Case Study 1 - HealthCO Case

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Question 1

Scalpel blades: Most customers buy scalpel blades and Toni begins her analysis by examining this common SKU. The DC ships on average 341 boxes of this blade per day, typically 1 box per customer. The volatility is quite low, the standard deviation of demand being 38 boxes per day. A box of blades cost $20.

Q 1. a

Scalpel blades are bought from one supplier, who provides many other SKUs. The supplier ships daily. Any quantity can be ordered, but only multiples of full pallets (2400 boxes per pallet) receive the negotiated price, other quantities incur a 3% surcharge. If you assume no 'per order costs' (typical) and a capital/storage cost of 10%, what is the economic order quantity for this scalpel blade? What order quantity would you recommend?

Solution

Scenario A:

Total Order Calculation for Full Pallets Given: - Daily demand = 341 boxes, - Number of days in a year = 365, - Pallet size = 2400 boxes.

The annual demand is 341×365, and to avoid the surcharge, HealthCo decides to order in full pallets, rounding up to the nearest whole pallet.

$$\text{Total Annual Demand} = 341 \times 365$$

$$\text{Number of Pallets} = \left\lceil \frac{341 \times 365}{2400} \right\rceil = 52$$

Max Holding Cost for Ordering 52 Pallets at the Beginning of the Year For the maximum holding cost when ordering 52 pallets at the beginning of the year, assuming the cost of a box is $20 and the holding cost rate is 10%:

$$\text{Max Holding Cost} = \frac{124,800}{2} \times \$20 \times 10\% = \$124,800$$

Holding Cost for Ordering 1 Pallet Per Week With weekly orders of 1 pallet, the average inventory is half a pallet, and the holding cost for a week is calculated as:

$$\text{Weekly Holding Cost} = \frac{2400}{2} \times \$20 \times 10\% = \$2400$$

If we order 1 pallet per week, the holding cost should be $2400, so according to the calculation above, ordering 1 pallet per week would have the least holding cost(which is also the total cost, because no surcharge occurs).

Scenario B:

Assuming HealthCo places one order per day, to meet a 97% probability of demand with the standard deviation as the maximum daily demand, HealthCo orders 412 units each time and makes purchases 302 times a year.

This results in a surcharge fee of $247.2 per order, totaling $74,654.40 annually. However, the total holding cost amounts to $412.00, calculated based on an average inventory of 412 units and an annual holding cost of $2.00 per unit.

1. Surcharge Fee Per Order Calculation:

$$S = q \cdot C \cdot r = 412 \cdot \$20 \cdot 3\%$$

2. Total Surcharge Fee Annually:

$$T_S = S \cdot N = 412 \cdot \$20 \cdot 3\% \cdot 302$$

3. Total Holding Cost:

$$H = \text{Average Inventory} \cdot \text{Annual Holding Cost per Unit} = 412 \cdot \$2$$

4. Total Cost:

$$T_C = T_S + H = (412 \cdot \$20 \cdot 3\% \cdot 302) + (412 \cdot \$2)$$

Therefore, in scenario B, the total cost reaches $75,066.40.

So from the analysis above, we would prefer to order 52 pallets the whole year and put order on a weekly basis.

Q 1. b

Assuming that Toni is targeting a 98% cycle service level and that a replenishment orders can be filled within 7 days (an order can be placed any day of the week). What Is the resulting safety stock? What is the overall average inventory?

Solution

For this scenario, we're calculating the safety stock required to achieve a 98% cycle service level and then determining the overall average inventory, including the safety stock and the order quantity.

Safety Stock Calculation Given: - Z-score for 98% cycle service level = 2.05, - Standard deviation of daily demand (σ) = 38 boxes, - Lead time (LT) = 7 days.

The safety stock (SS) can be calculated using the formula:

$$SS = Z \times \sigma \times \sqrt{LT}$$

Substituting the given values:

$$SS = 2.05 \times 38 \times \sqrt{7} = 206$$

Overall Average Inventory Calculation To find the overall average inventory, we add the safety stock to half the order quantity (since the average inventory assumes half the order quantity is always in stock, on average, between orders).

Given the order quantity (Q) is 2400 boxes, the overall average inventory (AI) is:

$$AI = SS + \frac{Q}{2}$$

Substituting the values:

$$AI = 206 + \frac{2400}{2} = 1406$$

Q 1. c

At this point, HealthCo uses a standard strategy of '2 weeks safety stock' (this is still a very common approach). What percentage of inventory could HealthCo save for SKUs that behave like this scalpel blade?

Solution

Safety Stock Calculation for 2 Weeks Safety Stock Given: - Z-score for a specified cycle service level (CSL) = 2.05, - Standard deviation of daily demand (σ_d) = 38 boxes, - Lead time (L) = 14 days (for 2 weeks safety stock).

