Chapter 8
OPERATIONAL DECISION MAKING

Key Learning Objectives

By the time you have finished studying this chapter, you should be able to:

- decide how to allocate scarce resources;
- use various costing techniques to make decisions on the utilisation of scarce resources;
- interpret the results of your analysis and advise management on such decisions;
- understand the application of the marginal costing/contribution approach to management decisions;
- recognise the importance of risk in the decision-making environment;
- recognise the importance of both quantitative and qualitative factors in decision making.

Introduction

So far in this book we have looked at the basics of management accounting and costing techniques. This chapter aims to apply these techniques to reach relevant decisions in the 'real' world. Inevitably in this 'real' world of the management accountant we are dealing with both quantitative and qualitative factors in reaching decisions, although many traditional textbooks tend to concentrate on the financial aspects of any decision. Hence this chapter will also attempt to recognise those factors other than financial ones which play an important part in the managerial decision-making environment. In this context the chapter develops a 'qualitative' matrix which aims to provide a frame of reference for managers to quantify these non-financial factors as a guide to decisions. This framework is seen as relevant to both the public and private sector. The chapter also looks at the importance of an understanding of risk by managers in the decision-making and business cycle and how to respond to – or better still prepare for – these eventualities. It is also vitally important that managers are able not only to understand the information they receive but also to interpret such information to maximise the benefits of decisions. In the private sector, therefore, the general assumption of profit maximisation is taken. For the

public sector such decisions are inevitably more complex due to their social, political and environmental context. It is hoped that as the chapter unfolds it will, through the techniques described and developed, provide a frame of reference to assist managers in potentially complex situations in whatever sector they work.

Marginal Cost and Marginal Revenue

As stated above, in the private sector the goal of companies has been assumed for simplicity to be profit maximisation. Other goals are possible such as sales revenue maximisation or just growing the sheer size of the company, which may be measured by such factors as the number of employees or the number of subsidiaries it controls. Profit maximisation can be achieved in the short term through perhaps setting high prices for products, or in the long term by some form of market penetration exercise. All strategies will be reflected ultimately in the amount of product to be produced and sold. In the public sector the emphasis has traditionally been on the cost of services. A greater emphasis today is being placed on increasing performance through achieving value for money, defined as economy, efficiency and effectiveness in the delivery of services. Where possible, however, more emphasis is also being placed on generating extra revenue as public sector budgets come under increased pressure due to a lack of available resources from general taxation.

In both the public and private sector the concepts of marginal cost and marginal revenue are relevant. Marginal revenue is the increase in unit revenue which corresponds to an increase in the unit provision of a service or product produced and sold. Marginal cost is the increase in cost for a unit increase in the service or product produced and sold. If marginal revenue is in excess of marginal cost then increasing the production or supply of a product or service will generate a profit on that unit. If marginal cost exceeds marginal revenue a loss will occur. In the public sector, for those services where no extra revenue can be generated because they are provided as free goods, we are dealing with the marginal cost of producing one extra unit of service. There will be no marginal revenue associated with such services and decisions would be made on the marginal benefit achieved for clients from the extra expense incurred. In the health service, for example, this can be measured by the improved quality of life that an operation can bring.

In decision making in the above context it is important to recognise the use of contribution analysis. 'Contribution' represents the difference between the selling price for a product or service and the variable costs of providing that product or service. It goes towards initially covering fixed costs, assuming that the selling price exceeds the variable cost. Once fixed costs are covered it is a contribution to profit. It is clear that in order to use this analysis we need to disaggregate costs into their variable and fixed components, making an understanding of cost behaviour essential. In this context the traditional format of the profit and loss account which essentially concentrates on a functional format – selling and distribution, administration – provides inadequate information for planning, control or decision making. This is because it does not classify costs by their behaviour.

As can be seen from Exhibit 8.1, the contribution approach divides costs into their fixed and variable elements and then deducts this from the sales figure to arrive at the contribution

margin. As stated, it can be seen that this represents the contribution to cover the remaining fixed cost elements of the expenses. The development of such statements is a decision for the organisation and should be designed so as to facilitate internal planning, control and decision making. In designing the format of the statement it is also possible that it can facilitate the appraisal of managerial performance, in particular where there is segmented reporting of profit and loss data or to emphasise different elements of the budget. It should also be observed that the results achieved are identical whichever approach is adopted. All that has been changed is the classification of costs incurred by the business.

EXHIBIT 8.1

Contribution Statement Compared with a Functional Financial Reporting Type Approach

Contribution Approach			**Functional Approach**	
		£		**£**
Sales Income		120,000		120,000
Less Variable Expenses				
Variable Production	55,000			
Variable Selling	10,000			
Variable Administrative	5,000			
		70,000	Cost of Goods Sold	59,000*
Contribution Margin		50,000	Gross Profit (Margin)	61,000
Less Fixed Expenses			**Less Operating Costs**	
Fixed Production	4,000		Selling	30,000
Fixed Selling	20,000		Administration	20,000
Fixed Administration	15,000			
		39,000		
Net Profit		11,000		11,000

*Cost of sales includes both fixed and variable costs

Assumptions of the Marginal Cost Approach

- Fixed costs remain fixed in the short term, irrespective of the level of activity.
- Fixed costs are not directly related to specific units.
- Variable costs vary directly in proportion to activity levels.
- Total costs can be split between fixed and variable elements.

Using Contribution Analysis for Decision Making

As stated in the Introduction, this chapter is concerned with decision making and therefore this section examines contribution analysis as a relatively simple but powerful technique in a decision-making context for a service industry.

Weeds R Not Us is a garden centre business of long standing operating in the Vale of Evesham in the Midlands of England. It can sell all it grows, given the rising interest in its activities following the popularity of gardening programmes on radio and television. The objective of the garden centre is to maximise revenues by growing and selling those flowers and shrubs which contribute most to that objective. It has a total of 40 acres of land that it can access.

As well as passing trade from amateur horticulturists, the garden centre supplies a stately home belonging to the National Trust. Under the terms of the contract it must supply 420 begonias, 185 fuchsias, 576 dianthuses and 110 bay trees for each of the next five years. Past experience shows that it can sell up to 4500 shrubs of any type, but these four shrubs are particularly popular and well suited to the soil and English climate.

The garden centre has considerable experience in budgeting, and Table 8.1 shows the budgeted cost for the next growing season.

Table 8.1 Budgeted cost for shrub growing

	Begonias	Fuchsias	Dianthuses	Bay trees
No. of shrubs per acre	210	185	192	220
Selling price each	£16	£19	£18	£21
Variable costs per acre				
Seedlings	£160	£220	£240	£325
Wages	£35	£30	£20	£25
Fixed cost per annum	£65,000			

Wage costs are treated as variable as gardeners are brought in and paid a daily rate per acre. This is traditional in the industry, although some of the shrubs require higher skill levels, hence the different variable costs for wages. No problems have been experienced in the past in acquiring suitable skilled labour at the budgeted rates.

Fixed costs cover management salaries, business rates on the office premises, selling and distribution costs. Since the business is classified as a farm, agricultural land is not subject to business rates.

This problem should be tackled in two stages. The first stage is this to identify the contribution per shrub per acre, as land is the limiting factor (Table 8.2). As can be seen, the greatest contribution per acre of land is from the bay trees. Table 8.3 shows the results for the growing period, taking account of the existing contract with the National Trust. It can be seen that bay trees provide the greatest contribution per limiting factor and as such should be selected to be grown in preference to the other alternatives.

Table 8.2 Contribution per acre

	Begonias	Fuchsias	Dianthuses	Bay Trees
Revenue	£3360	£3515	£3456	£4620
Variable costs	£195	£250	£260	£350
Contribution	£3165	£3265	£3196	£4270

Table 8.3 Maximum contribution and profit available

	Begonias	Fuchsias	Dianthuses	Bay Trees	Total £
Sales to National Trust	420	185	576	110	
Acres required	2	1	3		
Acres for bay trees				14	
Contribution per acre	£3,165	£3,265	£3,196	£4,270	
Total contribution	£6,330	£3,265	£9,588	£59,780	£78,963
Fixed costs					£65,000
Net profit					£13,963

In making the decision to concentrate on bay trees, however, the management would need to consider a range of other factors. Gardening is subject to changing fashions as much as any other business. As such they would need to consider market trends so the historic information for the centre on sales can only provide a guide to the future. Equally, the business needs to be aware of the competition in the area, new housing developments coming into the area or even industrial decline, as all will have a potential impact on sales in what is a discretionary purchase. It might be possible to negotiate other contracts to ensure that in the event of a change in consumer demand the centre will continue to flourish. The business is thus not immune from risk, despite having sold all it can produce in the past. In addition, given that it is a gardening business, the weather will have an important influence.

Financial Modelling using Contribution

The objective of financial modelling is to present a representation of business reality. In essence, the model should allow various assumptions to be made and then varied in order to carry out sensitivity analysis. In the context of contribution, one of the more basic financial models that maybe employed is that of break-even analysis. This, can be used to summarise the effect that sales volume changes can have on an organisation's revenues, costs and, therefore, profit. Break-even analysis is often considered under the heading cost–volume–profit analysis. The model is frequently used to present the effects on profits of various decisions as many individuals prefer a picture as opposed to a mass of figures and, consequently,

find it easier to understand. It should, however, be remembered that many managers use a complex range of tools and data to forecast profits or losses and their ability to understand should not be underestimated. In that sense what follows needs to be assessed as part of the contribution to a holistic managerial decision-making process.

To build an example of this concept we will assume a company is in the business of making picnic baskets, amongst other products, for sale to the general public and has provided the information contained in Exhibit 8.2. The exhibit is structured such that we will calculate the break-even model first and then use the data in the exhibit to construct further analysis.

