THIS IS THE SECOND OF TWO ARTICLES ON THE SUBJECT OF LIMITING FACTOR ANALYSIS, WHICH IS PART OF SECTION 17 OF THE CAT PAPER 4 *STUDY GUIDE*. THE FIRST ARTICLE WAS PUBLISHED IN THE ISSUE 01/2010 EDITION OF *STUDENT ACCOUNTANT*.

LIMITING FACTOR

RELEVANT TO CAT PAPER 4

This is the second of two articles on the subject of limiting factor analysis, which is part of Section 17 of the CAT Paper 4 *Study Guide*. The first article was published in Issue 01/2010 of *Student Accountant*.

The first article covered the limiting factor situation when the availability of a key resource is insufficient to satisfy sales demand (17c in the *Study Guide*). The problem was solved by establishing the mix of products to manufacture and sell that would best utilise the limited resource available. This was based on the contribution that each product made per unit of the scarce resource on the assumption that such situations are short-term problems and the objective is to maximise profit.

This second article covers the limiting factor situation where, once again, the availability of a key resource is insufficient to satisfy sales demand but where the resource limitation can be overcome by buying in components/products from another manufacturer (17d in the *Study Guide*). This problem is solved by minimising the incremental costs incurred in buying in sufficient components/products for the business to satisfy its sales demand. This is based on the difference in costs for each component/product (bought-in price versus variable costs of in-house manufacture) per unit of the scarce resource consumed in manufacture. This is again based on the assumption that such situations are short-term problems and the objective is to maximise profit.

Question 1 (Section B) from the June 2009 CAT Paper 4 exam will be used to illustrate the solution to this problem. The question was not generally well-answered by candidates. The examiner's comments will be considered after the question and solution.

Question 1, June 2009

Company XYZ produces two components (C1 and C2) and is planning the allocation of its available resources for the next period.

75 units of component C1 and 60 units of component C2 are required to be produced but machine hour capacity is restricted to a total of 300 hours. Any deficit of components produced in-house can be made up by the purchase of any quantity of either component from an outside supplier. The objective of Company XYZ is to satisfy the requirement for components at minimum total cost.

The following information is available concerning each component:

	Component C1	Component C2
Costs ($ per unit):		
Direct materials	6.20	8.70
Direct labour	5.10	7.50
Variable production overheads	1.20	1.30
Fixed production overheads	4.80	6.40
	17.30	23.90
Machine hours (per unit)	2.0	3.0
Price from outside supplier ($ per unit)	18.50	25.90

Required:
For the next period:

(a) Calculate the variable costs of producing each component in-house.

(b) Calculate the extra costs of buying in each component.

(c) Determine which component should have production priority. Show workings clearly and justify your conclusion.

(d) Calculate the number of units of each component that should be manufactured by Company XYZ.

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ANALYSIS: PT 2

Approach

As there is more than one component that uses the scarce machine resource, the approach to determining the optimal production plan, and the purchase requirements for components, is as follows:

1 Identify the scarce resource (limiting factor).
2 Establish the units of the scarce resource used by each component.
3 Calculate the variable production costs per unit of each component.
NB As stated earlier, it is assumed that the allocation of available resources is a short-term decision with the objective of minimising total cost (made clear in the question) and as a result maximising total profit. As such, total fixed costs can be assumed to be unaffected by the component mix and thus irrelevant to the decision.
4 Calculate the extra costs per unit of buying in (savings from in-house manufacture), ie the price of each component from the outside supplier in comparison with the variable costs of in-house manufacture.
NB Unless instructed otherwise in an exam, it should be assumed that it is a short-term problem and that total fixed costs will be unaffected by the resource allocation decision.
5 Calculate the extra costs of buying in each component (savings from in-house manufacture) per unit of the scarce resource used in manufacture.
NB It can only be by prioritising the allocation of manufacturing resources, to those components that save the most costs for each unit of the key resource consumed, that total costs will be minimised and total profit maximised.
6 Establish production priority by ranking components according to the extra cost of buying in (savings from in-house manufacture).
7 Allocate the available scarce resource according to the ranking.

UNLIKE QUESTION 4 FROM THE JUNE 2008 CAT PAPER 4 EXAM, QUESTION 1 FROM THE JUNE 2009 PAPER BREAKS THE REQUIREMENT DOWN INTO SEVERAL OF THE ABOVE STAGES FOR THE BENEFIT OF CANDIDATES.