The safety stock (SS) is calculated as:

$$SS = Z \times \sigma_d \times \sqrt{L} = 2.05 \times 38 \times \sqrt{14} = 292 \text{units}$$

Overall Average Inventory Calculation The overall average inventory (AI) including the safety stock and half the order quantity is:

$$AI = SS + \frac{Q}{2} = 292 + \frac{2400}{2} = 1492 \text{units}$$

Percentage of Inventory Savings Calculation To find the percentage of inventory HealthCo could save for SKUs behaving like the scalpel blade, compared to the standard strategy, we use the formula:

$$\text{Percentage} = \frac{AI_{\text{standard}} - AI_{\text{scalpel blade}}}{AI_{\text{standard}}} \times 100\%$$

$$\text{Percentage} = \frac{1492 - 1406}{1492} \times 100\% = 5.8\%$$

Question 2

A special antimicrobial bandage has a demand of 614 units per month. They are sold individually or in boxes of 800 at a much lower price. The standard deviation is 810 per month. However, this item can be quickly replenished - within just one day!

Q 2. a

What does the standard formula suggest as the safety stock target for a 98% cycle service level?

Solution

Given Data - Monthly demand = 614 units, - Standard deviation of monthly demand (σ) = 810 units, - Service level = 98%, which corresponds to a Z-score of 2.05.

Safety Stock Calculation The safety stock (SS) is calculated by adjusting the standard deviation of demand for the lead time and multiplying by the Z-score for the desired service level. In this case, the lead time appears to be implied as 1 month for simplicity, and we normalize the standard deviation for a daily basis (assuming 30 days in a month) before applying the Z-score.

$$SS = Z \times \frac{\sigma}{\sqrt{30}} \times 1 = 2.05 \times \frac{810}{\sqrt{30}} \approx 2.05 \times 147.8 \approx 303$$

Q 2. b

What would the current IT system suggest at the standard 2 weeks of supply safety Stock?

Solution

Given Data - Standard deviation of monthly demand (σ) = 810 units, - Service level corresponding to a Z-score of 2.05, - The period of interest for safety stock calculation is 14 days.

Safety Stock Calculation The safety stock (SS) is calculated by first adjusting the standard deviation of demand to a daily basis (assuming 30 days in a month), and then scaling this daily standard deviation by the square root of the lead time in days (14 days), and applying the Z-score for the desired service level.

$$\begin{aligned} SS &= \left(\frac{\sigma}{\sqrt{30}}\right) \times \sqrt{14} \times Z \\ &= \left(\frac{810}{\sqrt{30}}\right) \times \sqrt{14} \times 2.05 \\ &= 1136 \end{aligned}$$

Q 2. c

Consider the Excel file that shows order data. What do you think is actually happening? What would you suggest that Toni analyze next?

Solution

The ordering pattern is inconsistent. There are months with high demand (March, July, October) and months with zero demand (February, April, May, August, September, November). This could indicate seasonality or irregular ordering patterns by the customer.

If we still apply the Q/R model, we may leave products at the warehouse for two months at most. So the holding cost increases and the excess inventory of spare parts will affect the use of the current fund.

So we think that Toni could not rely on the plain from standard deviation, but to look at the trend of sales, evaluating which month will have orders and to place order ahead.

Question 3

A custom surgery kit that has been designed by an orthopedic surgeon is ordered 3 times per year. Custom surgery kits are assembled from standard parts in a sub-operation with a lead time of 1 week. How should Toni manage and optimize this inventory?

Solution

The custom surgery kit is ordered 3 times per year only, so Toni needs to increase Q, which determines how frequently you order, and R, which determines the 'bottom of the sawtooth'.

Applying the simulation of the Q/R model, we adjust parameters to simulate the R/Q model inventory.

