Break-Even and Short-term Decision Analysis

The breakeven point

- Cost-Volume-Profit (CVP) and Breakeven Point (BP) analysis can be used to examine how various 'what-if' alternatives being considered by a decision maker affect operating profit.
- The breakeven point is frequently one point of interest in this analysis. Managers wish to avoid the stigma of making a loss.
- The breakeven point is that quantity of output where total revenues and total costs are equal, that is, where the operating profit is zero.
- Using the information in the following example, this section examines three methods for determining the breakeven joint:
  - The equation method,
  - The contribution margin method and
  - The graph method.

The breakeven point

- Mary Frost plans to sell Do-All Software, a software package, at a heavily attended two-day computer convention in Edinburgh. Mary can purchase this software from a computer software wholesaler at €120 per package with the privilege of returning all unsold units and receiving a full €120 rebate per package. The units (packages) will be sold at €200 each. Mary has already paid €2000 to Computer Conventions Ltd for the booth rental for the two-day convention.
- What quantity of units will she need to sell in order to break even? Assume there are no other costs.

The breakeven point: the equation method

- The first approach for computing the breakeven point is the equation method. Using the terminology in this chapter, the income statement can be expressed in equation form as follows:
  - Revenues – Variables costs – Fixed costs = Operating profit
  - (USP x Q) – (UVC x Q) – FC = OP
  - This equation provides the most general and easy-to-remember approach to any CVP situation. Setting operating profit equal to zero in the preceding equation, we obtain:
  - € 200 x Q – € 120 x Q – € 2000= € 0
  - € 80 x Q = € 2000
  - Q =€ 2000 ÷ € 80 = 25 units
- If Mary sells fewer than 25 units, she will have a loss; if she sells 25 units she will break even; and if she sells more than 25 units, she will make a profit. This breakeven point is expressed in units. It can also be expressed in sales euros: 25 units x € 200 selling price = € 5000.

The breakeven point: the contribution margin method

- A second approach is the contribution margin method, which is simply an algebraic manipulation of the equation method. Contribution margin is equal to revenues minus all costs of the output (a produce or service) that vary with respect to the units of output. This method uses the fact that:
  - (USP x Q) – (UVC x Q) – FC = OP
  - (USP – UVC) x Q = FC + OP
  - UCM x Q= FC + OP
  - $Q = \frac{FC + OP}{UCM}$

- At the breakeven point, operating profit is, by definition, zero. Setting OP = 0, we obtain:

$$\text{Breakeven number of units} = \frac{\text{Fixed costs}}{\text{Unit contribution margin}} = \frac{FC}{UCM}$$

The breakeven point: the contribution margin method

- A contribution income statement groups line items by cost behavior pattern to highlight the contribution margin. The following such statement confirms the preceding breakeven calculations.

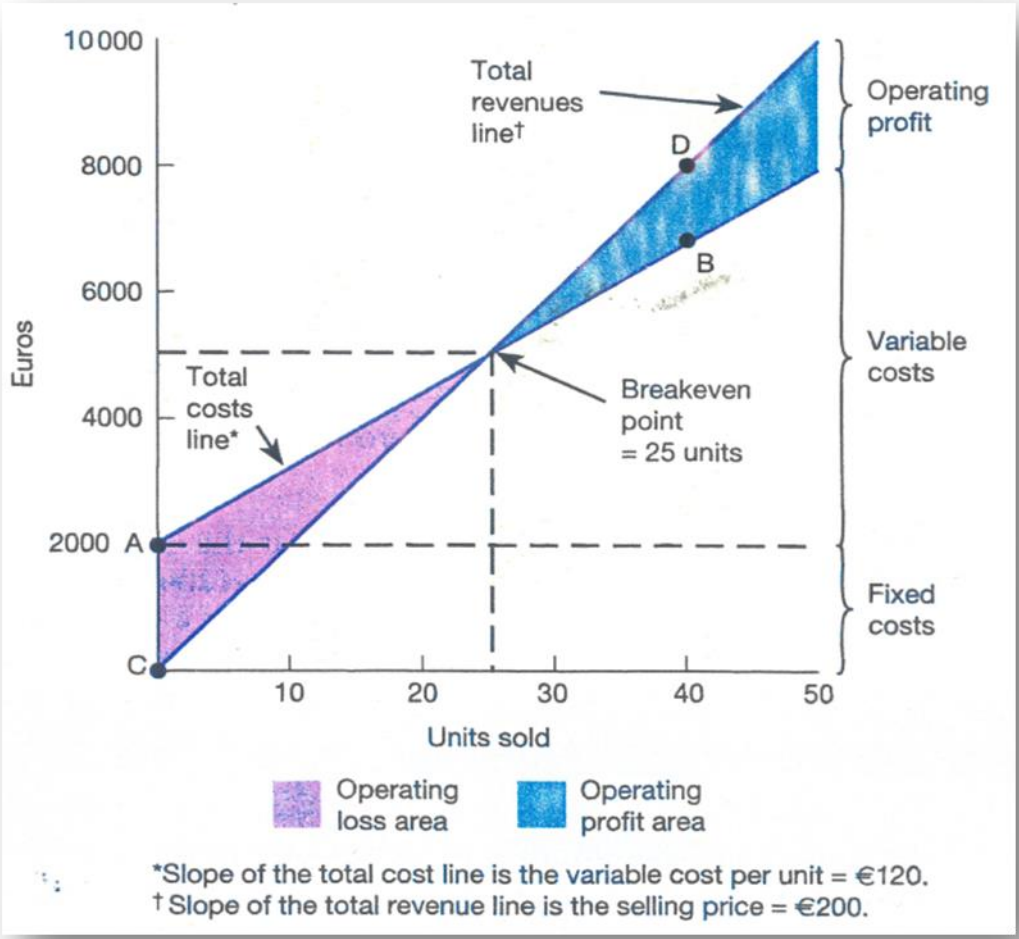
Revenues, €200 x 25	€ 5000
Variable costs, € 120 x 25	€ 3000
Contribution margin, €80 x 25	€ 2000
Fixed costs	€ 2000
Operating profit	€ 0

The breakeven point: the graph method

- In the graph method, we plot the total costs line and the total revenues line. Their point of intersection is the breakeven point. We need only two points to plot each line if each is assumed to be linear.
  - **Total costs line**. This line is the sum of the fixed costs and the variable costs. Fixed costs are €2000 at all output levels within the relevant range. To plot fixed costs, measure €2000 on the vertical axis (point A) and extend a line horizontally. Variable costs are €120 per unit. To plot the total costs line, use as one point the €2000 fixed costs at 0 output units (point A). Select a second point by choosing any other convenient output level (say, 40 units) and determining the corresponding total costs. The total variable costs at this output level are €4800 (40 x €120). Fixed costs are €2000 at all output levels within the relevant range. Hence, total costs at 40 units of output are €6800, which is point B in next slide's Exhibit. The total costs line is the straight line from point A passing through point B.
  - **Total revenues line**. One convenient starting point is zero revenues at the zero output level, which is point C in Exhibit 8.1. Select a second point by choosing any other convenient output level and determining its total revenues. At 40 units of output total revenues are €8000 (40 x €200), which is point D in next slide's Exhibit. The total revenues line is the straight line from point C passing through point D.

