Question (EOQ, positive lead time, shortages, production lot sizing): A retailer faces an annual demand for 2,400,000 shirts with the “Hubba Bubba Man” logo. It costs $450 to place a single order & the costs for keeping a single shirt in stock for an entire year are 60¢.

(a) How many units should the retailer order each time an order is placed & what are the associated costs?

(b) Given the result under (a), how many orders should be placed and what is the time between two consecutive orders (given a 360-day-year)? What is the reorder point if the lead time were 20 days?

(c) Assume now that it is possible to allow shortages, given that the portion of the demand that cannot immediately be satisfied will be satisfied immediately after the next shipment arrives. It has been estimated that the associated loss of goodwill equals costs of 80¢ per shirt & year. Compute the order quantity, the maximum shortage, & the associated costs.

(d) What would happen to the results in (c) if the unit shortage costs were to increase by, say, 10¢? Explain in one short sentence, indicating the reason why. Calculations are not required.

(e) Suppose now that the retailer were to purchase the equipment to make the shirts in-house. The machine is capable of making 10,000 shirts per day (again based on a 360-day-year). What is the number of shirts made in each production run? What are the total costs?

(f) How would the results under (e) change if the capacity of the machine under (e) were not 10,000 units per day but only 6,000? Explain in one short sentence. No calculations are necessary.

Solution: (a) \( D = 2,400,000 \), \( C_o = 450 \), \( C_h = 0.6 \), so that \( Q^* = 60,000 \) & \( TC^* = 36,000 \).

(b) Then \( N^* = 40 \) & \( t_c^* = 1/40 \) [years] = 9 [days]. Reorder point \( R = 20(2,400,000/360) - \left\lfloor \frac{20}{9} \right\rfloor 60,000 = 13,333.33 \).

(c) \( Q^* = 79,372.54 \) & \( S^* = 34,016.80 \). Costs \( TC = (holding \ costs) + (ordering \ costs) + (shortage \ costs) = 7,775.27 + 13,606.72 + 5,831.45 = 27,213.44 \).

(d) If \( c_s \) increases, shortages become more expensive, so that the order quantity \( Q^* \) & the maximum shortage \( S^* \) both decrease, while the total costs will increase.

(e) The regularity condition is satisfied. \( Q^* = 103,923.10 \) & \( TC^* = 10,392.30 + 10,392.30 = 20,784.60 \).

(f) The regularity condition is violated, i.e., the machine capacity is insufficient to satisfy the demand.