EXHIBIT 8.2

The Hardy Out Door Company

The Hardy Out Door Company has obtained data on its production of picnic baskets for sale to the general public. As might be expected, it is a seasonal business. The financial results for the last financial year were as follows:

Units produced and sold	5,800
Selling price	£59.00
Fixed overheads	81,000

Variable costs per unit

Wages	£25.50
Materials	£10.20
Overheads	£2.30

A budget has been prepared for the next financial year, showing the following information:

Units to be produced and sold	6,200
Selling price	£60.00
Fixed overheads to rise by	£9,000

Variable costs per unit

Wages	£26.50
Estimated material costs	£10.50
Overheads to rise by	£0.70

Fixed costs are allocated to the part of the premises used to produce the picnic baskets on the basis of floor area.

The following results were achieved during the three years prior to the last year. Thus the company has sales and cost data for the last four years.

Sales are normally made direct to the public, but a well-known retail company has just approached the firm with an order of 1000 units. They have indicated, however, that they are only willing to pay a maximum of £54 per basket.

	Last Year – 1	Last year – 2	Last year – 3
Actual sales	6,100	6,500	6,400
Selling price (£)	58	55	54
Fixed costs (£)	85,260	81,810	79,905
Variable costs (£)	278,750	247,000	249,600

Company management has just heard about the technique of break-even analysis (although you first read about it in Chapter 3) and has requested information regarding the break-even point and also the production of relevant graphs based on the predicted results for the next financial year. They also want comments on the information provided.

As stated in Chapter 3, the first step in this analysis is to calculate the contribution for the coming financial year. Contribution equals selling price minus variable costs:

$$£60.00 - (£26.50 + £10.50 + £3.00) = £20.00$$

To calculate the break-even figure we divide the fixed costs (£90,000) by the contribution (£20) which gives the break-even point in terms of the sales unit figure as 4500. Thus, once the company sells 4500 units every extra sale is a contribution to profit as fixed costs have been covered. Once the break-even figure has been achieved any additional sales represent what is termed the margin of safety. This means that the company has a 'comfort' zone by which sales can decline before it moves into a loss-making situation. It should be pointed out that sales below break-even are not termed 'the margin of danger', although in the long term all costs must be covered if any company is to survive.

Figure 8.1 shows the break-even chart. The relevant range has been assumed to be between 2000 units and 6500 units. Outside this range the assumptions of straight-line relationships might not hold. As can be seen activity levels below 4500 units represent a loss. In contrast, any activity level above 4500 units results in a profit being made.

Figure 8.2 is an alternative presentation to Figure 8.1, with the advantage of placing emphasis on the total contribution, which managers may prefer.

The third alternative method of presenting the information is shown in Figure 8.3. This graph, as the title suggests, stresses the relationship between sales volume and profit or loss. By reference to the graph it can be seen that if sales are equal to zero the total loss incurred is the amount of the fixed costs. The line representing units produced and sold allows us to read off the profit or loss at any point along that line.

These graphs allow managers to interpret what will happen to company profits under different market conditions. In addition, assumptions on price and variable cost, for example, can be varied again to assess the impact that such changes have on the business and the graphs redrawn for visual impact.

The straight lines drawn in these graphs represent accounting assumptions on cost and price behaviour and, by their nature, these differ from those made by economists. The effect of making accounting assumptions is that the functions are all linear and that, in the case of the

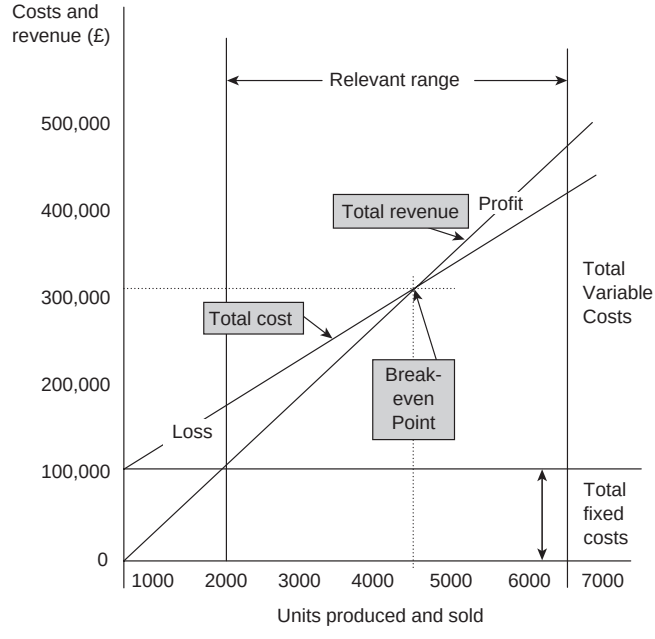

Figure 8.1 The break-even chart

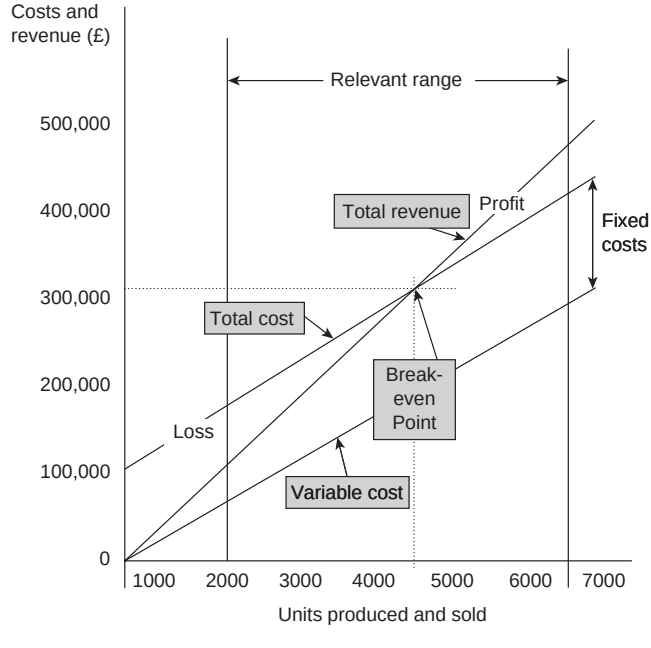

Figure 8.2 The contribution graph

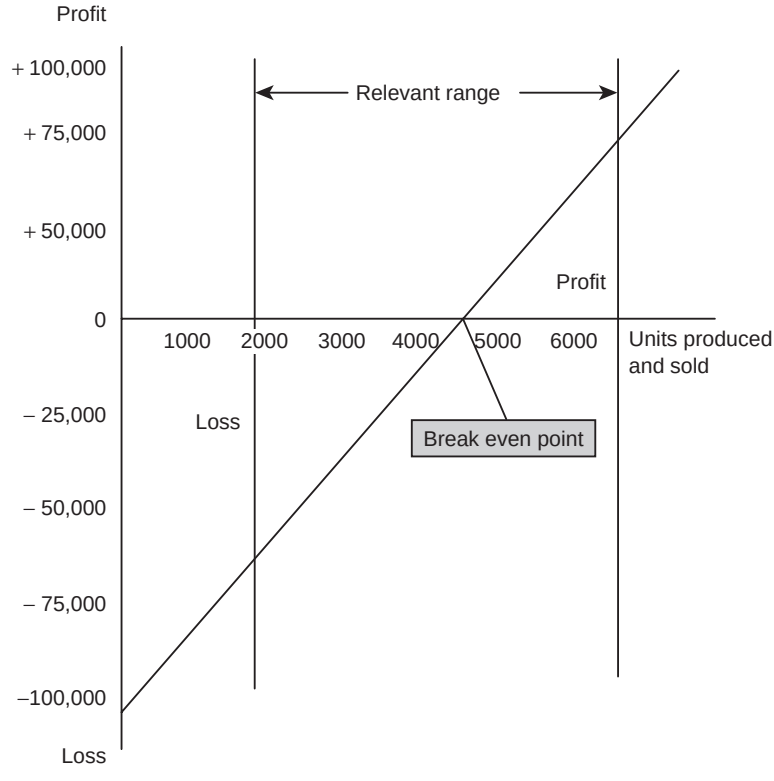

Figure 8.3 The profit-volume-graph

example shown, there is only one break-even point. The break-even chart can also be amended if stepped fixed costs were involved. All that would happen is that at the 'step-up' point the variable cost line and the sales revenue line would move up by the amount of the step to form higher parallel lines. This could result in two break-even points, one below the step and one above the step.

Setting Target Profits

While management will be interested in the break-even figure as the number of units that need to be sold to cover costs, they will be more interested in profits that can be earned from the product. To this extent a target profit figure of £10,000 could be input into the calculation. One way of doing this is to treat the target as the equivalent of extra fixed costs. In this context we would require unit sales of 10,100 to achieve a target profit of £10,000: (Fixed costs (£91,000) + target profit (£10,000))/contribution (£10). Management can now assess whether this level of sales activity can be achieved.

Table 8.4 Analysis of past performance

	Last year	Last year – 1	Last year – 2	Last year – 3
Actual sales	6,200	6,100	6,500	6,400
Income (£)	359,600	353,800	357,500	345,600
Fixed cost (£)	81,000	85,260	81,810	79.905
Variable costs (£)	235,600	228.750	247,000	249,600
Profit/(loss) (£)	43,000	39,790	28,690	16,095
Selling price (£)	58	58	55	54
Unit variable cost (£)	38	37.50	38	39
Contribution (£)	20	20.50	17	15
Breakeven units	4,050	4,159	4,812	5,327

The Model in Context

Exhibit 8.2 contains additional information to help set the decision in the real world. As can be seen, sales have declined from 6400 units four years ago to 6200 units last year, while the company is now estimating sales at 5800 for next year. Is this reasonable as the price has risen again? The projected break-even is at 4,500. Table 8.4 shows the results for the last four years and reveals an interesting picture. Unit variable cost is calculated by dividing the total variable cost by the number of units sold.