The breakeven point: the graph method

- The breakeven point is where the total revenues line and the total costs line intersect. At this point, total revenues equal total costs.



Target operating profit

- Let us introduce a profit element by asking the following question: How many units must be sold to earn an operating profit of €1200? The equation method provides a straightforward way to answer this question. Let QT be the number of units sold to earn the target operating profit:

  Revenues – Variable Costs – Fixed Costs = Target Operating Profit

  € 200QT – € 120QT – € 2000 = € 1200

  € 80QT = € 2000 + € 1200

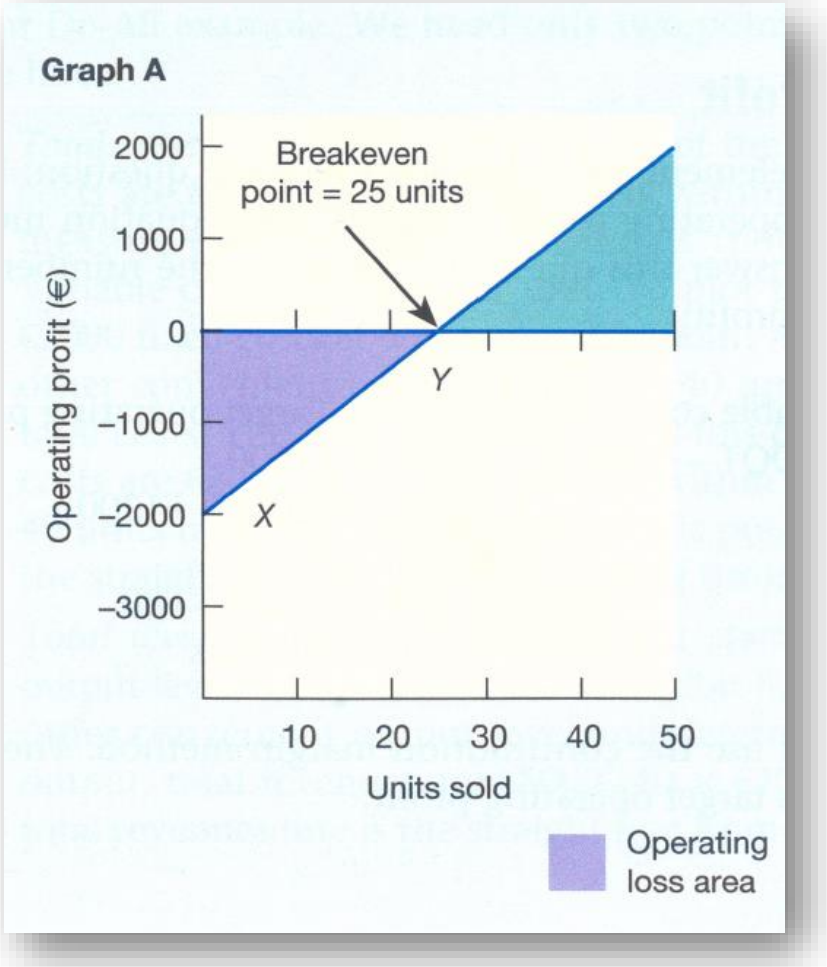
  € 80QT = € 3200

  QT = €3200 ÷ €80 = 40 units.

Proof:	Revenues, €200 x 40	€ 8000
	Variable costs, € 120 x 40	€ 4800
	Contribution margin, €80 x 40	€ 3200
	Fixed costs	€ 2000
	Operating profit	€ 1200

The profit-volume graph

- A Profit-Volume (PV) graph shows the impact on operating profit of changes in the output level.



Impact of income taxes

- Recall our previous equation method:
  - Revenues – Variable costs – Fixed costs = Operating profit
- We now introduce income tax effects:
  - Target in profit = (Operating Profit) – [(Operating profit) x (Tax rate)]
  - Target net profit = (Operating profit) x (1 – Tax rate)
  - $\text{Operating profit} = \dfrac{\text{Target net profit}}{1 - \text{Tax rate}}$
- So, taking income taxes into account, the equation method yields:
  - $\text{Revenues} - \text{Variables costs} - \text{Fixed costs} = \dfrac{\text{Target net profit}}{1 - \text{Tax rate}}$

Impact of income taxes

- Assume the following income statement:

Proof:	Revenues, € 200 x 50	€ 10000
	Variable costs, € 120 x 50	€ 6000
	Contribution margin	€ 4000
	Fixed costs	€ 2000
	Operating profit	€ 2000
	Income taxes, €2000 x 0,40	€ 800
	Net profit	€ 1200

- What number of units must be sold to earn a net profit of €1200, assuming operating profit is taxed at a rate of 40%?

$$\text{Operating profit} = \frac{\text{Target net profit}}{1 - \text{Tax rate}}$$

$$€200Q - €120Q - €2000 = \frac{€1680}{1-0.40}$$

€80Q - €2000 = €2800

€80Q = €4800

Q = €4800 ÷ €80 = 60 units

Contribution margin and gross margin

- Contribution margin = Revenues – All variable costs
- Gross margin = Revenues – Cost of goods sold
- Cost of goods sold in the merchandising sector is made up of goods purchased for resale.
- Cost of goods sold in the manufacturing costs (including fixed manufacturing costs).
- Service-sector companies can calculate a contribution margin figure but not a gross margin figure.
- Service-sector companies do not have a cost of goods sold item in their income statement.

Exercise 8.11

Fill in the blanks for each of the following independent cases.

Case	Selling price	Variable costs per unit	Total units sold	Total contribution margin	Total fixed costs	Operating profit/loss
a	£30	£20	70 000	£?	£?	-£15 000
b	25	?	180 000	900 000	800 000	?
c	?	10	150 000	300 000	220 000	?
d	20	14	?	120 000	?	12 000

Exercise 8.11

Suggested Solution

a	TCM	=	Q (USP-UVC)
		=	70 000 (£30 - £20)
		=	£700 000
	TFC	=	TCM – OP/L
		=	£700 000 - £15 000 = £685 000
b	TCM	=	Q (USP-UVC)
	£900 000	=	180 000 (£25 – UVC)
	UVC	=	£20
	OP/L	=	TCM-TFC
		=	£900 000 - £800 000 = £100 000
c	TCM	=	Q (USP – UVC)
	£300 000	=	150 000 (USP - £10)
	USP	=	£12
	OP/L	=	TCM-TFC
		=	£300 000 - £220 000 = £80 000
d	Q	=	TCM ÷ (UCP – UVC)
		=	£120 000 ÷ (£20 - £14)
		=	20 000
	TFC	=	TCM – OP/L
		=	£120 000 - £12 000 = £108 000

Exercise 8.22

La Pilotta has two restaurants in Lausanne that are open 24 hours a day. Fixed costs for the two restaurants together total SFr 450 000 per year. Service varies from a cup of coffee to full meals. The average bill for each customer is SFr 8.00. The average cost of food and other variable costs for each customer is SFr 3.20. The income tax rate is 30%. Target net profit is SFr 105 000.

