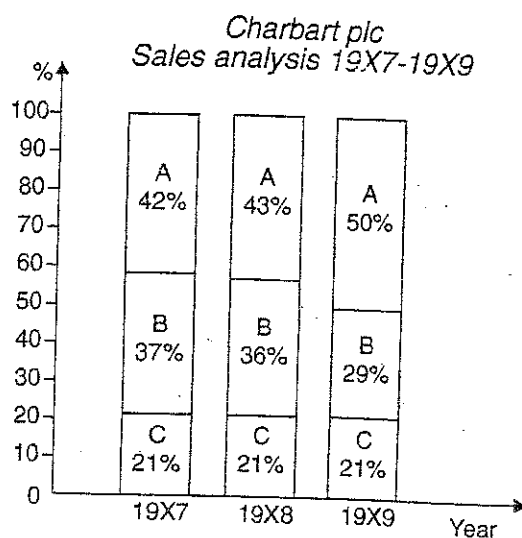
4.23 In this diagram the growth in sales is illustrated and the significance of growth in product A sales as the reason for the total sales growth is also fairly clear. The growth in product A sales would have been even clearer if product A had been drawn as the bottom element in each bar instead of the top one.

Percentage component bar charts

4.24 The difference between a component bar chart and a percentage component bar chart is that with a component bar chart, the total length of each bar (and the length of each component in it) indicates magnitude. A bigger amount is shown by a longer bar. With a percentage component bar chart, total magnitudes are not shown. If two or more bars are drawn on the chart, the total length of each bar is the same. The only varying lengths in a percentage component bar chart are the lengths of the sections of a bar, which vary according to the relative sizes of the components.

Example: a percentage component bar chart

4.25 The information in the previous example of sales of Charbart plc could have been shown in a percentage component bar chart as follows.



Working

	19X7		19X8		19X9	
	£'000	%	£'000	%	£'000	%
Product A	1,000	42	1,200	43	1,700	50
Product B	900	37	1,000	36	1,000	29
Product C	500	21	600	21	700	21
Total	<u>2,400</u>	<u>100</u>	<u>2,800</u>	<u>100</u>	<u>3,400</u>	<u>100</u>

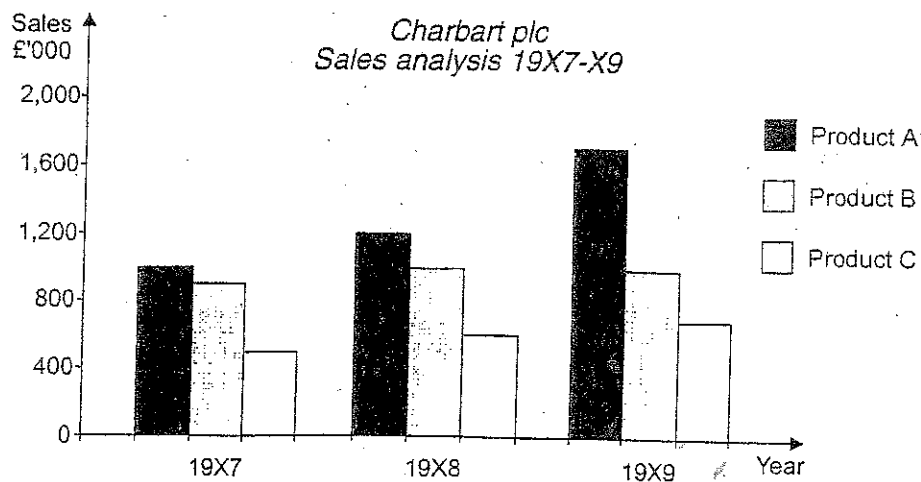
4.26 This chart shows that sales of C have remained a steady proportion of total sales, but the proportion of A in total sales has gone up quite considerably, while the proportion of B has fallen correspondingly.

Multiple bar charts (compound bar charts)

4.27 A multiple bar chart (or compound bar chart) is a bar chart in which two or more separate bars are used to present sub-divisions of data.

Example: a multiple bar chart

4.28 The data on Charbart plc's sales could be shown in a multiple bar chart as follows.



7 REPORT WRITING

- 7.1 We have seen that research turns up raw data which we need to analyse and interpret. Once the data has been analysed and interpreted we need to present our results in a report.
- 7.2 For the writing of a report to proceed efficiently, a logical structure is needed. When you begin writing-up your results you might want to consider the following points.
- (a) Is the *purpose* of the report clearly defined from the outset?
 - (b) Who or what is the *target* of your report? The intended target of the report can influence the way data is handled or the recommendations made.
 - (c) Is there a *wider audience* for the report? The likely audience could influence the style in which the report needs to be written (for example use of technical jargon, diagrammatic presentation of information).