The analysis begins to reveal a picture of the company as having a rising cost base which it is attempting to cover by raising prices. The price rises undertaken have been sufficient to compensate for these cost rises and the break-even target has fallen as the contribution has risen over the period. Profits have consequently increased. A significant contribution to this rise was the fall in fixed costs in the last financial year. In the next financial year fixed costs are predicted, however, to rise by 11%.

Sales are in decline so this raises concerns as to whether the target sales figure for next year will be achieved, particularly as the price has again been increased. The break-even sales figure has been around 4000–5000 units for a while and the projection for next year lies in the middle of this range. The margin of safety at a projection of 5800 units is clearly 1300, and this may provide a sufficient cushion to absorb any lost sales due to the price rise.

Unit variable costs have remained reasonably stable over the period shown. Further rises in these costs are forecasted to occur in the next financial year.

The exhibit comments that fixed costs are allocated to picnic baskets on the basis of floor area. This suggests that other products are being made in the workspace available in the production unit. A reasonable question therefore concerns whether the rise in fixed costs results from a change in the basis of allocation and whether this is fair. Further research is needed.

Outside of financial issues the company would need to consider issues such as design as it is possible that a price rise coupled with a dated design could lead to a failure to sell product despite a history of acceptable sales levels. This would be considered in the context of competitor analysis and risk.

With regard to the potential new order for 1000 units at £54 each, as variable costs are £40 there is a contribution of £14 towards fixed costs. Serious consideration can therefore be given to the order as it represents guaranteed sales and improved cash flow (subject to financial appraisal of the retail company). The company may also see this order as compensating for any further falls in sales given the historical picture.

Assumptions Underpinning Break-Even Analysis

Relevant Range

The accounting model presented is based on the assumption of linearity over the relevant range. This is the key to understanding the model and the cost/income behaviours represented. It attempts to provide an accurate picture over the range of output and sales that the business can realistically achieve in the planning horizon envisaged. In the case of Figure 8.1 this might be a range of 2000 to 6500 as shown. Outside this range, the assumption of linearity would not hold. It is within this range that the business has reliable information on cost and cost behaviour.

Fixed Costs

The assumption for fixed costs again is related to the relevant range, here the accountant assumes that over the levels of activity envisaged the costs the business is committed to meeting are known and can be represented in a linear manner. It is possible to reconstruct the graph without too much difficulty if the fixed costs follow a stepped pattern as outlined in Chapter 2.

Revenue Line

The total revenue line again is linear. As you will be aware, if you wish to sell more product the economist would consider supply and demand and suggest price reductions to achieve higher sale volumes. Here the accountant, however, assumes that the business is operating in a market where the selling price tends to be fixed in the short term. As stated above, the figures can be redrawn with alternative selling prices (and costs) to present an alternative picture to managers. Again, however, within the relevant range the assumption of linearity for the total revenue line is assumed to hold.

Time Horizon

The assumptions hold over the time horizon envisaged. Typically, as in this example, this time horizon is one year. If we consider typical fixed costs, property taxes are normally known for a year in advance and it is possible to budget reasonably accurately for managerial salaries (including any salary increments or pay rises). Operating capacity will also be known reasonably well in advance as it takes time to plan and commission new productive capacity. In the longer term, however, there will be a need to change the assumptions on which the model is based.

Cost Split between Fixed and Variable

The model assumes that it is relatively easy to split fixed and variable costs. In practice this is not as easy as is suggested, but it has to be done as accurately as possible if the model is to work. Fixed costs are assumed to be unrelated to the level of activity. This assumption will normally only hold true in the short term.

Stock is Ignored

The model takes no account of stock. This is, however, acceptable as basically the model is trying to influence managerial decision making and as such cannot be totally representative of what will actually happen. It is thus just one of the tools for decision making by managment.

Single Product/Constant Sales Mix

The illustration used in this section has concentrated on one product. In more complex analysis it is possible to assume that sales will be in accordance with a preplanned sales mix. This is carried out by measuring sales volume using standard batch sizes based on this planned mix.

Complexity in the Production Process

Cooper and Kaplan (1987) undertook an analysis in which they suggest that firms need to be aware of the complexity of the manufacturing process where multiple products are manufactured. They suggest that many so-called fixed costs vary with the range of items manufactured as opposed to the volume of manufacture. Thus, as complexity related costs do not vary significantly, in the short term the emphasis in cost–volume–profit techniques will tend to show a growth in short-term profits as new product variants are introduced. They will, however, potentially cause a rise in fixed costs in future periods resulting in long-term disadvantage to the firm. The work of Kaplan is placed in context by Otley (2001) – see the section on further reading later in the present chapter.

Consumer Behaviour

While reducing the price of a product should in theory generate more revenue, in practice consumer behaviour is complex. A reduced price may cause consumers to question quality even if there are no grounds to do so. Fashion changes can also dictate the purchase of goods. In the case of wicker picnic baskets the market has been adversely affected by the sale of ‘cool boxes’ as they possess better insulating properties.

To conclude this section, Exhibit 8.3 contains an illustration of the core formulas associated with break-even analysis.

EXHIBIT 8.3

Break-Even and Related Formulas

Sales – Variable Costs = Fixed Costs + Profit (or –Loss)

Contribution = Selling Price – Variable Costs

Profit/(Loss) = Contribution – Fixed Costs

$$\text{Break-even (units)} = \frac{\text{Fixed Costs}}{\text{Contribution}}$$

$$\text{Break-even (sales value)} = \frac{\text{Fixed Costs} \times \text{Sales Units}}{\text{Contribution}}$$

$$\text{Margin of safety (units)} = \frac{\text{Profit}}{\text{Contribution per unit}}$$

$$\text{Margin of safety (sales value)} = \frac{\text{Profit} \times \text{Sales}}{\text{Contribution}}$$

Linear Programming

The earlier garden centre example concentrated on one limiting factor, which was land. In order to maximise contribution the land was allocated to production by reference to the contribution per limiting factor. In practice, decision makers find that there is normally more than one limiting factor. In the manufacturing process these might be limited to the available labour, the available machine hours and the available materials. Effectively, in our garden centre example the limited factor equivalents to the manufacturing process could be land (materials) and labour.

The technique used to solve these decision dilemmas is termed *linear programming*, and this section of the chapter explains how the technique can be applied.

EXHIBIT 8.4

Maximise Contribution

A company manufactures two products, X and Y. During the next budget period it is estimated that there will be only 4200 direct labour hours available and that the supply of the common materials used by both products is restricted to 3600 units. Machine hours available are limited to 4000.

The budget for the next period shows the following standard information per unit of each product:

Product X	£	£	Product Y	£	£
Standard selling price		40	Standard selling price		59
less			less		
Materials	6		Materials	8	
Labour	15		Labour	30	
Variable overhead	4		Variable overhead	4	
		25			42
Contribution		15			17

Product X uses 3 units of material per unit produced, while product Y uses 4 units of material per unit produced. Material cost is £2 per unit.

Product X uses 3 hours of labour, while product Y uses 6 hours. The labour rate is £5 per hour.

Variable overheads are allocated on the basis of machine hours. The rate is £1 per hour. Product X uses 4 hours of machine time, as does product Y.

The sales department estimates that the organisation can sell an unlimited number of units of product Y, but that X is limited to 550 units.

Clearly this is a much more complex problem for the manager operating in this business environment than the garden centre decision maker, and linear programming is needed to solve it. Solutions can be found both graphically (two products) and by the manipulation of mathematical formulas (more than two products). Excel can be used to perform the mathematics, and the manager must then correctly interpret the results.

As the term linear programming implies, all relationships are assumed to be linear:

- The contribution per unit produced and sold within the relevant range remains constant, and therefore are linear.
- Resources utilised are constant whatever the units produced, and are therefore linear
- Units produced and resources allocated/available are infinitely divisible.
- The objective is to maximise the contribution.
- All variables in the equation must be equal to or greater than zero.

To solve the problem we state it mathematically by setting up an objective function. Denoting the contribution by C, we must

$$\text{maximise } C = 15X + 17Y,$$

subject to:

$$\begin{aligned} \text{materials} \quad & 3X + 4Y \leq 3600, \\ \text{labour} \quad & 3X + 6Y \leq 4200, \\ \text{machine hrs} \quad & 4X + 4Y \leq 4000. \end{aligned}$$

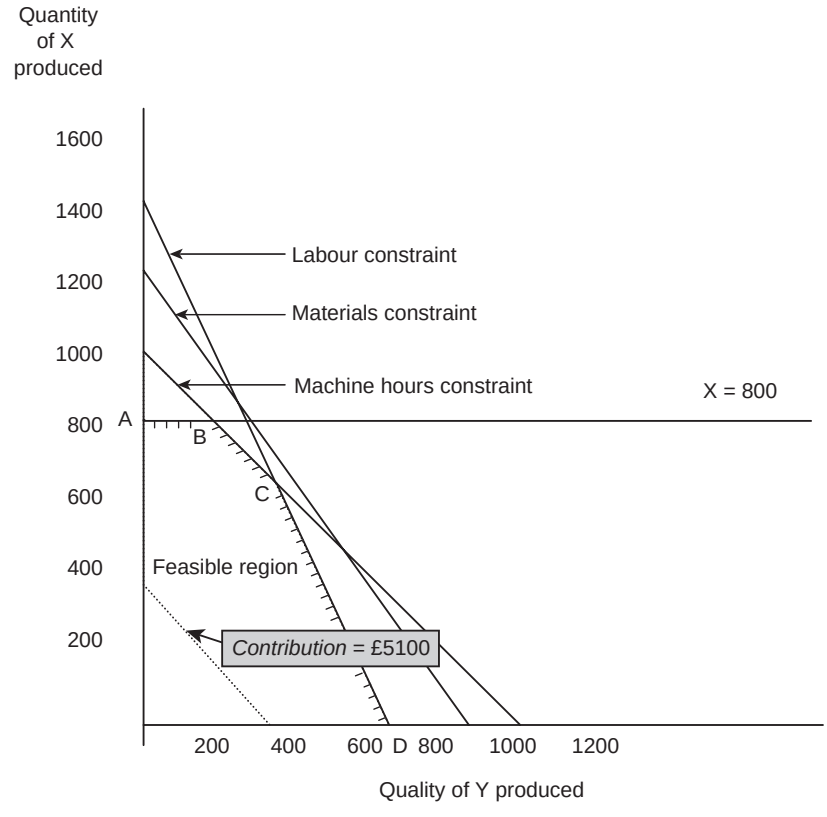

Figure 8.4 Graphical solution to contribution maximisation problem

Here the constraints have been expressed by relating the quantities of each resource used by each product against the maximum available resource for each of those elements in the production process. Taking materials as an example, the equation $3X+4Y$ means that 3 units of material are used to produce product X and 4 units of material used to produce product Y in the final solution when we know the decision as to how many units of each product will be made cannot exceed 3600 units of material. A similar logic applies to each of the other constraints.