Required:

1. Calculate the revenues needed to obtain the target net profit.
2. How much in sales terms is needed (a) to earn net income of SFr 105 000 and (b) to break even?
3. Calculate net income if the number of bills is 150 000.

Exercise 8.22

Suggested solution:

1.

Variable cost percentage is SFr 3.20/SFr 8.00 = 40%. Let R=Revenues needed to obtain target net profit, then:

$$R - 0{,}40\,R - \text{SFr } 450\,000 = \text{SFr } 150\,000$$
$$0{,}60\,R = \text{SFr } 450\,000 + \text{SFr } 150\,000$$
$$R = \text{SFr } 600\,000 \div 0.60$$
$$= \text{SFr } 1\,000\,000$$

Proof:	Revenues	SFr 1 000 000
	Variable costs (at 40%)	400 000
	Contribution margin	600 000
	Fixed costs	450 000
	Operating profit	150 000
	Income taxes (at 30%)	45 000
	Net profit	SFr 105 000

Exercise 8.22

Suggested solution:

2.

a Sales necessary to earn net profit of SFr 105 000:

$$\frac{\text{SFr}\,1\,000\,000}{\text{SFr}\,8} = 125\,000 \text{ sales necessary}$$

b Sales necessary to break even:

Contribution margin: SFr 8.00 – SFr 3.20 = SFr 4.80

$$\frac{\text{SFr}\,450\,000}{\text{SFr}\,4.80} = 93750 \text{ sales necessary}$$

3.

Using the short-cut approach described in the chapter:

Change in net profit = (150 000 – 125 000) x SFr 4.80 x (1 – 0.30)
= SFr 120 000 x 0.7 = SFr 84 000

New net profit = SFr 84 000 ÷ SFr 105 000 = SFr 189 000

Proof:	Revenues, 150 000 x SFr 8.00	SFr 1 200 000
	Variable costs (at 40%)	480 000
	Contribution margin	720 000
	Fixed costs	450 000
	Operating profit	270 000
	Income taxes (at 30%)	81 000
	Net profit	SFr 189 000

Decision making in the short term

- Decision-making involves choosing between alternatives.
  - For example, managers may be faced with decisions as to whether to discontinue a product or a channel of distribution, make a component within the company or buy from an outside supplier, introduce a new product or service and/or replace existing equipment.
- Something that these decisions have in common is that they are not routine. When decisions of this kind are being considered, special studies are undertaken.
- Making decisions requires that only those costs and revenues that are relevant to the alternatives are considered.
- If irrelevant cost and revenue data are included, the wrong decisions may be made. It is therefore essential to identify the relevant costs and revenues that are applicable to the alternatives being considered.
- Topics:
  - One-off special orders
  - Product-mix decisions
  - Make-or-buy decisions

Identifying relevant costs and revenues

- The **relevant costs** and **revenues** required for decision-making are only those that will be affected by the decision. Costs and revenues that are **independent** of a decision **are not relevant** and need not be considered when making that decision.
- The relevant financial inputs for decision-making purposes are therefore future cash flows, which will **differ between the various alternatives being considered**. In other words, only differential (or incremental) cash flows should be taken into account, and cash flows that will be the same for all alternatives are irrelevant.
- Because decision-making is concerned with choosing between future alternative courses of action, and nothing can be done to alter the past, then **past costs** (also known as **sunk costs**) are not relevant for decision-making.
- **Allocated common fixed costs** are also irrelevant for decision-making (e.g., facility sustaining costs, such as general administrative and property costs, are examples of common costs. They are incurred to support the organization as a whole and generally will not change whichever alternative is chosen. They will only change if there is a dramatic change in organizational activity resulting in an expansion or contraction in the business facilities.
- Common fixed costs may be allocated (i.e., apportioned) to cost objects but they should be disregarded for decision-making. This is because decisions merely lead to a redistribution of the same sunk cost between cost objects – they do not affect the level of cost to the company as a whole.

Identifying relevant costs and revenues

- Example from a non-business setting:
  - Consider a situation where an individual is uncertain as to whether he or she should purchase a monthly rail ticket to travel to work or use their car.
  - Assuming that the individual already owns and will keep the car, whether or not he or she travels to work by train, the cost of the road fund licence and insurance will be irrelevant. They are **sunk costs** and will remain the same irrespective of the mode of travel.
  - The cost of fuel will, however, be relevant, because this is a future cost that will differ depending on which alternative method of transport is chosen.
- The following general principles can therefore be applied in identifying relevant and irrelevant costs:
  - Relevant costs are future costs that differ between alternatives;
  - Irrelevant costs consist of sunk costs, allocated costs and future costs that do not differ between alternatives.

Exercise 10.14

Jääskinen Oy has just today paid for and installed a special machine for polishing cars at one of its several outlets. It is the first day of the company's fiscal year. The machine cost €20 000. Its annual operating costs total €15 000, exclusive of depreciation. The machine will have a four-year useful life and a zero terminal disposal price.

After the machine has been used for a day, a machine salesperson offers a different machine that promises to do the same job at a yearly operating cost of €9 000, exclusive of depreciation. The new machine will cost €24 000 cash, installed. The 'old' machine is unique and can be sold outright for only €10 000, minus €2 000 removal cost. The new machine, like the old one, will have a four-year useful life and zero terminal disposal price. Sales, all in cash, will be €150 000 annually, and other cash costs will be €110 000 annually, regardless of this decision.

For simplicity, ignore income taxes, interest and present-value considerations.

Exercise 10.14

Required:

1

a Prepare a statement of cash receipts and disbursements for each of the four years under both alternatives. What is the cumulative difference in cash flow for the four years taken together?

b Prepare income statements for each of the four years under both alternatives. Assume straight-line depreciation. What is the cumulative difference in operating profit for the four years taken together?

c What are the irrelevant items in your presentations in requirements (a) and (b)? Why are they irrelevant?

2 Suppose the cost of the 'old' machine was €1 million rather than €20 000. Nevertheless, the old machine can be sold outright for only €10 000, minus €2 000 removal cost. Would the net differences in requirements 1 and 2 change? Explain.

3 'To avoid a loss, we should keep the old machine.' What is the role of book value in decisions about replacement of machines?

Exercise 10.14

Suggested Solution:

1a Statements of cash receipts and disbursements

The difference is €8,000 for four years taken together. In particular, note that the €20,000 book value can be omitted from the comparison. Merely cross out the entire line; although the column totals are affected, the net difference is still €8,000.

Note the motivational factors here. A manager may be reluctant to replace simply because the large loss on disposal severely harms profitability in Year 1. Nevertheless, the cumulative cash flow effects are beneficial to the company as a whole (assuming a world of no income taxes and no interest).