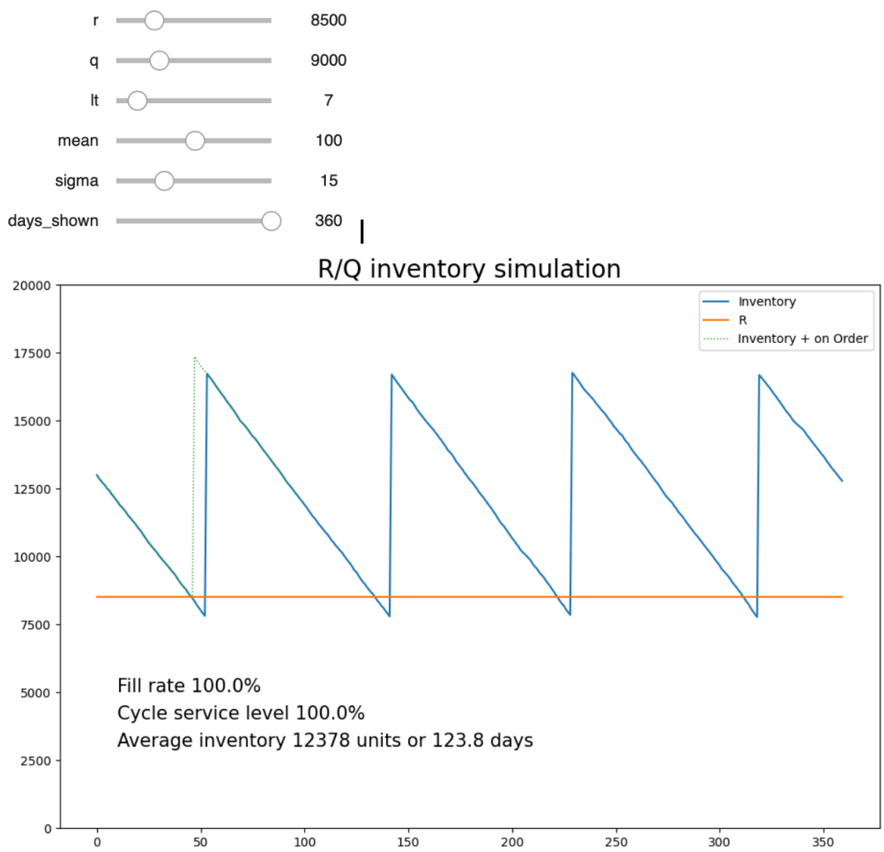

Figure 1: Figure 3. a

What's more, Toni can manage and optimize inventory as follows: Increase the purchasing frequency. For example, according to the simulation, if we adjust to release the order 6 times one year, the average inventory will decrease greatly. While we need to consider the total ordering cost and total holding cost, and then take strategies accordingly.

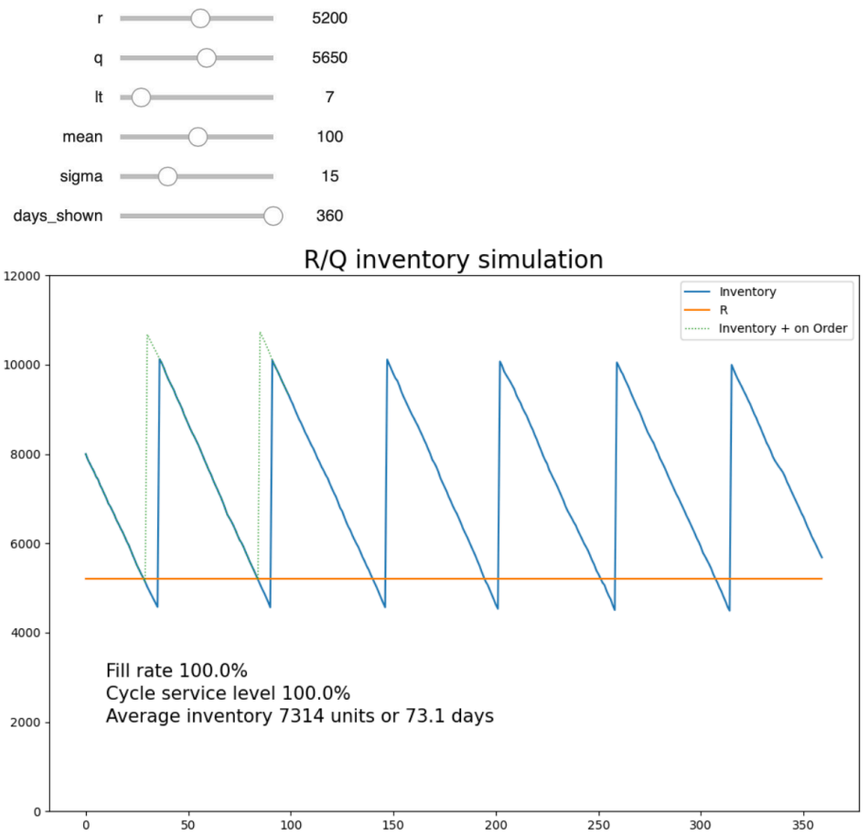

Figure 2: Figure 3. b

Record the inventory data and adjust the inventory management strategy according to certain patterns, which may change from time to time. Keep good relationships with suppliers and shipping companies to explore opportunities of reducing the lead time.

Question 4

A rarely used suture sells only 20 individual units per week, with a weekly standard deviation of 10. HealthCo has to buy them from the supplier in boxes of 500 with a lead time of 1 week. How should Toni think about safety stock to make a 98% fill rate (not cycle service level)?

Solution

Given Data - Weekly demand = 20 units, - Weekly standard deviation (σ_w) = 10 units, - Lead time = 1 week, - Target fill rate = 98%, - For the target fill rate, we're assuming a service level with a corresponding Z-score of 1.88 (though the text mentions 97%, it discusses adjusting for a 98% fill rate).