To satisfy the final assumption outlined earlier, product X must be greater than or equal to zero but, given the maximum we can sell, be no greater than 550. As Y has no upper limit the assumption here is that product Y must be greater than or equal to zero. This assumption of non-negativity avoids getting results which are counter-intuitive. This is expressed as

$$0 \leq X \leq 550, \quad Y \geq 0.$$

Let us use the graphical method first. Figure 8.4 shows the constraints plotted for the quantities of the two products that can be produced. The only region on the graph which satisfies all four constraints is within the area ABCD. This is known as the *feasible region*. Outside

this region it is not possible to satisfy all four constraints. It is still, however, necessary to find which production level for X and Y maximises contribution. If we therefore choose a random contribution line of £5,100 this would represent 340 units of X or 300 units of Y. As stated, our objective is to maximise contribution so higher-level contributions can be represented by drawing parallel lines until we reach the boundary of the feasible region. In this example the farthest we can move from the origin and still satisfy the constraints is at point C. It should also be noted that the materials constraint lies completely outside the boundary of the feasible region and it is the other three constraints which are crucial in determining production.

Reading from the graph the maximum contribution is achieved at approximately 600 units of X and 400 of Y. This is proved below:

contribution at point A is $800 \times £15 + 0 \times £17 = £12{,}000$;
contribution at point B is $800 \times £15 + 200 \times £17 = £15{,}400$;
contribution at point C is $600 \times £15 + 400 \times £17 = £15{,}800$;
contribution at point D is $0 \times £15 + 700 \times £17 = £11{,}900$.

As indicated by the word 'approximately', it is obviously not always possible to measure from a graph the exact output at point C, and consequently a more accurate alternative is to solve the simultaneous equations which can be formed from the binding constraints at that point:

$$4X + 4Y \leq 4000, \quad (1)$$

$$3X + 6Y \leq 4200. \quad (2)$$

Multiply equation (1) by 3 and equation (2) by 2,

$$12X + 12Y \leq 12000,$$
$$6X + 12Y \leq 8400.$$

By a process of division $6X$ equals 3600, so X is 600. By substitution, Y is 400. This is the financial calculation result, but it cannot be divorced from the marketing information. The question in this case is that from marketing we believe we can sell an unlimited number of Y and a maximum of 550 for X. While further research may be needed into these claims the results, now that we have a potential production plan produced by solving the equation, indicate that the initial market research supports that production plan.

This can be further developed by use of Table 8.5 to show if it is worth attempting to procure more of the scarce resources. What the table shows is that we have no spare capacity in either labour or machine hours, but spare capacity in materials. If we could remove these constraints would it be worth the company paying a premium to do so. If we take labour, the equations would be revised:

$$4X + 4Y = 4000 \text{ (unchanged machine hours)},$$
$$3X + 6Y = 4201 \text{ (revised labour constraint)}.$$

Table 8.5 Shadow prices – resource table

Constraint	Total available	Constraints used at optimum (hrs per product)	Total used	Spare capacity	Shadow price?
Labour	4200	1800 X, 2400 Y	4200	0	Yes
Materials	3600	1800 X, 1600 Y	3400	200	No
Machines	4000	2400 X, 1600 Y	4000	0	Yes
Market	800	600X	600	200	No

Solving, we obtain

$$X = 599.67 \text{ and } Y = 400.33.$$

Therefore the planned production of X should be reduced by 0.33 and Y increased by 0.33. This is termed the marginal rate of substitution. The change in contribution arising from obtaining one extra element of labour is

Increase in contribution from Y is (0.33 × £17)	£5.61
Decrease in contribution from X is (0.33 × £15)	£4.95
Increase in contribution	£0.66

Therefore the value of an additional unit of labour is £0.66. This is the *opportunity cost* or *shadow price*. The company is thus able to pay up to £0.66 over and above the present cost of labour and still obtain a contribution towards fixed costs.

Obviously it is not possible to produce and sell 0.67 units of X and 0.33 units of Y. Output has to be expressed in whole numbers, but the basis of the calculation can be used to calculate the revised optimal output if extra units of labour are available.

Developing this theme, the company is advised that 50 extra units of labour are available at £5.50 per hour. This is below the opportunity cost by £0.16. The revised equations are now

$$4X + 4Y = 4000,$$
$$3X + 6Y = 4250.$$

X is now 583.33 and Y is 416.67. This makes the total contribution £15,833. At this level of production we still satisfy the material constraints as we would use only 3417 units of material. Therefore the decision that the company should take is to buy in the extra labour.

EXHIBIT 8.5

Cost Minimisation

The above example has concentrated on maximising contribution, but managers may also be interested in cost minimisation. This is illustrated in the following example which relates to a business manufacturing a fuel additive, Polycon, for tractors to improve engine performance. Every 10,000 litres of the product requires three elements: 600 g of A, 400 g of B and 450 g of C. In order to obtain these additives, it is necessary to purchase two ingredients, X and Y, which contain them. This information is set out below:

	Composition (g) of	
	X	Y
Additive A	3	8
Additive B	4	4
Additive C	3	5

Ingredient X costs £20 per litre, and Y costs £40 per litre.

The maximum that can be stored on site is 100 litres of each ingredient and the objective of the company is to decide how much of the ingredients should be added to every 5,000 litres of the additive to minimise costs.

$$\text{minimise } Z = 20X + 40Y,$$

Subject to

$$3X + 8Y \geq 600,$$
$$4X + 4Y \geq 400,$$
$$3X + 5Y \geq 450.$$

Note the equations are now greater than or equal to the minimum requirements. The limitations on storage are expressed by the equations:

$$X < 100,$$
$$Y < 100.$$

Finally the non-negative constraint is $X, Y \geq 0$.

Figure 8.5 shows the graph obtained by plotting the constraints. The feasible region is bounded by the points P, Q, R, S and T. Drawing in the minimum cost line $Z = 20X + 40Y$ and moving this line inwards towards the origin would give the minimum cost at the nearest point of the feasibility region that the line would touch to the origin. This is point Q

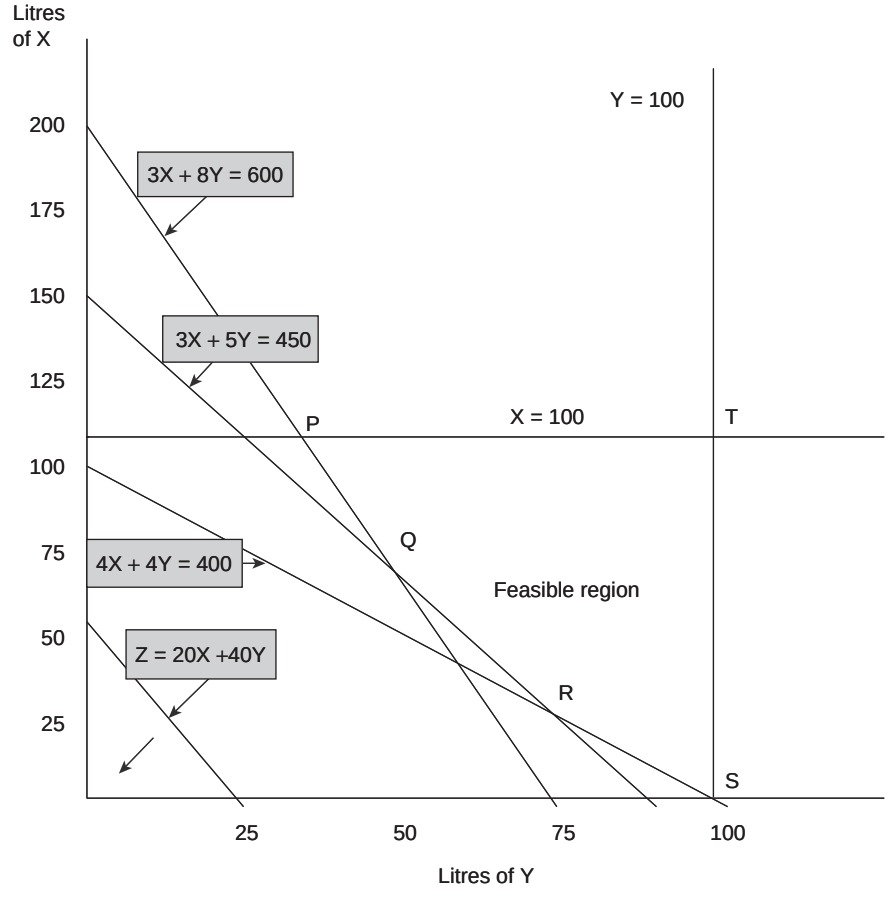

Figure 8.5 Graphical solution to cost minimisation problem

and the minimum cost is $66X + 50Y = £3{,}300$. This could also be solved by using the simultaneous equations for point Q: solving

$$3X + 8Y = 600,$$
$$3X + 5Y = 450.$$

gives $X = 66.67$ and $Y = 50$. Thus if the company is to achieve its decision objective of minimising the cost of the additives while satisfying all constraints, it would mix 66 units of X and 50 of Y in each batch of 5000 litres produced.