	Keep			Buy new machine		
	Year 1	Years 2–4	Four years together	Year 1	Years 2–4	Four years together
Receipts from operations:						
Sales	€150,000	€150,000	€600,000	€150,000	€150,000	€600,000
Deduct disbursements:						
Other operating costs	(110,000)	(110,000)	(440,000)	(110,000)	(110,000)	(440,000)
Operation of machine	(15,000)	(15,000)	(60,000)	(9,000)	(9,000)	(36,000)
Purchase of 'old' machine	(20,000)*		(20,000)	(20,000)		(20,000)
Purchase of 'new' equipment				(24,000)		(24,000)
Cash inflow from sale of old equipment				8,000		8,000
Net cash inflow	€5,000	€25,000	€80,000	€ (5,000)	€31,000	€88,000

Exercise 10.14

Suggested Solution:

1b Again, the difference is €8,000.

1c The €20,000 purchase cost of the 'old' equipment, the sales and the other costs are irrelevant because their amounts are common to both alternatives.

Income statements

	Keep		Buy new machine		
	Years 1–4	Four years together	Year 1	Years 2–4	Four years together
Sales	€150,000	€600,000	€150,000	€150,000	€600,000
Costs (excluding disposal):					
Other operating costs	110,000	440,000	110,000	110,000	440,000
Depreciation	5,000	20,000	6,000	6,000	24,000
Operating costs of machine	15,000	60,000	9,000	9,000	36,000
Total costs (excluding disposal)	130,000	20,000	125,000	125,000	500,000
Loss on disposal:					
Book value ('cost')	–	–	20,000	–	20,000*
Proceeds ('revenue')	–	–	(8,000)	–	(8,000)
Loss on disposal	–	–	12,000	–	12,000
Total costs	130,000	520,000	137,000	125,000	512,000
Operating income	€20,000	€80,000	€13,000	€25,000	€88,000

Exercise 10.14

Suggested Solution:

2 The net difference would be unaffected. Any number may be substituted for the original €20,000 figure without changing the final answer. Of course, the net cash outflows under both alternatives would be high. The Car Wash manager really blundered. However, keeping the 'old' equipment will increase the cost of the blunder to the cumulative tune of €8,000 over the next 4 years.

3 Book value is irrelevant in decisions about the replacement of equipment, because it is a past (historical) cost. All past costs are down the drain. Nothing can change what has already been spent or what has already happened. The €20,000 has been spent. How it is subsequently accounted for is irrelevant. The analysis in requirement (1) clearly shows that we may completely ignore the €20,000 and still have a correct analysis. The only relevant items are those expected future items that will differ among alternatives.

Despite the economic analysis shown here, many managers would keep the old machine rather than replace it. Why? Because, in many organisations, the income statements of requirement (2) would be a principal means of evaluating performance. Note that the first-year operating income would be higher under the 'keep' alternative. The conventional accrual accounting model might motivate managers towards maximising their first-year reported operating income at the expense of long-run cumulative betterment for the organisation as a whole. This criticism is often made of the accrual accounting model. That is, the action favoured by the 'correct' or 'best' economic decision model may not be taken, either because the performance–evaluation model is inconsistent with the decision model or because the focus is only on the short-run part of the performance–evaluation model.

Exercise 10.15

Air Calabria owns a single jet aircraft and operates between Cantazaro and Venice. Flights leave Cantazaro on Mondays and Thursdays and depart from Venice on Wednesdays and Saturdays. Air Calabria cannot offer any more flights between Cantazaro and Venice. Only tourist-class seats are available on its planes. An analyst has collected the following information:

Seating capacity per plane	360 passengers
Average number of passengers per flight	200 passengers
Flights per week	4 flights
Flights per year	208 flights
Average one-way fare	€500
Variable fuel costs	€14 000 per flight
Food and beverage service cost (no charge to passenger)	€20 per passenger
Commission to travel agents paid by Air Calabria (all tickets are booked by travel agents)	8% of fare
Fixed annual lease costs allocated to each flight	€53 000 per flight
Fixed ground services (maintenance, check in, baggage handling) cost allocated to each flight	€7 000 per flight
Fixed flight crew salaries allocated to each flight	€4 000 per flight

For simplicity, assume that fuel costs are unaffected by the actual number of passengers on a flight.

Exercise 10.15

Required:

1 What is the operating profit that Air Calabria makes on each one-way flight between Cantazaro and Venice?

2 The Market Research Department of Air Calabria indicates that lowering the average one-way fare to €480 will increase the average number of passengers per flight to 212. Should Air Calabria lower its fare?

3 Cima-Rosa, a tour operator, approaches Air Calabria on the possibility of chartering (renting out) its jet aircraft twice each month, first to take Cima-Rosa's tourists from Cantazaro to Venice and then to bring the tourists back from Venice to Cantazaro. If Air Calabria accepts Cima-Rosa's offer, Air Calabria will be able to offer only 184 (208 - 24) of its own flights each year. The terms of the charter are as follows: (a) For each one-way flight, Cima-Rosa will pay Air Calabria €75 000 to charter the plane and to use its flight crew and ground service staff; (b) Cima-Rosa will pay for fuel costs; and (c) Cima-Rosa will pay for all food costs. On purely financial considerations, should Air Calabria accept Cima-Rosa's offer? What other factors should Air Calabria consider in deciding whether or not to charter its plane to Cima-Rosa?

Exercise 10.15

Suggested Solution:

1

Average one-way fare per passenger		€500	
Commission at 8% of €500		40	
Net cash to Air Calabria per ticket		€460	
Average number of passengers per flight		200	
Revenues per flight (€460 x 200)		€92 000	
Food & beverage cost per flight (€20 x 200)		4 000	
Total contribution from passengers		88 000	
Fuel costs per flight		14000	
Contribution per flight		74000	
Fixed costs allocated to each flight:			
Lease costs	€53000		
Baggage handling	7000		
Flight crew	4000	64000	
Operating income per flight			€10000

2

Exercise 10.15

Suggested Solution:

2

If fare is	€480.00
Commission at 8% of €480	38.40
Net cash per ticket	441.60
Food and beverage cost per ticket	20.00
Contribution per passenger	€421.60
Total contribution margin from passengers (€421.60x212)	€89,379.20

All other costs are irrelevant

On the basis of quantitative factors alone, Air Calabria should decrease its fare to €480 because reducing the fare gives Air Calabria a higher contribution margin from passengers (€89379.20 versus €88000).

Exercise 10.15

Suggested Solution:

3

In evaluating whether Air Calabria should charter its plane to Cima-Rosa, we compare the charter alternative to the solution in requirement (2) because requirement (2) is preferred to requirement (1).

Under requirement (2), Air Calabria gets	€89379.20
Deduct fuel costs	14000.00
Total contribution per flight	€75 379.20

Air Calabria gets €75 000 per flight from chartering the plane to Cima-Rosa. On the basis of quantitative financial factors Air Calabria is better off not chartering the plane and instead lowering its own fares.

Students who compare the €75 000 that Air Calabria earns from chartering its plane to the contribution from passengers in requirement (1) (€74 000) will conclude that Air Calabria should charter the plane to Cima-Rosa. Strictly speaking, though, the correct answer must compare the charter fee of €75 000 to the €75 379.20 passenger contribution in requirement (2) since lowering the fare is certainly an alternative available to Air Calabria.