Suggested structure

- 7.8 Any report should be arranged so that the basic message and the main topics of argument emerge progressively and so that the conclusions and recommendations follow logically from those arguments and analysis.

All documents to be presented in a report, including any appendices, need to state clearly their contents, the source of the information and the date.

- 7.9 No strict version of report structure is, or could be, imposed. The topics of the research project will, in part, determine the structure of the report. However, a generalised structure is suggested below, with appropriate guidelines as necessary.

- (a) *Title page.* A succinct but precise title is desirable. It should immediately identify the subject matter.
- (b) *Contents page.* Besides detailing the chapters/sections involved, this should also include a list of tables, diagrams and so on.
- (c) *Acknowledgements.* It may be just a matter of courtesy to acknowledge those who have assisted in the preparation of your project, but reference to them may also lend weight to the report.
- (d) *Summary.* A summary provides a brief review of the main report and should also create interest by whetting the reader's appetite. The summary should note the purpose of the research, how it addressed the particular issue or topic and what conclusions and recommendations have been made.
- (e) *Introduction.* This will probably briefly describe what the report is about and why it has been written.
- (f) *Terms of reference.* This explains the purposes of the report and any restrictions on its scope: what is to be investigated, what kind of information is required and so on. If the report is self-initiated (rather than requested by someone else) however, it is more appropriate to call this section 'Objectives'.
- (g) *Method of investigation.* This outlines the steps taken to make an investigation, collect data: telephone calls or visits made, documents or computer files consulted, expert advice obtained, computations or analyses made should all be briefly described. This is important because it gives credibility to the findings. Alternatively, if the report's audience do not like the conclusions, they will seek first to discredit the method of investigation, so it must be given.
- (h) *Findings.* Presentation, analysis and discussion of data and other research information. There should be a logical flow, with ideas being presented in sequence. In some cases, a chronological sequence may be appropriate.

If there is any sort of problem situation in an exam question, your structure should be on the following lines.

- (i) Analyse the facts of the situation.
- (ii) State the principles of the matter in hand and any exceptions to them.
- (iii) Apply those principles to the facts of the case.
- (iv) Identify any ambiguities and problems thrown up by this process.

- (i) *Conclusions.* The conclusions are directly drawn from the analysis and discussion.
- (j) *Action taken.* This section may sometimes be necessary: it will outline the changes that the author has already implemented in response to the findings and conclusions.
- (k) *Recommendations.* Strong, well-founded proposals for change will reflect a successful project and an impressive report. Avoid non-committal recommendations and try to present recommendations in a logical order, for example presenting recommendations for the short, medium and long term in sequence. For each recommendation the following can be tabulated.
 - (i) *What* is recommended
 - (ii) *Who* needs to act on the recommendation
 - (iii) *Costs and benefits* of the recommendation, with figures if possible, indicating the time scale involved
 - (iv) *Cross-references* to the points in the report leading to the recommendation
- (l) *Appendices.* To be included here are a listing of any references, any other appropriate bibliography, glossaries of technical terms used, and copies of any important supporting documentation. It may be necessary to include in an appendix any body of material that is too large or detailed for the findings section (for example computer analyses).

Presentation

- 7.10 The key is *organisation*: into sentences, into paragraphs, into chapters, into parts. A poorly organised report will be hard to read and it will be difficult for the reader to extract the value of the research you have done.
- 7.11 Whether your report is word-processed or typed, you may need to include graphs, charts or other diagrams where relevant. Be very neat when drawing them (they should be clearly labelled) and make sure you include all the visual material to which you refer. Spreadsheet software might be used for presenting tabular information, and most modern packages also have fairly sophisticated graphic capabilities.

Writing style

- 7.12 It may worry you that you do not feel you can express yourself clearly in writing. This is a common problem but one which can be overcome if the following points are heeded.
 - (a) Write clearly and simply. Long sentences are no 'better' than short ones and often serve to confuse: many people lose track of what they wanted to say by the end of one!
 - (b) Use vocabulary with which you are familiar. Do not be tempted to adopt a 'fancy style' of words which you would not use in normal life and which you may not fully understand.
 - (c) Try to vary your vocabulary and sentence structure as much as possible whilst keeping your meaning clear.
 - (d) Avoid the first person singular - for example 'I think that'. You will feel and sound more objective if you introduce an idea in another way - 'it could be said that...'
 - (e) Write in short paragraphs - *nothing* is more off-putting to an assessor than a dense area of intricately connected (or often totally unconnected) sentences.
 - (f) Paragraphs should connect smoothly with each other. Connecting words are often used for this purpose, such as 'therefore', 'however' and 'thus'.