Relevant Costing

In making managerial decisions it is essential that managers recognise the importance of considering only relevant costs and benefits. This section looks at these issues. It deals first with financial costs and benefits, and then goes on to develop a technique to enable managers to consider qualitative issues in decision making. In financial terms, the relevant costs and benefits relate to the future cash flows of the organisation which would differ as a result of implementing the decision. This type of analysis thus concentrates on the incremental or differential changes that must be considered. Any cash flows that would remain the same for any alternatives that are being considered are irrelevant.

This section considers four areas:

- ceasing (or shutting down) production of a product or service;
- the make or buy decision;
- pricing;
- special orders.

Cessation of Production of a Product or Service

Managers are frequently required to consider whether a particular product, service or section is unprofitable and thus should be discontinued. It is particularly important that managers define closely what is meant by 'unprofitable'. Even if a product or service is seen as making a 'loss' if its variable costs are less than its selling price, it is making a contribution towards fixed overhead. Clearly this contribution would be lost if production or supply ceased. It may also be the case that sales of other products or services may suffer.

EXHIBIT 8.6

Ceasing Production

Country Limited makes three products (picnic baskets, picnic seats and picnic tables) and uses an absorption costing basis. In addition, you discover that production overheads of £333,000 consist of £200,000 which are fixed. The variable element for each of the three products is: picnic baskets, £3,000; picnic seats, £45,000; and tables £85,000. Non-production overhead is entirely fixed. There are no opening and closing stocks as all items are made to order, with just-in-time management techniques.

The information in Table 8.6 has been extracted from the budget forecast for next year. In order to reach the correct decision the above information is recast as shown in Table 8.7.

Table 8.6 Country Limited absorption budget statement

	Picnic baskets	Picnic seats	Picnic tables	Total
Sales (units)	2000	24000	6000	32000
	£	£	£	£
Sales revenue	31,000	480,000	600,000	1,111,000
Direct material – variable	18,000	150,000	80,000	248,000
Direct labour – variable	12,000	100,000	90,000	202,000
Production overhead	8,000	150,000	175,000	333,000
Non-production overhead	15,000	25,000	40,000	80,000
Profit (loss)	(22,000)	55,000	215,000	248,000

Table 8.7 Country Limited restated contribution budget statement

	Picnic baskets (£)	Picnic seats (£)	Picnic tables (£)	Total (£)
Sales	31,000	480,000	600,000	1,111,000
Variable costs				
Materials	18,000	150,000	80,000	248,000
Labour	12,000	100,000	90,000	202,000
Overheads	3,000	45,000	85,000	133,000
	33,000	295,000	255,000	583,000
Contribution	(2,000)	185,000	345,000	528,000
Fixed costs				280,000
Profit				248,000

It can be seen that in Table 8.7 the restated budget for picnic baskets neither makes a profit nor contributes towards fixed overheads. It would thus appear that the decision on a profit maximisation basis would be to close this line. However, we need to give further consideration to a number of points:

- The accuracy of the budget forecast; here we could consult historical data, for example.
- The obviously integrated nature of the product mix, as closing picnic baskets may cost the company sales. They may even be included as a loss leader or even frequently given away with the table and chair sets to further encourage sales.
- Are the figures for the variable element of production overhead accurate?
- If the decision to close the picnic basket line is to be made, managers need to consider its contribution to the long-term business plans of the organisation.
- As all stock is bought on a just-in-time basis there are no stock holding or stock pricing costs, but does the budget reflect agreed contract prices with suppliers?

- The contribution on picnic baskets is only a small negative, so could the price be increased.
- Are any efficiency gains in the use of labour and materials possible?

The above points concentrate on financial issues only and we will return in the final section of this chapter to consider the qualitative issues concerning such decisions.

Make or Buy Decisions

Where a company carries out several processes within the value chain, it is following a policy of vertical integration by controlling all aspects of production. While this may have a number of advantages for the company in terms of control of the supply process, it may not necessarily be the most cost-efficient way of managing the business. Thus a decision to make the part or buy it from an external supplier is naturally termed a *make or buy* decision. By buying from a supplier, that supplier can potentially maximise the benefits of economies of scale which may also result in better quality and not just lower prices. Obviously there are situations in which a company would never consider subcontracting production, for example, where it would put its competitive position at risk either through disclosing trade secrets or risking poor quality.

EXHIBIT 8.7

Avoidable and Unavoidable Costs

Tenby Ltd. produces product X, for which the following information is available:

Cost category	Unit cost (£)
Direct materials	10
Direct labour	5
Variable overhead	1
Section Supervisor	2.5
Depreciation	2
Fixed overhead	4
Total	24.5

An outside UK-based supplier has indicated that it can supply the 10,000 units required at a price of £20 per unit. The question for Tenby is what are the avoidable and unavoidable costs of producing product X. These costs are set out in Table 8.8.

As can be seen, the price differential in favour of in-house manufacture is £1.50 per unit – £15,000 for 10,000 units for the budget period. Depreciation is a sunk cost in relation to

Table 8.8 Avoidable costs

Cost category	Budgeted Unit Cost (£)	Avoidable Cost Per Unit (£)	
		Make	Buy
Direct Materials	10	10	
Direct labour	5	5	
Variable overhead	1	1	
Section supervisor	2.5	2.5	
Depreciation	2		
Fixed overhead	4		
Total Cost	24.5	18.5	
Purchase Price			20

product X and may be for special machinery to make the product, but it is ignored in the decision. The fixed overhead represents general overhead apportioned to the product and as such is unavoidable. All other costs are relevant to the decision as they vary with the production of the product; in the case of the supervisor, this cost can be avoided by redundancy.

If we assume now that the supervisor would be entitled to a redundancy payment of £12,500 on top of the above calculation, then we can see that there is still a cost differential in favour of manufacture of product X, even if now it is only £2,500. This requires further thought, however, in that if in the next budget period the alternative supplier came forward again, how would we treat this cost? In this situation the company has already effectively used the £12,500 once to make the 'make' decision and as such should only count £2,500 as being unallocated. Next year (and assuming no other changes) the decision would be to buy. A more sophisticated analysis would incorporate discounted cash-flow analysis, which will be discussed in Chapter 9.

Finally, in this section opportunity cost needs to be mentioned. It has been assumed in the above example that the capacity potentially released by a buy decision will be idle. It could, of course, be used to manufacture an alternative product. If this were possible then Tenby would need to consider the value of the opportunity forgone in reaching its decision. This has particular implications for the use of the specialist machinery mentioned above.

Relevant Costing Explored

Relevant costs and revenues are those that will occur in the future and are relevant to specific decisions. The idea of cost relevance can be illustrated as follows.

A company has 100 components in stock at a manufacturing cost of £100,000, but the prospective customer can no longer afford to pay for them and it has proved impossible to find an alternative customer for the components. Two alternative uses for the components have been identified (see Table 8.9):

Table 8.9 A conventional approach to identifying revenues and costs

	Conversion (£)	Scrap (£)
Revenue	50,000	5,000
Costs		
Manufacturing	100,000	100,000
Conversion	30,000	
Carriage	1,000	500
Total costs	131,000	100,500
Loss	81,000	96,500

Table 8.10 Relevant costs and revenues

	Conversion (£)	Scrap (£)
Revenue	50,000	5,000
Relevant cost		
Conversion	30,000	
Carriage	1,000	500
Total relevant costs	31,000	500
Net cash flow	19,000	4,500

- Convert them into garden gnomes at a cost of £30,000 and then sell them for £50,000, incurring carriage costs of £1000.
- Scrap the components for £5000. Carriage costs will also be £1000.

This approach gathers together all the costs and revenues. However, in terms of the decision whether to convert or scrap the components, not all of the costs are relevant. The non-relevant cost in this case is that of manufacturing: this is a historic or 'sunk' cost and has already been incurred, whichever decision we make. We can remove it from Table 8.9, to give the statement in Table 8.10. As the statement shows, the preferred option is conversion. Conversion will lead to an increase in future net cash flows of £19,000, whereas they will increase by just £4,500 under the scrap option.

Relevant costs have the following characteristics:

- They are *future* costs.
- They are *differential* costs (they differ between different alternatives).
- They are *decision-specific* (if you change the decision, the relevant costs will change).

We now examine the application of relevant cost principles in three cost areas: salaries and wages, materials and depreciation.

Salaries and Wages

If there is spare capacity in the workforce, the relevant cost of wages is zero if the workforce is paid whilst spare capacity exists. If there is no spare capacity, the relevant cost of labour may be represented by the following cases:

- The costs of overtime working when the existing workforce is required to work overtime to complete the project. In this situation the relevant cost is the cost of overtime working.
- The cost of bringing in new workers to cover for existing workers when this is done to take work off existing workers to allow them to work on a new project. In this situation, the relevant cost is the cost of the replacement workers.
- The contribution that is lost when workers are transferred from another project. This occurs when the labour force is fully employed and where workers must be moved away from one profitable area in order to work on another. In this situation, the relevant cost of labour is its opportunity cost.

Materials

The relevant costs of materials depend initially on whether the materials are to be purchased or are in stock. If they are to be purchased, then the relevant cost is the future acquisition cost of the materials.

If they are already in stock, then the *book value* (or the historic cost of the materials) is irrelevant, as it is a historic or sunk cost. However, materials in stock do have a relevant cost. If the materials are in continuous use within the business, then the relevant cost is equal to the replacement cost of the materials. This is because, if materials are in continuous use, once they are used they will be replaced. If, on the other hand, the materials are not in continuous use – for example, they are obsolete, ordered in error or have become surplus to requirements – then their relevant cost is their opportunity cost and this may be estimated as the greater of their net realisable value and their value in alternative use.