Exercise 10.15

Suggested Solution:

3

Other qualitative factors that Air Calabria should consider in coming to a decision are:

a The lower risk from chartering its plane relative to the uncertainties regarding the number of passengers it might get on its scheduled flights.

b Chartering to Cima-Rosa means that Air Calabria would not have a regular schedule of flights each week. This arrangement could cause inconvenience to some of its passengers.

c The stability of the relationship between Air Calabria and Cima-Rosa. If this is not a long-term arrangement, Air Calabria may lose current market share and not benefit from sustained charter revenues.

One-off special orders or special pricing decisions

- Special pricing decisions relate to pricing decisions outside the main market. Typically, they involve one time only orders or orders at a price below the prevailing market price.
- Basic guideline: variable costs are relevant. Price should exceed per unit variable costs (and if any relevant fixed cost).

- Example:
  - ABC manufactures quality bath towels at its highly automated Heidelberg plant. The plant has a production capacity of 48 000 towels each month.
  - Current monthly production is 30 000 towels. Retail department stores account for all existing sales.
  - Expected results for the coming month (August) are (Note that these amounts are predictions.):

Budgeted income statement for August, absorption-costing format for Huber GmbH		
	Total	Per unit
Sales (30 000 towels x € 20)	€ 600 000	€ 20
Cost of goods sold	€ 360 000	€ 12
Gross margin (gross profit)	€ 240 000	€ 8
Marketing costs	€ 210 000	€ 7
Operating profit	€ 30 000	€ 1

One-off special orders or special pricing decisions

- The manufacturing costs per unit of €12 consist of direct materials €6 (all variable), direct manufacturing labour €2 (€0,50 of which is variable), and manufacturing overhead €4 (€1 of which is variable).
- The marketing costs per unit are €7 (€5 of which is variable). Huber ABC has no R&D costs or product-design costs. Marketing costs include distribution costs and customer-service costs.
- A luxury hotel chain offers to buy 5000 towels per month at €11 a towel for each of the next three months. No subsequent sales to this customer are anticipated. No marketing costs will be necessary for the 5000-unit one-off special order. The acceptance of this special order is not expected to affect the selling price or the quantity of towels sold to regular customers.

- **Should ABC accept the hotel chain's offer?**

One-off special orders or special pricing decisions

Comparative income statements for August, contribution income statement format for Huber GmbH				
	Without one-off special order 30 000 units		With one-off special order, 35 000 units	Difference, 5000 units
	per unit	Total	Total	Total
Sales	€20.00	€600000	€655000	€55000‡
Variable costs				
Manufacturing	7.50*	225000	262500	37500§
Marketing	5.00	150 000	150 000	-#
Total variable costs	12.50	375 000	412 500	37 500
Contribution margin	7.50	225 000	242 500	17 500
Fixed costs				
Manufacturing	4.50†	135 000	135 000	-#
Marketing	2.00	60 000	60 000	-#
Total fixed costs	6.50	195 000	195 000	-
Operating profit	€1.00	€30 000	€47 500	€17 500

* Variable manufacturing costs =direct materials, €6 + direct manufacturing labour, €0,50 + manufacturing overhead, €1 = €7.50

One-off special orders or special pricing decisions

- Therefore:
  - The relevant costs are the expected future costs that differ between the alternatives – the variable manufacturing costs of €37 500 (€7.50 per unit x 5000 units).
  - The fixed manufacturing costs and all marketing costs (including variable marketing costs) are irrelevant in this case; they will not change in total whether or not the special order is accepted.
  - Therefore, the only relevant items here are sales revenues and variable manufacturing costs. Given the €11 relevant revenue per unit (the special-order price) and the €7.50 relevant costs per unit. Huber would gain an additional €17 500 [(€ 11.00 - €7.50) x 5000] in operating profit per month by accepting the special order.

Exercise 10.23

Fri-Flask specialises in the manufacture of one-litre plastic bottles. The plastic moulding machines are capable of producing 100 bottles per hour. The firm estimates that the variable cost of producing a plastic bottle is 25 ore. The bottles are sold for 55 ore each.

Management has been approached by a local toy company that would like the firm to produce a moulded plastic toy for them. The toy company is willing to pay DKr 3.00 per unit for the toy. The unit variable cost to manufacture the toy will be DKr 2.40. In addition, Fri-Flask would have to incur a cost of DKr 20 000 to construct the mould required exclusively for this order. Because the toy uses more plastic and is of a more intricate shape than a bottle, a moulding machine can produce only 40 units per hour. The customer wants 100 000 units. Assume that Fri-Flask has a total capacity of 10 000 machine-hours available during the period in which the toy company wants delivery of the toys. The firm's fixed costs, excluding the costs to construct the toy mould, during the same period will be DKr 200 000.

Exercise 10.23

Required:

1 Suppose the demand for its bottles is 750 000 units, and the special toy order has to be either taken in full or rejected totally. Should Fri-Flask accept the special toy? Explain your answer.

2 Suppose the demand for its bottles is 850 000 units, and the special toy order has to be either taken in full or rejected totally. Should Fri-Flask accept the special toy order? Explain your answer.

3 Suppose the demand for its bottles is 850 000 units, and Fri-Flask can accept any quantity of the special toy order. How many bottles and toys should it manufacture?

4 Suppose the demand for its bottles is 900 000 units, and the special toy order has to be either taken in full or rejected totally. Should Fri-Flask accept the special toy order? Explain your answer.

5 Suppose the demand for its bottles is 900 000 units, and Fri-Flask can accept any quantity of the special toy order. How many bottles and toys should it manufacture?

6 Suppose the demand for its bottles is 950 000 units and Fri-Flask can accept any quantity of the special toy order. How many bottles and toys should it manufacture?

Exercise 10.23

Required:

1 Suppose the demand for its bottles is 750 000 units, and the special toy order has to be either taken in full or rejected totally. Should Fri-Flask accept the special toy? Explain your answer.

2 Suppose the demand for its bottles is 850 000 units, and the special toy order has to be either taken in full or rejected totally. Should Fri-Flask accept the special toy order? Explain your answer.

3 Suppose the demand for its bottles is 850 000 units, and Fri-Flask can accept any quantity of the special toy order. How many bottles and toys should it manufacture?

4 Suppose the demand for its bottles is 900 000 units, and the special toy order has to be either taken in full or rejected totally. Should Fri-Flask accept the special toy order? Explain your answer.

5 Suppose the demand for its bottles is 900 000 units, and Fri-Flask can accept any quantity of the special toy order. How many bottles and toys should it manufacture?

6 Suppose the demand for its bottles is 950 000 units and Fri-Flask can accept any quantity of the special toy order. How many bottles and toys should it manufacture?

Exercise 10.23

Suggested solution:

1 Time spent on manufacturing bottles $= \frac{750\,000 \text{ bottles}}{100 \text{ bottles per hour}} = 7500$ hours

So, 10 000 - 7 500 = 2 500 hours available for toys.