Solution

Unlike Question 4 from the June 2008 CAT Paper 4 exam, which was used to illustrate the limiting factor problem dealt with in the previous article, Question 1 from the June 2009 paper breaks the requirement down into several of the above stages for the benefit of candidates. The following solution goes through each of the seven stages of the above approach to provide the answers to the four-part question:

1 Limiting factor
It is already clear from the question that the restriction on machine hour capacity is the limiting factor, ie it will be insufficient to meet the requirements for components and as a consequence some components will have to be bought in from an outside supplier to fulfill those requirements. To prove the fact (because such calculations may be required in answer to other such questions), the total machine hours required to achieve the requirements for components are:

Component C1	2.0 machine hours per unit × 75 units =	150 machine hours
Component C2	3.0 machine hours per unit × 60 units =	180 machine hours
		330 machine hours

Machine hours available are 30 less (300 - 330) than those required and components will have to be bought in so as to meet the total requirements for components.

2 Units of the scarce resource used by each component
This is given in the question (and already used in stage 1 above) as Component C1, 2.0 machine hours per unit and Component C2, 3.0 machine hours per unit.

3 Variable production costs per unit of component:
Component C1 $12.50 per unit (6.20 + 5.10 + 1.20)
Component C2 $17.50 per unit (8.70 + 7.50 + 1.30)

4 Extra costs of buying in (savings from in-house manufacture):

	Component C1 ($ per unit)	Component C2 ($ per unit)
Price from outside supplier	18.50	25.90
Variable costs of in-house manufacture	12.50	17.50
	6.00	8.40

5 Extra costs of buying in (savings from in-house manufacture) per unit of scarce resource:
Component C1 $6.00/unit ÷ 2.0 m/c hrs/unit = $3.00 per machine hour
Component C2 $8.40/unit ÷ 3.0 m/c hrs/unit = $2.80 per machine hour

THOSE CANDIDATES WHO CORRECTLY IDENTIFIED THE PROBLEM AND THE METHOD OF SOLUTION SCORED VERY HIGH MARKS BUT OVERALL THIS WAS THE WORST ANSWERED QUESTION IN SECTION B OF THE EXAM PAPER BECAUSE A SIGNIFICANT MAJORITY OF CANDIDATES WERE UNABLE TO TACKLE THE PROBLEM.

6 Production priority
On the basis of the extra costs of buying in (savings from in-house manufacture), Component C1 should have manufacturing priority because more cost is saved per unit of the scare resource consumed compared with Component C2. It should be noted that the priority, in this example, is different from that indicated by using (incorrectly) the extra costs per unit of component. This would have indicated that Component C2 should have production priority (saving $8.40 per unit which is more than Component C1, $6.00). Although Component C2 has a higher saving per unit of component than C1 from in-house manufacture, it consumes disproportionately more machine hours to achieve it.

7 Allocate the scarce resource
The scarce resource of machine hours needs to be allocated according to the production priority established in stage 6 above. 75 units of Component C1 will be manufactured and the balance of machine hours available will be used to manufacture Component C2 with the balance of the requirements for Component C2 bought in. Thus:
Component C1 150 machine hours (from stage 1 above) 75 units
Component C2 150 machine hours 50 units (150 hours ÷ 3.0 hours/unit)
300 machine hours

Only 50 units of Component C2 (out of the 60 units required) can be manufactured with the remaining manufacturing capacity.

The production plan of 75 units of Component C1 and 50 units of Component C2 would minimise total costs (and as a consequence maximise total profit).

The alternative approach, to determining the component units to be manufactured, would have been to establish the bought-in requirements and from that to establish the production plan. As 30 extra machine hours are required (see stage 1 above) this would require 10 units of Component C2 to be bought in (30 m/c hrs ÷ 3 m/c hrs/unit) leaving a production plan of 75 units of Component C1 and 50 units of Component C2 (60 - 10).

Examiner's comments on candidates' performance

Those candidates who correctly identified the problem and the method of solution scored very high marks but overall this was the worst answered question in Section B of the exam paper because a significant majority of candidates were unable to tackle the problem.

In answer to Part (a), one or other of the following were very common:

(i) variable production overheads only (ie no prime costs)

(ii) total production costs (ie including fixed production overheads as well as variable production costs).

VERY FEW CANDIDATES WERE ABLE TO ANSWER PART (C) ADEQUATELY. A NUMBER OF CANDIDATES INCORRECTLY TREATED THE BOUGHT-IN COST AS A SELLING PRICE AND INVENTED A CONTRIBUTION (SELLING PRICE - VARIABLE COSTS) PER MACHINE HOUR.

In answer to Part (b), candidates at times calculated the total costs of buying in all of the component requirements rather than the extra costs.

Very few candidates were able to answer Part (c) adequately. A number of candidates incorrectly treated the bought-in cost as a selling price and invented a contribution (selling price - variable costs) per machine hour. This was effectively trying to treat it as the first type of limiting factor problem that was covered in Part 1 of this article. Overall, candidates rarely understood the importance of machine hours and were rarely able to justify their chosen production priority.

Part (d) was answered reasonably well overall where answers were based on candidates' own figures and own conclusions from Part (c). However, a number of candidates provided answers with no regard to the machine hours available and/or to the maximum requirements for each component.

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