The net realisable value is equal to the sales proceeds less the selling costs, for example, carriage. The value in alternative use is the saving obtained by using the material elsewhere within the company, for example, in place of another material that is currently in use.

The following example demonstrates the application of these principles to the relevant cost of material. A contract requires 1000 kg of material A, 500 kg of material B and 200 units of C.

Material A is in continuous use by the company. The company currently has 400 kg in stock at a total book value of £2000. Future purchases of material A will cost £5.20 per kilogram.

There are 100 kg of material B in stock, with a total book value of £350 if used on the contract. Material B will not be replaced. It has no anticipated use other than disposal for £1.20 per kilogram. Its replacement cost is £2.80 per kilogram.

Table 8.11 Relevant cost of material, and explanations

Material A	
Material A is in continuous use and so all material to be used should be valued at replacement cost. 100 kg × £5.20	520
The book value is sunk or historic cost.	
Material B	
Material B is not in continuous use and the relevant cost of materials in stock is its opportunity cost. £1.20 × 100.	120
Additionally 400 kg. will be purchased at a cost of 400 kg × £2.80.	1120
The book value is sunk or historic cost.	
Material C	
There are sufficient items in stock. Material C is not in regular use and its relevant cost is its opportunity cost. If sold, it will realise 200 kg × £1.50 = £300.	
If converted and used in place of Y, it will save the company 200 kg × (£2 – £1.20) = £160.	
C's opportunity cost is the higher of these	300
The book value is sunk or historic cost.	
Total relevant cost of materials	£2060

There are 300 units of C in stock. This material is not in regular use by the company and would realise only £1.50 per unit if sold, whereas its original price was £2.75 per unit. Its replacement price is £2.50 per unit. However, the stock of C could be used in the business in place of another component, Y, if £1.20 were spent on the conversion of each unit of C. Y is in continuous use by the business and its current replacement price is £2 per unit.

Table 8.11 summarise the relevant costs for this example

Depreciation

Depreciation is based upon the historic cost, estimated life and estimated scrap value of fixed assets. Because deprecation is related to historic or sunk cost, it is not a relevant cost. However, the use of equipment that is owned can have a relevant cost, as is illustrated in the following situations:

- Using equipment on a project may result in a reduction in its resale value as a result of the additional wear and tear or because holding on to the asset reduces its resale value. In both cases the reduction in resale value may be regarded as a relevant cost.
- Equipment may be hired out to other companies. If such equipment is to be used on a project, then the hire charge revenue that is forgone by the company should be regarded as a relevant cost.

EXHIBIT 8.8

Reviewing a Project

A project which to date has cost the company £50,000 is under review. It is anticipated that, should the project be allowed to proceed, it will be completed in one year when it will generate income of £250,000. Shown below are the additional expenses that the managing director estimates will be necessary to complete the work.

- Materials, £90,000. These have just been received and paid for. They have cost £90,000 and if not used on the project would have to be disposed of by special means at a cost of £5,000.
- Labour, £60,000. The men are highly skilled and very difficult to recruit. They have been transferred to the project from a production department and, at a recent board meeting, the works director claimed that if the men were returned to him he could earn the company each year a contribution of £80,000 over and above the cost of materials and labour.
- Project staff, £40,000. A decision has already been taken that this will be the last project undertaken, and consequently when work on the project ceases, the staff will be made redundant.
- Share of general building services, £35,000. The managing director is not very sure what is included in this expense. He knows, however, that the accounts staff apportion similar amounts each year to each department.

Table 8.12 Calculation for Exhibit 8.8

Revenue	£
£150,000 is future income and is relevant	250,000
Costs	
£50,000 is a sunk cost and is not relevant	
Materials. Historic cost is not relevant as the materials have been delivered and paid for. However, if the company does not proceed with the contract, the relevant cost of disposal will be saved if the company proceeds with the contract.	(5,000)
Labour. In this case the £60,000 cost of labour is a common cost as it will be incurred whether or not the company goes ahead with the project. The works director estimates that the labour could earn a contribution of £80,000. As this is is after deducting labour costs, which are not relevant, the company will loose (£80,000 + £60,000) as a result of undertaking the contract. This the opportunity cost of labour in this case.	140,000
Project staff. This is a relevant cost as it will only be incurred if the project goes ahead.	40,000
Share of building services represents an apportionment and is a common cost that will be incurred irrespective of whether the project proceeds.	
Total relevant costs	175,000
Net cash flow	75,000

Assuming the estimates are accurate, and given that Table 8.12 shows that the net cash flow is positive, the managing director is advised to allow the project to proceed.

Qualitative Factors in Decisions

The above section covered the financial analysis in make or buy decisions but qualitative factors can be important. The following applies a public sector technique known as *desiderata* to such analysis. While it is normally used on capital projects, there is no reason why it cannot be used in the private sector in this or any other type of decision.

As was seen in Exhibit 8.6, Tenby considered on a financial basis that the make decision was the correct one. We will now add an overseas supplier to the equation who has come in with an offer price of £18.00 per unit. Should Tenby thus use this supplier?

The company now needs to draw up a list of other issues (the desiderata) which affect its choice. This would be done possibly by a team of individuals to ensure all factors are considered. Table 8.13 illustrates the result of such discussions.

In terms of the factors identified for this company, we can see that the make decision scores highest. Other managers might include other factors, such as exposure to foreign exchange risk. The financial decision, while marginally favouring buying from overseas,

Table 8.13 Desiderata table for make or buy appraisal

Criteria important to Tenby	Weights in the decision	Option 1 score: make	Option 2 score: UK source	Option 3 score: Overseas
Reliability of Supply	25	25	20	10
Impact on motivation of company workforce	15	12	8	7
Customer reaction	10	5	5	5
Quality of supply	50	45	40	28
Total benefits	100	87	73	50

with the new information provided is outweighed in this instance by the qualitative factors now input into the decision. Managers would need to assess the significance of this result. The advantage of the use of desiderata is that quantitative information has now been expressed in numeric terms. Obviously such information is subjective, but it is an attempt to move the debate over such issues forward to give managers more information in a manageable format to arrive at the correct decision for their company. The technique can also

be used in a variety of decision-making situations and is further explored in Chapter 9 when capital investment decisions are considered.

Pricing Decisions

There are two types of pricing decision, which relate to either internal customers or external customers. In the former case, one division of an organisation charges another for goods or services provided, and this is known as *transfer pricing*. In both the public sector and private sector such transfer prices may be subject to an internal service level agreement which is effectively an internal contract for the supply of goods or services at a set price and set quality.

Cost Plus Pricing

In simple terms, the pricing decision is about covering costs and earning a mark-up which represents profit. The problem comes in what to include in the costs. One approach could be to take prime costs (all direct costs) and add production overheads to give the full production cost. Full production cost would then form the basis for the addition of the mark-up percentage (say, 25%). By this method the firm has a cushion in the price for any budget variation, but there is no guarantee that the price at 25% over production costs will cover other non-productive costs such as selling and distribution and give a satisfactory level of profit. The alternative is to include non-production costs in calculating the unit cost of output and then to add the mark-up percentage. By this method the company would hope to reduce the failure to cover all its costs. The final alternative, cost plus, would be to calculate the variable cost per unit of production and then add on a large profit mark-up to cover all fixed costs (production and non-production), but this is a high-risk strategy as all fixed costs might not be covered. In addition, whatever price is set, the company would need to consider the marketplace and the actions of its competitors as the percentage mark-up needs to be realistic in terms of achievability.

On page 229 we looked at the issue of a special order and recognised that the company would accept the order as the price was above unit variable cost. Production and non-production overheads were unaffected by this decision and the order represented cash flow to the company. There is, of course, a danger that other customers could hear of the discounting on normal selling price and therefore expect similar treatment.

Lowering the price raises the issue of selling below costs and whether this is acceptable in any circumstances. The following suggestions are made:

- A new product is being introduced and the company wishes to create demand so it sets a price below cost in anticipation of raising the price later. There is, of course, a danger that this may not be possible.
- The market is in recession and as such a company needs cash flow. It would, of course, hope to cover variable costs at a minimum as in the short term it can ignore fixed overheads to generate cash flow.

- Product life cycles are important. In the early days of the product, when there is a desire to recover the investment costs, a high price (coupled with a positive consumer image) will be set. As the product moves through its life cycle prices may be reduced to continue to sell the product. In this context the decision maker is into life cycle costing, under which an attempt is made to track budgeted and actual costs and associated revenues through each stage of the product life cycle.
- Predatory pricing (loss leading) may be used to enter a new market and attract sales and potentially customer loyalty.
- Defensive pricing to defend the market from a potential entrant to ensure that the market is unattractive to that potential entrant.
- To use spare capacity (as with a special order) since fixed costs would be covered by the normal activities and pricing policy of the company.

Target Costing

Under this system management would set a potential target price based on capturing an envisaged share of the market. The firm will thus take direct account of market intelligence and will build the product (or provide the service) to this target price. The price obviously builds in a profit percentage, and costs are budgeted to come in below this figure. The advantages of this method are as follows:

- The price is set in advance based on specific market intelligence and requires detailed consideration of all relevant strategic information.
- Once the price has been established tight budgetary control is vital if planned profits are to be delivered. Once the price is set managers are forced to find savings if one particular element of the budget shows increased costs, otherwise the company's strategy is at risk of failure.
- It overcomes the problem of cost-based prices which can ignore the marketplace. In terms of the delivery of a service, for example, it is not unusual for public sector organisations to simply increase prices by the rate of inflation (usually from 1 April) without any demand analysis. This clearly ignores market information.

Transfer (Internal) Prices

It is quite common for larger organisations to employ an internal market system where one segment of the entity will trade with another to encourage efficiency. Under this system income for one segment is expenditure for another, although when the consolidated accounts of the organisation are compiled these transactions will cancel each other out. It is important that these internal prices are set to optimise the results for the business as a whole and not to encourage suboptimizing where the goals of a segment are seen as more important by managers in the segment than the best interests of the company as a whole. The summary of the article by Spicer (1988) at the end of this chapter places transfer pricing in an organisational context. The topic is also developed further in Chapter 10.