The moulded plastic toy requires $\frac{100\,000 \text{ units}}{40} = 2500$ hours, so Fri-Flask has enough capacity to accept the toys order. Additional income from accepting the order is:

Revenue DKr3.00 x 100000	DKr300000
Variable costs 2.40 x 100000	240000
Contribution margin	60000
Fixed costs	20000
Additional income	DKr40000

So, Fri-Flask should accept the order since it has enough excess capacity to make the 100 000 toys.

2 Time spent on manufacturing bottles $= \frac{850\,000}{100} = 8500$ hours

So 10 000 - 8500 = 1500 hours available for toys.

From requirement (1) moulded plastic toy requires 2500 hours and generates DKr40000 in operating income.

So if the toy order is accepted, 1000 hours (2500 hours required - 1500 hours available) of bottle making will be forgone, equal to 100 000 bottles (100 bottles/hr x 1 000 hrs).

Operating income from accepting	DKr40 000
Forgone contribution margin (100000 bottles x DKr0.30)	30000
Increase in operating income	DKr10 000

So, Fri-Flask should accept the special order.

Exercise 10.23

Suggested solution:

3 Without considering the fixed costs of the toy mould, the contribution per machine-hour of the constrained resource for bottles and the special toy are as follows:

	Bottles	Toys
Contribution margin per unit	DKr0.30	DKr0.60
Multiplied by units made in 1 machine-hour	100	40
Contribution margin per machine-hour	DKr30	DKr24

This suggests that Fri-Flask should make as many bottles as it can rather than the special toys because bottles generate a higher contribution margin per machine-hour.
So if Fri-Flask used the 1 500 hours available to it for making toys after using the 8 500 hours to make bottles, it would be able to make 1 500 x 40 = 60 000 toys and earn operating income of:

Contribution margin 60000 x DKr0.60	DKr36000
Fixed mould costs	20 000
Increase in operating income	DKrl6 000

The contribution margin earned covers the fixed costs of the mould, so Fri-Flask should make 850000 bottles and 60000 toys.

Exercise 10.23

Suggested solution:

4 Time spent on manufacturing bottles = $\frac{900\,000}{100}$ = 9000 hours

So, 10 000 – 9 000 = 1 000 hours available for toys.

So, if the toy order is accepted, then 1 500 hours (2 500 hours required – 1 000 hours available) of bottle capacity will be forgone = 150 000 bottles

Contribution from accepting toy offer	DKr40 000
Forgone profits on bottles 150000 x DKr0.30	(45 000)
Increase (decrease) in operating income	DKr (5 000)

So, *reject* the special order.

5 As in requirement (3), Fri-Flask should first use the 9 000 hours to make bottles and then consider using the 1 000 hours available to it for making toys. It would be able to make 1 000 hours x 40 = 40 000 toys and earn operating income of:

Contribution margin 40000 x DKr0.60	DKr24 000
Fixed mould costs	20000
Increase in Operating income	DKr 4 000

Fri-Flask should make 900 000 bottles and 40 000 toys.

Exercise 10.23

Suggested solution:

6 As in requirements (3) and (5), Fri-Flask should first use 9 500 hours to make bottles and then consider using the 500 hours available to it for making toys. It would be able to make 500 hours x 40 = 20 000 toys and earn operating income of

Contribution margin 20 000 x DKr0.60	DKrl2 000
Fixed mould costs	20000
Increase (decrease) in operating income	DKr (8 000)

So, Fri-Flask should refuse to make any plastic toys. If it tried to make the toy product more profitable by making more toys, it would have to give up the plastic bottles. This trade-off is not worthwhile because Fri-Flask makes DKr24 per hour from the toys and would lose DKr30 per hour from the plastic bottles.

Product-mix decisions under capacity constraints

- In the short-term sales demand may be in excess of current productive capacity. For example, output may be restricted by a shortage of skilled labour, materials, equipment, or space.
- When sales demand is in excess of a company's productive capacity, the resources responsible for limiting the output should be identified. These scarce resources are known as limiting factors.
- Within a short-term time period it is unlikely that constraints can be removed and additional resources acquired.
- Where limiting factors apply profit is maximized when the greatest possible contribution to profit is obtained each time the scarce or limiting factor is used.

Product-mix decisions under capacity constraints

- Assume the following:

	Snowmobile engine	Boat engine
Selling price	€800	€1000
Variable costs per unit	560	625
Contribution margin per unit	€240	€375
Contribution margin ratio	30%	37,5%

- At first glance, boat engines appear more profitable than snowmobile engines.
- The product to be emphasized, however, is not necessarily the product with the higher individual contribution margin per unit or contribution margin percentage.
- Rather, managers should aim for the **highest contribution margin per unit of the constraining factor**- that is, the scarce, limiting or critical factor.

Product-mix decisions under capacity constraints

- Assume that only 600 machine-hours are available daily for assembling engines. Additional capacity cannot be obtained in the short run.
- The constraining factor, then, is machine-hours. It takes 2 machine-hours to produce one snowmobile engine and 5 machine-hours to produce one boat engine.

	Snowmobile engine	Boat engine
Contribution margin per engine	€240	€375
Machine-hours required to produce one engine	2 machine-hours	5 machine-hours
Contribution margin per machine-hour (240 ÷2; 375 ÷5)	€120	€75
Total contribution margin for 600 machine-hours (€120 x 600; €75 x 600)	€72 000	€45 000

- Producing snowmobile engines contributes more margin per machine-hour, which is the constraining factor in this example. Therefore, choosing to emphasize snowmobile engines is the correct decision.

Exercise 9.15

A company manufactures three products, X, Y and Z. The sales demand and the standard unit selling prices and costs for the next accounting period, period 1, are estimated as follows:

	X	Y	Z
Maximum demand (000 units)	4.0 $ per unit	5.5 $ per unit	7.0 $ per unit
Selling price	28	22	30
Variable costs:			
Raw materials ($1 per kg)	5	4	6
Direct labour ($12 per hour)	12	9	18

Required:

1. Determine the limiting factor, If supplies in period 1 are restricted to 90 000 kg of raw material and 18 000 hours of direct labour.
2. In period 2 the company will have a shortage of raw materials, but no other resources will be restricted. The standard selling prices and costs and the level of demand will remain unchanged. In what order should the materials be allocated to the products if the company wants to maximize profit?

Exercise 9.15

Suggested solution:

1.

	X	Y	Z	Total
Demand (units)	4 000	5 500	7 000	
Materials (kg)	20 000	22 000	42 000	84 000
Labour (hours)	4 000	4 125	10 500	18 625

Labour is the limiting factor.

2.

