**Why data is important in planning and control**

**EOQ & (Q, r)**

**<Problem Description>**

|  |
| --- |
| Yonsei IMS retail is a retailer that handles variety of household products. The manager, Mr. Smith, recently achieved 100 million won in monthly sales, and decided to introduce a decision-making system to reduce the cost of store managing in order to open a second store. Currently, the store has daily product sales data. Through the analysis of these data, Mr. Smith wants to come up with the appropriate amount of orders to reduce costs through inventory management of 3 main sellers.  Until now, Mr. Smith used a fixed period order system by using the three main sellers selected from the products sales data. However, if demand changes, excess inventory or inventory shortages can occur. Mr. Smith wants to make changes as it can cause cash flow problems. Thus, he is trying to derive an efficient operation by utilizing the data on the daily product sales in the past month.  Let’s utilize the data given below and come up with an appropriate product-specific order plan for Yonsei IMS retail. |

**<Basic data>**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Yonsei IMS retail picked 3 main sellers (Y01, Y02, Y03) based on the sales data collected for a month. Daily sales for each product is given in Table 1, Table 2, and Table 3. Necessary basic parameters are also given in Table 4.  <Table 1> Y01 demand data (1)   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | **Day** | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | | **Demand** | 11 | 12 | 12 | 14 | 14 | 12 | 11 | 11 | 12 | 13 | 12 | 13 | 12 | 12 | 11 | | **Day** | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | | **Demand** | 13 | 11 | 13 | 12 | 13 | 12 | 12 | 10 | 10 | 12 | 12 | 12 | 13 | 12 | 11 |   <Table 2> Y02 demand data (1)   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | **Day** | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | | **Demand** | 10 | 13 | 8 | 9 | 11 | 8 | 13 | 12 | 11 | 13 | 9 | 10 | 13 | 8 | 12 | | **Day** | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | | **Demand** | 13 | 13 | 13 | 10 | 10 | 10 | 8 | 10 | 13 | 10 | 9 | 9 | 12 | 11 | 9 |   <Table 3> Y03 demand data (1)   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | **Day** | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | | **Demand** | 15 | 14 | 14 | 16 | 15 | 13 | 17 | 16 | 15 | 15 | 16 | 17 | 13 | 18 | 17 | | **Day** | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | | **Demand** | 16 | 18 | 17 | 17 | 15 | 16 | 14 | 13 | 18 | 16 | 14 | 14 | 16 | 18 | 17 |   <Table 4> Base parameter   |  |  |  |  |  | | --- | --- | --- | --- | --- | | Notation | Description | Value | | | |  | Total planning horizon (days) | 30 | | | |  | Replenishment lead time (days) | Y01 | Y02 | Y03 | | 2 | 3 | 2 | |  | Unit purchasing cost per unit ($) | Y01 | Y02 | Y03 | | 30 | 40 | 50 | |  | Fixed ordering cost ($) | 150 | | | |  | Daily interest rate (%) | 20 | | | |  | Backorder penalty cost ($) | Y01 | Y02 | Y03 | | 45 | 60 | 75 |   <Table 5> Y01 demand data (2)   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | **Day** | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | | **Demand** | 11 | 9 | 14 | 17 | 5 | 11 | 18 | 19 | 7 | 11 | 12 | 17 | 6 | 20 | 9 | | **Day** | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | | **Demand** | 16 | 11 | 19 | 11 | 9 | 9 | 6 | 16 | 8 | 17 | 10 | 12 | 11 | 14 | 5 |   <Table 6> Y02 demand data (2)   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | **Day** | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | | **Demand** | 10 | 6 | 17 | 6 | 9 | 18 | 9 | 8 | 6 | 14 | 10 | 13 | 8 | 7 | 10 | | **Day** | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | | **Demand** | 6 | 15 | 14 | 10 | 10 | 7 | 12 | 18 | 11 | 5 | 10 | 14 | 15 | 8 | 14 |   <Table 7> Y03 demand data (2)   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | **Day** | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | | **Demand** | 25 | 24 | 10 | 10 | 5 | 7 | 22 | 12 | 10 | 11 | 22 | 21 | 12 | 15 | 25 | | **Day** | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | | **Demand** | 18 | 14 | 16 | 6 | 10 | 24 | 7 | 30 | 24 | 22 | 21 | 8 | 10 | 8 | 21 |   **\*\*\*Initial Inventory is 30 and included in calculating the inventory cost** |

**<Experiment result & analysis>**

**※ Based on the data given above, answer the following questions. Please show calculations if necessary, and answer the questions in detail.