The objectives of a system of transfer prices should be to:

- report results for each segment which reflect the managerial performance of the segment or division;
- motivate individual managers to make sound decisions such that their results also improve the results of the company as a whole;
- support segment autonomy while not undermining decision making in the organisation as a whole.

There are a number of alternative bases for transfer pricing available including: negotiated prices, opportunity cost, total cost, variable cost, and adjusted market price.

In these decisions the role of the management accountant is to supply decision-relevant information and to interpret that information. In giving advice on setting transfer prices, whatever price is to be charged will be based around the objectives set out above.

Conclusions

This chapter has:

- used various costing techniques to make decisions on the utilisation of scarce resources;
- shown how to interpret the results of analysis to advise management on such decisions;
- developed an understanding of the application of marginal costing/the contribution approach to management decisions;
- recognised the importance of risk to the management decision making environment
- recognised the importance of both quantitative and qualitative factors in the decision-making environment.

Summary

Having read this chapter, you have reviewed the utilisation of scarce resources to maximise profits within an organisation based on an understanding of the contribution per unit of scarce resource. This was then developed to examine how break-even analysis can contribute to a manager's understanding of business behaviour. The identification of fixed and variable costs via a variety of techniques was considered and decision making examined using a method to quantify qualitative factors. Finally, the chapter looked at pricing both from an external and internal perspective. It should be remembered that there is rarely a single correct answer to the decisions required by managers. What is important is that the data available are analysed correctly and presented in a form which managers can

use. It is therefore crucial that the management accountant provides that information in the form required and that managers are aware of their information needs in specific circumstances. This represents a considerable challenge to both parties.

Recommended Further Reading

Otley, D. (2001) 'Extending the boundaries of management accounting research: developing systems for performance management', *British Accounting Review*, 33(3): 243–261.

This paper opens by pointing out that by the mid-1980s the practice of management accounting was in decline, with little in the way of new developments for decades. Therefore management accounting was seen as irrelevant to contemporary organisations and, even worse, its influence seen as counterproductive to good managerial decision making. Otley points out that since 1987, when Johnson and Kaplan's book *Relevance Lost* appeared, Johnson appears to have given up on accounting to emphasise 'softer' areas, while Kaplan has pushed forward the reinvention of management accounting practices. Kaplan's work is essentially strategic management accounting, through a change in emphasis of the historic context of cost accounting to become forward-looking, to concentrate on planning, to move from an emphasis on cost to one on value, to stress marketing as well as production and recognise external clients and competitors as opposed to the internal factors. While the author feels that this emphasis perhaps undervalues the contribution of previous practice, he goes on to quote a past president of the Chartered Institute of Management Accountants as claiming this new emphasis releases 'the management accountant from the factory floor'(Bromwich and Bhimani, 1989).

Otley goes on to look at the so-called second major innovation to come from Kaplan (see Kaplan and Norton, 1996), the 'balanced scorecard', which is seen as a framework for performance measurement that includes both financial and non-financial elements in the strategic decision-making process. However, he points out that the literature on the balanced scorecard shows a lack of coverage of target setting, resource allocation, reward systems design, and the separation of tactical and strategic feedback, despite diagrams covering these items in the 1996 book. In contrast, the economic value-added technique developed by Stern Stewart Corporation is seen as putting no 'explicit' emphasis on strategy either in practice or in theory, but adherence to the principle of generating shareholder value is achieved by close attention to each stage of the management process. Performance measurement is core to the system, and rewards devised to mitigate inappropriate behaviour within feedback processes which update targets over time to achieve 'value added'. Initially these approaches were seen as in conflict, but more recently a more collaborative approach seems to be developing, taking the benefits of both ideas. In the context of the paper by Otley, what is stressed is that management accounting practices have changed radically over the past fifteen years. This is through the linking of financial and non-financial measures and presents major challenges to the discipline.

The remainder of the paper goes on to explore issues of how management accounting research has adopted to this environment. Otley's answer is 'not very well' in that the discipline seems to have become somewhat sterile, perhaps losing touch with management practices. The theme of the paper is the widening role of the management accountant in both public and private organisations. The call in the paper is to put 'management' back into management accounting; the interest in 'real' organisations in understanding and developing their systems of performance management has never been greater. Otley concludes by saying that in his opinion management accounting researchers should 'seize these opportunities'.

Spicer, B.H. (1988) 'Towards an organisation theory of the transfer pricing process', *Accounting, Organizations and Society*, 13(3): 303–22.

Spicer's article builds upon the work of Watson and Baumler (1975) relating to the behavioural aspects of transfer pricing (TP).

The classical approach makes assumptions about the firm (e.g. profit maximising) and tries to develop an optimal TP model using an analytical (linear programming) approach. The assumptions, however, limit the wider organisational analysis of the effects of TP, for example on the firm's various strategies of diversification, management accounting and control. It must be recognised, however, that the benefits of any chosen TP system are contingent upon the organisational structure of the firm.

The firm, states Spicer, can be seen as a network of transactions whose costs vary with complexity. These transactions (both internal and external to the firm) and their associated choices, have associated problems, such as bounded rationality and opportunism. Therefore moral hazard is introduced into exchange relationships (by taking advantage of asymmetric information).

Spicer refers to Watson and Baumler, who argue that authors on TP have failed to 'offer a coherent theory of decentralisation' so that the relationship between TP and decentralisation is not well thought out. The TP system should try to optimise effective *differentiation* (i.e. segmentation) and *integration* (i.e. common purpose) of the firm. TP enhances differentiation by pinpointing responsibilities and, via negotiation, can aid in the integration process. Spicer refers to Swieringa and Waterhouse (1982) and Eccles (1985) who comment that the *process* of TP (rather than the details) may be useful in furthering organisational control. They concluded that the need for (and details of) the TP process will depend heavily upon the *diversification and decentralisation strategies* of the company – the more a firm is diversified, the less likely it is to have a high level of interdivisional transfers and the less of a problem TP is.

Spicer argues that two decisions are necessary: the design of the intermediate product (standardised or specialised/unique) and whether to make or buy the intermediate product. He provides a table examining the dimensions of such decisions and states that the costs and hazards associated with such decisions are dependent upon the investments in assets necessary, the degree of uncertainty, and the extent (frequency and volume) of activity.

Spicer goes on to analyse this further, looking at a particular case where the intermediate product is made within the firm and transferred between different profit centres with different profit streams. This analysis looks specifically at: the dimensions of intrafirm transactions, internal contracting hazards (how they arise and how they can be dealt with), and the need for adaptation and co-operation (to achieve overall objectives). The analysis discusses these factors at length and also considers the factors involved in deciding the degree of managerial autonomy in the TP process.

Spicer puts forward nine hypotheses, drawn from the preceding discussion, relating to the factors likely to affect the mode and process of TP likely to be chosen by an organisation. These hypotheses deal with the effects on TP of factors such as: diversification strategy; product design; organisational structure; transaction-specific investment; frequency and volume of transactions; degree of uncertainty; degree of conflict; the need for articulation and negotiation; the bases of TP (e.g. cost- or market-based); and degree of central control.

Overall, using a contingency approach, the article attempts to place TP within a wider organisational context and prepares the ground for further empirical research.

Case Study: The Odd-Job Manufacturing Company

The Odd-Job Manufacturing Company (OJMC) produces toolboxes from plastic and metal in a single plant. The basic product is made from strong 5 mm plastic with a plastic handle and metal hinges and wheels. The company has a good reputation in the market because the standard toolbox is a high-quality item, has been well-produced and has sold well for many years.

Two years ago the company decided to expand its product line and produce bespoke boxes for the different retail outlets, usually those that specialise in do-it-yourself supplies. These boxes differ from the standard because they are produced in a range of sizes, they have a metal handle and carry the logo of the specific retail outlet. The standard one-size toolboxes are simply imprinted with the company's initials, OJMC.

In order to reduce the labour cost of the speciality toolboxes, much of the assembly work is done by automated machines. These machines are used to a much lesser degree in the production of the standard toolbox. With the lower cost of labour, the accounting department has determined that the speciality toolboxes are less costly to manufacture than the standard toolboxes. This is shown in the summary data below. Because the bespoke toolboxes are special-order items, they are priced at a higher level than the standard toolbox.

The managing director of OJMC, T.E.N. Onsaw, exploded when he saw the above figures and demanded, 'Why do we produce the standard item? It seems time to cut back, cut the standard, just produce the special lines and see if we can grow them more.'

The company's marketing director, Pierre Lasterboard, commented, 'I agree that the bespoke business is working better and there seems to be plenty of work out there,

Per unit	Standard (£)	Bespoke (£)
Selling price	9.00	10.00
Manufacturing cost	8.94	6.10
Gross profit	0.06	3.9

particularly as the competition has not been able to touch our price. Our biggest competitor charges £15 for bespoke items.'

However, the finance director, Dee Rill, is not as easily convinced. She observes that, 'Since we introduced the bespoke lines, our annual net profit has fallen by £350,000. This business has produced sales but it has also required investment and other costs.' The Managing Director responds, 'Dee, that's all very well but the unit gross profit figures tell their own story! Your argument just seems to be suggesting that neither line makes a profit – yet the company makes a profit so we must be doing something right. As chief accountant, Dee, I suggest that you sort this out as soon as possible and let me have something definitive before we move any further on this issue.'

Dee begins her investigation and first obtains a breakdown of the manufacturing cost of each of the company's product lines as follows:

	Standard	Specials
Units produced each month	10,000	5,500
	Per unit	Per unit
	£	£
Direct materials	5.00	4.13
Direct labour (at £4 per hour)	0.80	0.40
Prime cost	5.80	4.53
Manufacturing overhead (£15.69 per hour)	3.14	1.57
Manufacturing cost	8.94	6.10

Note that the manufacturing overhead is absorbed via direct labour hours and the absorption rate of £15.69 per hour is obtained from the budgeted manufacturing overhead (£40,012) divided by the budgeted direct labour hours (2550 hours).