	X	Y	Z
	$	$	$
Selling price	28	22	30
Variable cost	17	13	24
Contribution	11	9	6
kg	5	4	6
Contribution per kg ($)	2.20	2.25	1
Ranking	2	1	3

Outsourcing and make-or-buy decisions

- Outsourcing is the process of obtaining goods or services from outside suppliers instead of producing the same goods or providing the same services within the organization.
- Decisions on whether to produce components or provide services within the organization or to acquire them from outside suppliers, are called outsourcing or 'make or buy' decisions.
- Outsourcing is an increasingly common practice.
- Decisions about whether a producer of goods or services will insource or outsource are also called make-or-buy decisions. Sometimes qualitative factors dictate management's make-or-buy decision.
- Algorithm:
  - Identify the new variable costs that we would incur if we outsource.
  - Identify the variable costs that would disappear if we outsource.
  - Identify the fixed costs that we could avoid if we outsource.

Outsourcing and make-or-buy decisions

- Thor Co. manufactures 20,000 of part 457 that is currently used in one of its products. The costs to make this part are:

Direct materials per unit	$ 9,00
Direct labor per unit	5,00
Variable overhead per unit	1,00
Fixed overhead	180.000
Allocated common costs	100.000

- Fixed manufacturing overhead is the cost of leasing and operating the equipment necessary to produce part 457.
- Thor Co. manufactures 20,000 of part 457 that is currently used in one of its products. The costs per unit to make this part are:

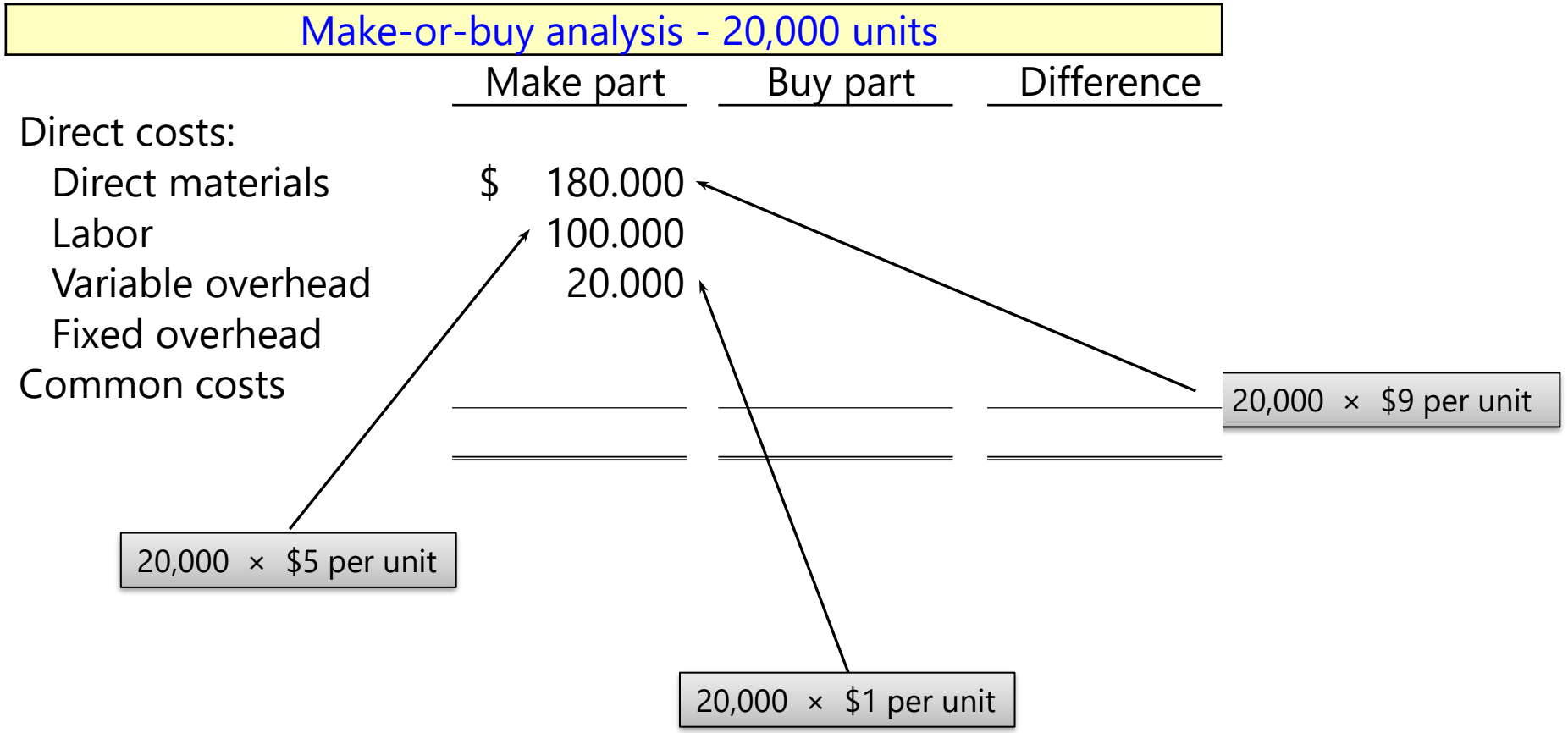
Direct materials	$ 9,00
Direct labor	5,00
Variable overhead	1,00
Fixed overhead ($180,000 ÷ 20,000)	9,00
Common costs ($100,000 ÷ 20,000)	5,00
Unit cost	$ 29,00

Outsourcing and make-or-buy decisions

- Common costs are allocated on the basis of direct labor hours.
- Total unit cost of $29 is based on 20,000 parts produced each year.
- An outside supplier has offered to provide the 20,000 parts at a cost of $25 per part.

- Should we accept the supplier's offer?

Outsourcing and make-or-buy decisions



Outsourcing and make-or-buy decisions

Make-or-buy analysis - 20,000 units			
	Make part	Buy part	Difference
Direct costs:			
Direct materials	$ 180.000		
Labor	100.000		
Variable overhead	20.000		
Fixed overhead	180.000		
Common costs	100.000		
	$ 580.000		

20,000 × $29 per unit

Outsourcing and make-or-buy decisions

Make-or-buy analysis - 20,000 units

	Make part	Buy part	Difference
Direct costs:			
Direct materials	$ 180.000	$ 500.000	$ 320.000
Labor	100.000		(100.000)
Variable overhead	20.000		(20.000)
Fixed overhead	180.000		(180.000)
Common costs	100.000	100.000	-
	$ 580.000	$ 600.000	$ 20.000

20,000 × $25 purchase price

The common costs remain unchanged.

Outsourcing and make-or-buy decisions

Make-or-buy analysis - 20,000 units			
	Make part	Buy part	Difference
Direct costs:			
Direct materials	$ 180.000	$ 500.000	$ 320.000
Labor	100.000		(100.000)
Variable overhead	20.000		(20.000)
Fixed overhead	180.000		(180.000)
Common costs	100.000	100.000	-
	$ 580.000	$ 600.000	$ 20.000

Should we make or buy part 457?

What is the relevant unit cost of making part 457?
Relevant costs are costs to be incurred at some future time and that differ for each option available to the decision maker.