Annual Demand Calculation The annual demand (D_{annual}) is the product of weekly demand and the number of weeks in a year:

$$D_{\text{annual}} = 20 \times 52 = 1040 \,\text{units}$$

Safety Stock Calculation Given the lead time is 1 week, the standard deviation of lead time demand (σ_{LTD}) equals the weekly standard

deviation. Thus, the safety stock (SS) can be calculated as:

$$SS = Z \times \sigma_{\text{LTD}} = 1.88 \times 10 \approx 19 \text{units}$$

This formulation helps Toni in planning the inventory to ensure a high fill rate, considering the infrequent demand and significant variability for the suture product. Adjustments to the reorder point (R) and mean value are suggested to optimize the inventory model further and meet the fill rate requirement. While, according to simulation, the service level is too low in this case, she should raise the safety stock to avoid stockout.

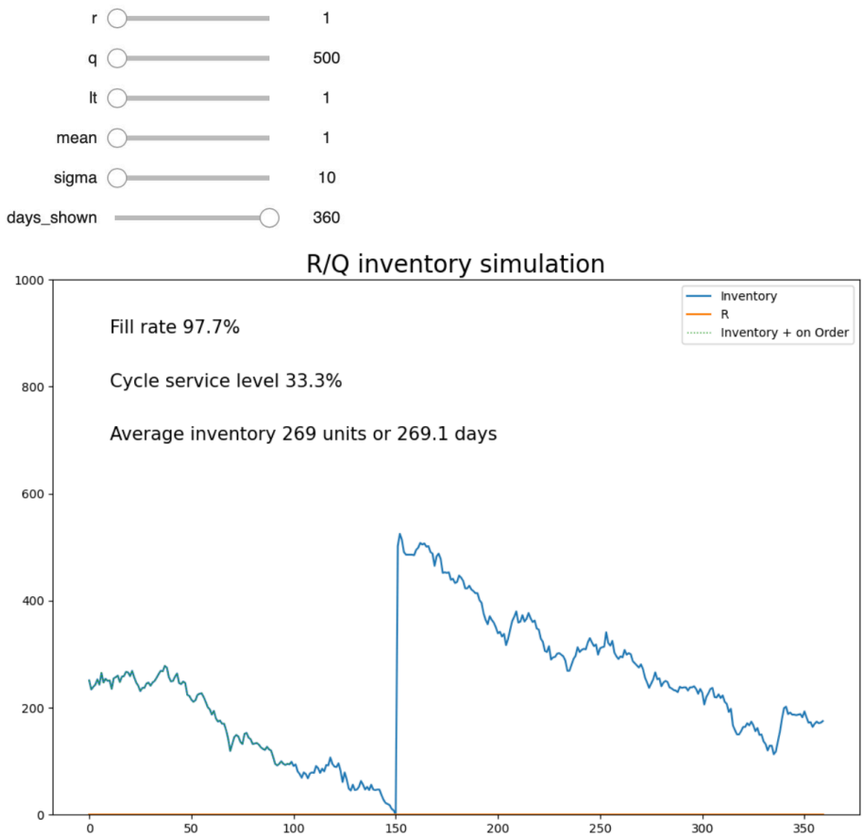

Figure 3: Figure 4. a.

Question 5 (optional - Extra credit)

Looking at the scalpel blades of question 1: While that supplier takes orders daily, most other suppliers have an agreement for only one order per week on a fixed day, say Tuesday. Any received order is delivered on the Tuesday thereafter. If the blade supplier used this strategy, what would the required safety stock and the total average inventory be?

Solution

The scenario where most suppliers deliver orders once a week reduces the flexibility of refilling the stock, and so the inventory manager should increase both safety stock and the total average inventory to protect HealthCo from stockout.

Discussion for increasing the safety stock: More difficult to deal with volatile demand: Inventory people cannot release another order even if they already forecast a sudden increase in future days. They have to wait until next Tuesday, increasing the risk of stockout and profit loss. Less tolerance to mistakes: If the company misses the opportunity to release the order on Tuesday, they have to wait for a week for the next opportunity. For scenario in a), the company just loses the revenue of one day, or can make up with safety stock. But in this case, the company would lose the revenue of the whole week.

Discussion for increasing the total average inventory: The total average inventory (TAI) is the sum of half the order quantity and the safety stock. This can be represented as:

$$TAI = \frac{Q}{2} + SS$$

Given that Q is constant until a new forecast is made, any increase in safety stock (SS) directly increases the total average inventory. This relationship highlights the impact of adjusting safety stock levels on overall inventory management.

In total, at the scenario that most suppliers deliver weekly, we must prepare more safety stock to protect HealthCo from potential volatile demand as well as the delivering delay risk, complementing the lack of flexibility and responsiveness of daily deliveries.