Further investigation reveals that standard toolboxes are produced in batches of 200 units, whilst speciality toolboxes are produced in batches of 25 units. In consequence, in each month the company makes 100 set-ups for the bespoke items and 50 set-ups for the standard products. Each machine set-up requires 1 hour for the standard product and 2 hours for the bespoke product.

Each standard toolbox requires 0.5 hours of machine time but, due to its higher level of automation, each bespoke toolbox requires 2 hours of machine time.

At the end of the production process all toolboxes are inspected to ensure that quality standards are met. The standard toolbox requires little inspection time as the workers correct for any quality problems as they process the units. In total the standard toolbox requires 300 hours of inspection per month, and the speciality toolbox 500 hours of inspection time per month.

Dee also has access to results of a consultant's recent study of monthly overheads. The consultant's report includes the following summary:

Overhead activity (cost driver)	Overhead cost £	No. of events	Standard products	Speciality products
Purchasing (no. of orders)	3,000	60	48	12
Material handling (no. of receipts)	3,750	60	52	8
Production orders and set-ups (set-up time)	5,062	150	50	100
Inspection (inspection hours)	4,000	800	300	500
Frame assembly (assembly hours)	10,200	2,550	2,000	550
Machine-related (machine hours)	14,000	7,000	2,000	5,000
Total	40,012			

Complete Dee Rill's investigation and write a report to the managing director that examines the strengths and weaknesses of the existing costing system, examines the consequences for the company of continuing with it and evaluates an alternative system. You should illustrate how an alternative system should work and explain its significance for the company's production and marketing strategies.

Questions

1. Submarine Cables makes mobile telephones for underwater use. The budgeted revenues and costs for the year ended 30 June 2004 are as follows:

Revenues	£600,000
Variable costs	420,000
Fixed costs	150,000
Net profit	30,000

Capital employed will be £600,000. Budgeted output for the year ended 30 June 2004 is 30,000 units, which represents 60% of output capacity.

The management of the company are concerned about the low level of budgeted profit and return on capital employed. They have asked you to analyse and evaluate the following independent options for improving performance:

(a) An enquiry has been received from a wholesaler in Kazakhstan who has indicated that he is prepared to take 12,000 units at a price of £16 per unit, with Submarine Cables paying the carriage and customs charges estimated at £2000. Submarine Cables has never previously dealt with this wholesaler or this distant market.
(b) Reduce selling price by 10%. It is thought that this will increase demand to capacity. However, it will need to be supported by a new system of salesmen's commissions; these will be 50 pence per unit sold in 2000/2001.
(c) The managing director believes in setting targets and has announced a profit target of 10% of capital employed. The managing director wants to know what price increase is necessary to achieve the target with the current level of sales, and what sales increase is necessary to achieve the target with the current price per unit.
(d) A machine may be leased at a cost of £15,000 per annum. The machine will cause variable costs to fall by 50% per unit; it will also increase current capacity by 20%.

For each option (a)–(d), determine whether it is financially worthwhile and comment on its non-financial aspects.

2. Didcot is small company that specialises in producing virtual reality (VR) machines for large international entertainment companies. One of these has offered Didcot a contract to produce and deliver 1000 identical VR machines over a 26-week period starting on 1 June 2004.

Each machine requires the following materials:

- *2 square metres of Yalloy*: Yalloy is in continuous use by the company and 500 square metres are currently in stock at a book value of £80 per square metre. Future purchases will cost £90 per square metre.
- *1 translucent fitment*: 1500 are in stock at a book value of £10 each. However, this type of fitment will have no other use if not used on this contract, although they may be sold for scrap at £2 each. It is possible to purchase a new version of the fitment at £20 per fitment, although the type in stock is adequate for the contract.
- *2 yardarm controllers*: there are none in stock. The current purchase price is £50 per controller.
- *1 piezo control*: these will be purchased at £25 each and are specific to VR machines in the contract.

The following mixture of labour is required:

- *Skilled*: each VR machine will require 3 hours of skilled labour. Skilled labour is currently paid £4.80 per hour and will be fully employed on other work during the next 26 weeks. In order to fulfil the contract a skilled worker will be taken off other work which will be undertaken by a temporary replacement provided by a local agency at £6 per hour.
- *Semi-skilled*: each machine will require 4 hours of semi-skilled labour. The current rate for semi-skilled labour is £3.50 per hour and sufficient temporary workers can be recuited for this work.

In the case of both skilled and semi-skilled employees, national insurance adds a further 12% to the cost of employment. This is not payable by Didcot in the case of agency workers.

Supervision of the work will be carried out by a senior manager who is currently paid £25,000 per year (with superannuation and national insurance adding a further 20% to the costs of employment). In order to free her time to undertake this work, an agency will provide cover at a cost of £500 per week.

Didcot absorbs production overhead by a machine rate that is currently £40 per hour. Of this, £15 is variable and £25 is fixed. Each VR machine will require 2 machine hours. Additionally, fixed overheads directly attributable to the production of VRs are likely to increase by £15,000 over the period of the contract.

The costs of negotiating and drawing up the contract to supply 1000 VR machines have amounted to £800.

A price of £520 per machine has been agreed with the entertainment company. The entertainment company has stipulated within the contract that it will pay only £250 per machine for any that are delivered up to four weeks late. Machines delivered more than four weeks late will be delivered free of charge.

(a) Prepare a statement of the relevant costs of the contract and state whether or not the contract should be undertaken by Didcot. Provide notes to indicate why you have selected some costs and rejected others.
(b) Comment on *three* significant factors that management needs to consider before finally agreeing to take the contract.

3. Traffick PLC has been forced to close for two weeks because of supply problems. During that time the company produced no count meters. The company issued a press statement that the supply failure had cost the company £1 million. This figure was based on the loss of turnover over the two-week period.

The company's financial accountant has subsequently made a more detailed assessment of the cost, as follows:

		£000	£000
Lost revenue (40,000 units @£25 each)			1000
Costs saved	Standard cost per unit (£)		
Materials	1.0	40	
Direct labour	2.5	100	
Depreciation	4.0	160	
Variable overhead	3.0	120	
Sub-contracting work	1.0	40	
Fixed overhead	5.0	200	660
Cost of the supply failure			340

The following information is available:

(i) The direct labour was paid 75% of the normal wage during the two-week period, and this amounted to £75,000.

(ii) Depreciation is based on the straight-line method. However, there is a variable component of depreciation amounting to 50 pence per unit produced.

(iii) Fixed overhead is absorbed at the rate of 200% on direct wages.

(iv) The maintenance team was able to carry out a major overhaul of one of the machines during the period of closure. They had to purchase materials costing £5000, but a contractor would normally have performed the overhaul at a cost of £25,000 (including materials). The cost of the maintenance team is included within fixed overheads. The cost of the materials has not yet been recorded.

(v) The sales manager has estimated that because of the closure, there will be unsatisfied demand amounting to half the production lost. This can be made up by the production workforce working overtime during the next month. Overtime is paid at an enhanced rate of 50% above the normal hourly rate.

(a) Examine points (i)–(v) and discuss the relevance of each of these costs to the identification of the cost of closure.

(b) Produce a statement indicating the net cost of the closure. You will need to explain the inclusion (or exclusion) of any items that you have not discussed in part (a) of the question.

(c) Outline *two* potential problems with the use of relevant costing in decision making.

4. Emily Wye is currently working on the production schedules for next month. Her firm manufactures two types of ceramic grids:

	Type A £	Type B £
Selling price	60	70
Material X1 (at £2 per kg)	3	6
Material X2 (at £5 per kg)	10	10
Direct labour (grade 1)	12	9
Direct labour (grade 2)	10	15
Variable overhead	5	7

Notes:

(i) Labour rates and maximum labour hours available in the next month are:

Grade	Hourly rate	Max. monthly hours
1	£6	640
2	£5	Unlimited

(ii) Both products involve machine work, type A requiring 1 hour and B half an hour. The machine is available for 400 hours per month.

(iii) Next month the company will have available 900 kg of X1. The firm can buy as much X2 as it wishes.

(iv) Fixed overheads in the coming month will amount to £1950.

(a) The company wishes to maximise contribution. Set out the objective function and the constraints.

(b) Determine the optimum output of each product next month using the graphical approach to linear programming. Calculate the optimum profit for the month.

(c) Calculate the amount of spare capacity available next month.

(d) Discuss three limitations of linear programming.

Jane Lane is the management accountant of a small manufacturing company. Jane normally gets involved in the production scheduling of the firm. She is currently working on this for the last three months of 2004, making use of her management accounting and linear programming skills.

The company manufactures components for rock climbing, including two types of ice axe, the X1 and the X2. During the last quarter of 2004, each X1 will have a selling price of £67 and each X2 a selling price of £78.

The cost of each axe is made up as follows:

	X1 (£)	X2 (£)
Materials: STX2 at £12 per metre	15	18
Labour: at £4.50 per hour	9	18
Variable overhead: at £5 per mc/hr	10	15

In addition, monthly fixed manufacturing overheads are budgeted to be £2000 per month and fixed non-manufacturing overheads are budgeted to be £5000 for the three-month period.

The company will have the following resources available to it for the last quarter of the year: 800 metres of STX2, 2000 hours of labour and 1800 machine hours. The firm wishes to supply its retailers with no less than 150 of each type of axe during the final quarter.

(a) The company wishes to maximise contribution. Set out the objective function and the constraints.
(b) Determine the optimum production of each product over the final quarter using the graphical approach to linear programming and calculate the optimum net profit for the final quarter of 2004.
(c) Calculate the shadow price of STX2 and explain how Jane may use it.