Direct materials	$ 9,00
Direct labor	5,00
Variable overhead	1,00
Fixed overhead ($180,000 ÷ 20,000)	9,00
Total relevant unit cost	$24,00

Advantage of making
20,000 units × ($25.00 – $24.00) = $20,000

Outsourcing and make-or-buy decisions

If Thor could use the space currently being used to make Part 457 for another purpose, resulting in a cost savings of $45,000, would you change your decision?

Yes. The cost savings of $45,000 overcomes the $20,000 disadvantage of buying.
Now there is a $25,000 advantage to buying.

The real issue is the most profitable use of the space.

Exercises 9.23

WZ is a manufacturing company with two factories. The company's West factory currently produces a number of products. Four of these products use differing quantities of the same resources. Details of these four products and their resource requirements are as follows:

	J	K	L	M
Product	$/unit	$/unit	$/unit	$/unit
Selling price	56	40	78	96
Direct labour ($8 per hour)	20	16	24	20
Direct material A ($3 per litre)	6	3	0	9
Direct material B ($5 per kg)	10	0	15	20
Variable overhead (see note 1)				
Labour related	1.25	1	1.50	1.25
Machine related	1.25	2	0.75	1
Total variable cost	38.50	22	41.25	51.25
Other data:				
Machine hours per unit	5	8	3	4
Maximum demand per week	1 000	3 500	2 800	4 500

Exercises 9.23

Notes:

1 An analyses of the variable overhead shows that some of it is caused by the number of labour hours and the remainder is caused by the number of machine hours.

2 Currently WZ purchases a component P from an external supplier for $35 per component. A single unit of this component is used in producing N the company's only other product. Product N is produced in WZ's other factory and does not use any of the resources identified above. Product N currently yields a positive contribution. WZ could manufacture the component in its West factory, but to do so would require: 1 hour of direct labour, 0.5 machine hours, and 2 kgs of direct material B. WZ purchases 500 components per week. WZ could not produce the component in its other factory.

3 The purchasing director has recently advised you that the availability of direct materials A and B is to be restricted to 21 000 litres and 24 000 kgs per week respectively. This restriction is unlikely to change for at least 10 weeks. No restrictions aree expected on any other resources.

4 WZ does not hold inventory of either finished goods or raw materials.

5 WZ has already signed a contract, which must be fulfilled, to deliver the following units of its products each week for the next 10 weeks:

Product	Contract units
J	100
K	200
L	150
M	250

These quantities are in addition to the maximum demand identified above.

Exercises 9.23

Required:

1. Calculate whether WZ should continue to purchase the component P or whether it should manufacture it internally during the next 10 weeks.

Suggested solution:

1.

If all of the resources required to produce component P are readily available the relevant costs will be as follows:

	$/unit
Direct labour (1 hour @ $8/hour)	8.00
Direct material B (2kgs @ $5/kg)	10.00
Variable overhead (working 1):	
Direct labour (1 hour @ $0.50 / hour)	0.50
Machine hours (0.5 hours @ $0.25 / hour)	0.125
	18.625

Exercises 9.23

Suggested solution:

1.

W1 Product J requires 2.5 labour hours ($20/$8) so the labour related variable overhead rate is $0.50 per hour ($1.25/2.5 hours). Product J also requires 1.5 machine hours giving a machine related variable overhead rate of $0.25 per hour ($1.25/5 machine hours).

Assuming that all of the above resources are readily available the relevant cost of producing component P is less than the purchase price so the component should be produced internally. However, both materials A and B will be in scarce supply over the next 10 weeks so it is necessary to examine how this will influence the optimum production programme of WZ. The following schedule compares the kg required to meet the planned production programme compared with the availability of materials:

Resource	Available	Total	J	K	L	M	Total
Direct material A	21 000	20 150	2 200	3 700	0	14 250	0
Direct material B	24 000	31 050	2 200	0	8 850	19 000	1 000

Note that the above schedule is based on the maximum weekly demand plus existing contractual commitments. Material B is a binding constraint so the optimal production programme should be determined based on the ranking per unit of limiting factor (kg of material B).

Exercises 9.23

Suggested solution:

	J	L	M	P
	$	$	$	$
Selling price / buying cost	56	78	96	35
Direct labour	20	24	20	8
Material A	6	0	9	0
Material B	10	15	20	10
Overhead:				
Labour	1.25	1.50	1.25	0.50
Machinery	1.25	0.75	1	0.125
Contribution	17.50	36.75	44.75	16.375
Contribution /kg of material B	8.75	12.25	11.19	8.19
Rank	3	1	2	4

Note that product K is not included in the above ranking because it does not use material B. Therefore, product K can be produced to meet maximum demand. Since the component is the lowest ranked usage of material B then WZ should continue to purchase the component so that the available resources can be used to manufacture products L, M and J.

Customer profitability and relevant costs

- In addition to making choices among products, companies must often decide whether they should add some customers and drop others.
- This section illustrates relevant-revenue and relevant-cost analysis when different cost drivers are identified for different activities.
- The cost object is customers.
- Example: Assume that the analysis refers on customer profitability at Imbro-Glio, the Naples sales office of Papa-Geno Srl, a whole-saler of specialized furniture.

Customer profitability and relevant costs

	Lucrezia	Borgia	Rigo-Letto	Total
Sales	€500 000	€300 000	€400 000	€1 200 000
Cost of goods sold	370 000	220 000	330 000	920 000
Materials handling labour	41 000	18 000	33 000	92 000
Materials handling equipment cost written off as depreciation	10 000	6 000	8 000	24 000
Rent	14 000	8 000	14 000	36 000
Marketing support	11 000	9 000	10 000	30 000
Purchase orders and delivery processing	13 000	7 000	12 000	32 000
General administration	20 000	12 000	16 000	48 000
Total operating costs	479 000	280 000	423 000	1 182 000
Operating profit	€21 000	€20 000	€(23 000)	€18 000

Drop the costumer (because of loss)?

Customer profitability and relevant costs

- The key question is: What are the relevant costs and relevant revenues?
- The following information about the effect of reducing various activities related to the Rigo-Letto account is available.
  - Dropping the Rigo-Letto account will save cost of goods sold, materials handling labour, marketing support, purchase-order and delivery processing costs incurred on the Rigo-Letto account.
  - Dropping the Rigo-Letto account will mean that the warehouse space currently occupied by products for Rigo-Letto and the materials handling equipment used to move them will become idle.
  - Dropping the Rigo-Letto account will have no effect on fixed general administration costs.

Customer profitability and relevant costs

	Amount of total revenues and total costs		Difference: incremental (loss in revenue) and savings in costs from dropping Rigo-Letto account
	Keep Rigo-Letto account	Drop Rigo-Letto account	
Sales	€1 200 000	€800 000	€(400 000)
Cost of goods sold	920 000	590 000	330 000
Materials handling labour	92 000	59 000	33 000
Materials handling equipment cost written off as depreciation	24 000	24 000	0
Rent	36 000	36 000	0
Marketing support	30 000	20 000	10 000
Purchase orders and delivery processing	32 000	20 000	12 000
General administration	48 000	48 000	0
Total operating costs	118 200	797 000	385 000
Operating profit (loss)	€18 000	€3 000	€(15 000)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