QUESTION

(a) A retailer purchases animal feed from a supplier, which it then sells to farms. The purchase price for the feed is £5 per kilogram. However, a discount of 5% is given if an order of at least 2 000 kilograms is placed with the supplier. Alternatively, a discount of 10% is given if an order of at least 3000 kilograms is placed.

Demand for the feed is steady, and the annual demand is 27 000 kilograms. The cost of placing an order with the supplier is £80, and the cost of holding the feed in stock is £12 per kilogram per annum.

The retailer owns a storage facility that can store up to 500 kilograms of feed. Moreover, the retailer can hire additional storage units at an annual cost of £1 000 per unit. Each additional unit can hold up to 500 kilograms of feed.

Analyze the strategy that the retailer should follow regarding its ordering of feed from the supplier and the hiring of additional storage units.

(a) Consider the planning of production over four time periods for which the demand is given in the following table.

Period	1	2	3	4
Demand	60	40	20	30

The initial stock level is zero. A set-up cost of £100 is incurred for each period in which there is production. The stock holding cost is £2 per unit of stock held at the end of each period. The objective is to schedule production so that demand is met at minimum cost.

Formulate the problem of finding the minimum cost as a shortest path problem in a network, and hence determine *all* optimal production schedules.

ANSWER

(a) The cost per annum is

$$K = \frac{sd}{Q} + \frac{1}{2}hQ + cd\left(1 - \frac{\text{discount}}{100}\right) + 1000n$$

where n is the number of storage units hired.

The EOQ value is

$$Q = \sqrt{\frac{2sd}{h}} = \sqrt{\frac{2.80.27000}{12}} = 600$$

For $Q = 600$

$$K = 3600 + 3600 + 135000 + 1000 = 143200$$

It may be cheaper not to hire one of the storage units.

For $Q = 500$

$$K = 4320 + 3000 + 135000 = 142320$$

It is worthwhile to check if the 5% or 10% discount should be obtained.

For $K = 2000$

$$K = 1080 + 12000 + 128250 + 3000 = 144330$$

For $K = 3000$

$$K = 720 + 18000 + 121500 + 5000 = 145220$$

Comparing the costs, the optimal strategy is to order 500 units and not hire any additional storage.

(b) We first evaluate the cost for the possible decisions.

$Q_1 =$	60	100
	100	100+80
	120	100+120+40
	150	100+180+100+60
$Q_2 =$	40	100
	60	100+40
	90	100+100+60
$Q_3 =$	20	100
	50	100+60
$Q_4 =$	30	100

The network is therefore as follows.

DIAGRAM

There are two shortest paths, 0 - 2 - 4 and 0 - 1 - 3 - 4, giving production plans

δ	1	2	3	4
Q_j	100	0	50	0

δ	1	2	3	4
Q_j	60	60	0	30