**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 1. Using the information given, obtain the economic order quantity (EOQ) and order cycle for each product.  The economic order quantity can be achieved by the following formula.  (A: Fixed ordering cost, D: Expected demand rate over total planning horizon – initial inventory, h: holding cost \* total planning horizon)  The order cycle for a product can be achieved by the following formula.  (: economic order quantity, D: expected demand rate over total planning horizon – initial inventory / total planning horizon)  Using the given demand data of each item, the expected demand rate over the total planning horizon (30 days) is gained.   |  |  |  |  | | --- | --- | --- | --- | |  | Y01 | Y02 | Y03 | | D  (expected demand rate over T) | 360 | 320 | 470 |   Now, let’s calculate the EOQ and Order Cycle for each item, starting with Y01.  The order quantity is rounded up because it must be an integer.  Using the same calculation steps for items Y02 and Y03, the EOQ and order cycle is obtained as the following table.   |  |  |  |  | | --- | --- | --- | --- | |  | Y01 | Y02 | Y03 | | EOQ | 24 | 20 | 21 | | Order Cycle | 2.1818 | 2.0690 | 1.4318 |   (end of question 1)  2. Using the information given, obtain the reorder point (r) and order quantity (Q).  The order quantity can be achieved by the following formula.  (A: Fixed ordering cost, D: Expected demand rate over total planning horizon – initial inventory, h: holding cost \* total planning horizon, b: backorder cost, n(r): expected quantity which lead time demand exceeds the base stock level)  The reorder point can be achieved by the following formula.  (h: holding cost, Q: order quantity, b: backorder cost, D: Expected demand rate over total planning horizon – initial inventory)  The Poisson Distribution table with its mean being the expected demand during lead time ( is used to find .  (D: Expected demand rate over total planning horizon – initial inventory, T: total planning horizon, l: lead time)  Using the given data of each item, the expected demand rate during lead time is obtained.   |  |  |  |  | | --- | --- | --- | --- | |  | Y01 | Y02 | Y03 | |  | 22 | 29 | 29.333 |   Now, let’s calculate the order quantity and reorder point for each item, starting with Y01.  is obtained through using the EOQ model (=24).  is the minimum r value which satisfies (  Iterate the following calculation using and .   |  |  |  |  | | --- | --- | --- | --- | | ***n*** | ***Qn*** | ***G(r)*** | ***rn*** | | 0 | 24 | 0.7090909 | 24 | | 1 | 26.91762574 | 0.6737257 | 24 | | 2 | 26.91762574 | 0.6737257 | 24 |   If the following condition is satisfied, set .  Using the same calculation steps for items Y02 and Y03, the order quantity and reorder point is obtained as the following table.   |  |  |  |  | | --- | --- | --- | --- | |  | Y01 | Y02 | Y03 | | Order quantity | 27 | 23 | 25 | | Reorder point | 24 | 32 | 33 |   (end of question 2)  3. Based on the results obtained, establish an operational plan for historical data of each product and show whether the results can satisfy the customer demands. (Make 2 tables for each product, total of 6 tables)  [ Item Y01 ]  < EOQ >  Using the economic order quantity and the order cycle obtained through question 1, the following operational plan is obtained.     |  |  |  |  |  | | --- | --- | --- | --- | --- | | Total order quantity | Total order frequency | Total inventory | Total backorder | Total cost | | 312 | 13 | 34 | 468 | | Total purchase cost | Total ordering cost | Total inventory cost | Total backorder cost | 32574 | | 9360 | 1950 | 204 | 21060 |   It is observable that although the total inventory level is low, the total backorder level is high which also means that the customer demands cannot be satisfied. It also follows that the total cost is consisted most of the total backorder cost.  < (Q, r) >  Using the order quantity and reorder point obtained through question 2, the following operational plan is obtained.     |  |  |  |  |  | | --- | --- | --- | --- | --- | | Total order quantity | Total order frequency | Total inventory | Total backorder | Total cost | | 378 | 14 | 427 | 0 | | Total purchase cost | Total ordering cost | Total inventory cost | Total backorder cost | 16002 | | 11340 | 2100 | 2562 | 0 |   It is observable that the total backorder level is zero which means that the customer demands are being satisfied. However, it is also observable the total inventory level is high, leading to high inventory costs and inefficiency in cost.  -  Analysis for items Y02 and Y03 are similar as item Y01. The (Q, r) model is able to manage customer demands more efficiently. The following tables are the operational plans for each item and the cost analysis of the plans.  [ Item Y02 ]  < EOQ >     |  |  |  |  |  | | --- | --- | --- | --- | --- | | Total order quantity | Total order frequency | Total inventory | Total backorder | Total cost | | 280 | 14 | 27 | 599 | | Total purchase cost | Total ordering cost | Total inventory cost | Total backorder cost | 49456 | | 11200 | 2100 | 216 | 35940 |   < (Q, r) >     |  |  |  |  |  | | --- | --- | --- | --- | --- | | Total order quantity | Total order frequency | Total inventory | Total backorder | Total cost | | 345 | 15 | 854 | 1 | | Total purchase cost | Total ordering cost | Total inventory cost | Total backorder cost | 22942 | | 13800 | 2250 | 6832 | 60 |   [ Item Y03 ]  < EOQ >     |  |  |  |  |  | | --- | --- | --- | --- | --- | | Total order quantity | Total order frequency | Total inventory | Total backorder | Total cost | | 441 | 21 | 32 | 444 | | Total purchase cost | Total ordering cost | Total inventory cost | Total backorder cost | 58820 | | 22050 | 3150 | 320 | 33300 |   < (Q, r) >     |  |  |  |  |  | | --- | --- | --- | --- | --- | | Total order quantity | Total order frequency | Total inventory | Total backorder | Total cost | | 475 | 19 | 409 | 1 | | Total purchase cost | Total ordering cost | Total inventory cost | Total backorder cost | 30765 | | 23750 | 2850 | 4090 | 75 |   In summary, for all three items Y01, Y02, and Y03, the EOQ model maintained effective inventory levels in the cost of high backorder costs. On the other hand, the (Q, r) model maintained effective backorder levels in the cost of high inventory costs. So, in the perspective of satisfying consumer demand, the (Q, r) model is more efficient than the EOQ model, as the (Q, r) model has substantially low backorder levels. Furthermore, considering the fact that the penalty costs of backorder are much higher than the holding costs in this case, the (Q, r) model is also seen to be more cost effective.  (end of question 3)  4. What is the cause of inventory shortages or excess inventory occur despite using EOQ or (Q, r) model? Describe based on assumptions for EOQ and (Q, r).  The Economic Order Quantity (EOQ) Model is a model which assumes that   1. Demand is constant and continuous 2. Ordering and Holding costs are constant over time 3. The whole batch quantity is delivered at the same time 4. No shortages are allowed   One of the causes of inefficient inventory managements can be due to the variability of demand. Although the EOQ model assumes that the demand is constant, actual demand tends to vary than forecasted which would lead to either accumulated excess inventory or stock out.  Another cause could be due the EOQ model’s assumption of not accounting for the possibility of shortages. EOQ model has no mechanism for dealing with shortages which leads to inefficient inventory managements.  -  The (Q, r) Model is a model which assumes that   1. Demand is random and stationary 2. Lead time is fixed 3. Inventory level is continuously reviewed   Under the (Q, r) model’s assumption, demand is perceived to be random and stationary which means that the demand rate maintains a constant average and variance over time. However, demand patterns could trend upwards or downwards or have seasonality. This leads to differences between forecasted and actual demand, resulting in shortages and excess supply.  Additionally, if the actual demand turns out to be significantly deviated from the statistical assumptions used to calculate the reorder point, this can lead to either excess inventory or shortages.  (end of question 4)  5. Mr. Smith obtained demand data with same mean, but daily demand with more fluctuations from Question #3 demand data (Table 5, Table 6, Table 7). Establish an operational plan for each product and show whether the results can satisfy the customer demands. (Make 2 tables for each product, total of 6 tables)  [ Item Y01 ]  < EOQ >  Using the economic order quantity and the order cycle obtained through question 1, the following operational plan is obtained.     |  |  |  |  |  | | --- | --- | --- | --- | --- | | Total order quantity | Total order frequency | Total inventory | Total backorder | Total cost | | 312 | 13 | 43 | 569 | | Total purchase cost | Total ordering cost | Total inventory cost | Total backorder cost | 37173 | | 9360 | 1950 | 258 | 25605 |   It is observable that, compared to the demand with less fluctuation, the total backorder level is higher. This means that the EOQ model is not efficiently dealing with demand fluctuations, and the more customer demands are not being met.  < (Q, r) >  Using the order quantity and reorder point obtained through question 2, the following operational plan is obtained.     |  |  |  |  |  | | --- | --- | --- | --- | --- | | Total order quantity | Total order frequency | Total inventory | Total backorder | Total cost | | 378 | 14 | 417 | 1 | | Total purchase cost | Total ordering cost | Total inventory cost | Total backorder cost | 15987 | | 11340 | 2100 | 2502 | 45 |   Although it is a mere change, it is observable that the total backorder level increased to one. The fluctuation of demand has resulted in backorder which shows that the customer demands are not being entirely satisfied.  -  Analysis for items Y02 and Y03 are similar as item Y01. Although the (Q, r) model is able to manage customer demands more efficiently that the EOQ model, it is noticeable that there exists an increase in backorder level in the (Q, r) model also. The following tables are the operational plans for each item and the cost analysis of the plans.  [ Item Y02 ]  < EOQ >     |  |  |  |  |  | | --- | --- | --- | --- | --- | | Total order quantity | Total order frequency | Total inventory | Total backorder | Total cost | | 280 | 14 | 37 | 431 | | Total purchase cost | Total ordering cost | Total inventory cost | Total backorder cost | 39456 | | 11200 | 2100 | 296 | 25860 |   < (Q, r) >     |  |  |  |  |  | | --- | --- | --- | --- | --- | | Total order quantity | Total order frequency | Total inventory | Total backorder | Total cost | | 345 | 15 | 597 | 3 | | Total purchase cost | Total ordering cost | Total inventory cost | Total backorder cost | 21006 | | 13800 | 2250 | 4776 | 180 |   [ Item Y03 ]  < EOQ >     |  |  |  |  |  | | --- | --- | --- | --- | --- | | Total order quantity | Total order frequency | Total inventory | Total backorder | Total cost | | 441 | 21 | 34 | 423 | | Total purchase cost | Total ordering cost | Total inventory cost | Total backorder cost | 57265 | | 22050 | 3150 | 340 | 31725 |   < (Q, r) >     |  |  |  |  |  | | --- | --- | --- | --- | --- | | Total order quantity | Total order frequency | Total inventory | Total backorder | Total cost | | 475 | 19 | 456 | 25 | | Total purchase cost | Total ordering cost | Total inventory cost | Total backorder cost | 33035 | | 23750 | 2850 | 4560 | 1875 |   In summary, for all three items Y01, Y02, and Y03, the EOQ model maintained low holding costs regardless of fluctuations in demand. Yet, its drawback was in the cost of high backorder costs which got higher as the demand fluctuated more.  Comparatively, the (Q, r) model maintained effective backorder levels in the cost of high inventory costs. Yet, it is observable that backorder levels did increase – at least a small amount - as demand fluctuated more.  So, in the perspective of satisfying consumer demand, the (Q, r) model is more efficient than the EOQ model, as the (Q, r) model has substantially low backorder levels. Furthermore, considering the fact that the penalty costs of backorder are much higher than the holding costs in this case, the (Q, r) model is also seen to be more cost effective.  (end of question 5)  6. We identified that EOQ and (Q, r) model showed poor performance with demand fluctuations. Suggest a methodology for an order plan to minimize the cost considering the demand fluctuation occurring in real life.  1) Increasing accuracy in demand forecasting:  Advanced forecasting techniques will help refine demand predictions. Historical sales data, with market trends, seasonal patterns, and promotional impacts, will serve as inputs to machine learning algorithms. These predictive models will adapt to demand fluctuations, offering a robust foundation for inventory decisions.  2) Dynamic Reordering Method:  Rather than using a (Q, r) policy or EOQ policy of fixed order quantities, implementing a dynamic policy can adjust order quantities and reorder points based on the latest demand and lead time information. A tiered approach for reorder quantities, where the order size can be scaled up or down based on the confidence level in the demand forecasts, will also allow a flexible inventory management.  (end of question 6) |