INTRODUCTION TO ENTERPRISE ANALYTICS

ALY6050, WINTER 2020

MODULE 4 PROJECT ASSIGNMENT

DECISION MAKING

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Introduction

The assignment provides exposure on performing what-if analysis and optimization techniques on the Inventory Management Decision Model. Using the given data, we have implemented the decision model for the company and worked on optimizing the model by using some of the optimization techniques. We have used certain parameters that are important from the perspective of maximizing the quantity at the company and minimizing the cost at the inventory.

Analysis

Part I

- The inventories are required by many organizations for managing their stock. Using the inventory data, we have tried to minimize the total inventory cost.
- The holding cost has been used for maintaining the inventory, this cost involves warehousing of the stock.
- The ordering cost include replenishment of the inventory. We have assumed the annual demand of 16000 units to be constant and the per unit cost as $77.

  The uncontrollable inputs that we have used which impacts the total inventory cost are Supplier cost per order and Customer Demand. The decision variable that have been used are, Opportunity cost for 1 year, Holding Cost per unit and Economic Ordering Quantity, which is calculated using, SQRT(Order Demand * Order Cost per Order) / Carrying Cost per Unit as 702.(2)

  $Q = \sqrt{\dfrac{2DS}{H}}$, showing formula for EOQ.

  The Model Parameters are Annual Ordering Cost, Annual Holding Cost and the Order cost per order.(1)
- In order to implement the parameters and perform calculations to understand the decision model, we have used the following mathematical calculations:

  Annual Ordering Cost = (Annual Demand * Unit Cost) + Order Cost per order

  Annual Holding Cost= (Annual Demand * Unit Cost * Carrying Cost Rate)

  In order to calculate the Total Cost for the inventory, we will have to generate the order quantity at certain intervals and perform simulations in excel. In our case, we have considered intervals of 50, which will help in analyzing the total cost. Further, we need to know the ordering cost at the inventory. (1)

Order Quantity	Ordering Cost	Holding Cost	Total Cost
702	5128.21	5135.13	10263.34
500	7200.00	3657.5	10857.50
550	6545.45	4023.25	10568.70
600	6000.00	4389	10389.00
650	5538.46	4754.75	10293.21
700	5142.86	5120.5	10263.36
750	4800.00	5486.25	10286.25
800	4500.00	5852	10352.00
850	4235.29	6217.75	10453.04
900	4000.00	6583.5	10583.50
950	3789.47	6949.25	10738.72
1000	3600.00	7315	10915.00

Fig.1: Calculations for Total Cost

The ordering cost for each of the order quantity has been calculated using:
Ordering Cost= (Annual Demand/Order Quantity) * Order cost per order
Similarly, the Holding Cost has been calculated using the carrying cost rate of 19% for each of the order quantity.
Holding Cost= (Order Quantity /2) * Unit Cost * Carrying Cost Rate
Now, the Total Cost at the inventory has been calculated using the Ordering Cost and Holding Cost.

Total Cost = Ordering Cost + Holding Cost

- We have used the data tables to calculate the minimized total cost,
  Total Cost= (Demand/Order Quantity)*Order Cost per order + (Order Quantity/2) * Unit Cost * Carrying Cost Rate and the minimized total cost has been calculated to 10389. On performing calculations, it was seen that the total cost is 146630, while, EOQ is an optimal method and shows the total cost to be minimized as 10389.(2)
- In order to analyze the total cost and the order quantity, we have plotted a graph for effective analysis as given below:

Observations: As can be seen from the graph, we are trying to plot the minimized possible order quantity against the total cost. This method is used to determine the optimal number of units ie.700, in order to minimize the total cost. It can be interpreted that the curve reaches a minimum point that denotes the optimal number of units as per the Economic Ordering Quantity.

Fig.2: Plot of Total Cost vs Order Quantity

- We have used the excel solver to verify our results performed in earlier steps and to find out the optimal solution.

SOLVER	
Annual Demand	16000
Fixed cost	77

Observations: It can be seen that the results shown by the excel solver match the calculated values.

Fig.3: Excel Solver Results

- In order to verify the impact of the input parameters like, Order cost per order ie. 225 and unit cost ie.77, on the output parameters, we need to carry out What-if analysis. This involves performing sensitivity analysis, to model the results by changing our input parameters and analyzing the outputs. It was verified that the total cost matched the calculated cost.

Part II

- In order to calculate the minimum cost, we have performed 1000 simulations and calculated the cost for each of them.
- Considering, the unit cost of the inventory, ie. 77 and order cost ie. 225 and the holding cost. The triangular distribution has been specified as, 16000 for the peak, 18000 for upper limit and 13000 for lower limit. (3)
- Further, we need to carry out simulations in order to gauge the optimal value, hence we conduct 1000 random number generation. Since, we are considering triangular distribution, we are calculating the ptriangular function, this will be used for calculating the cumulative probabilities.

```
ptriangular<-function(x,a,b,c)
{ KK<-(1/((b-a)*(c-a)))*(x-a)^2
PP<-1-(1/((b-a)*(b-c)))*(b-x)^2
prob<-ifelse(x<c,KK,PP)
return(prob) }
```

Fig.4: Cumulative Distribution Function Code

```
qtriangular<-function(p,a,b,c)
{ QQ<-a+sqrt((b-a)*(c-a)*p)
qq<-b-sqrt((b-a)*(b-c)*(1-p))
q<-ifelse(p<(c-a)/(b-a),QQ,qq)
return(q) }
```

Fig.5: Function for inverse problems

- The qtriangular function is used for calculating the inverse corresponding (q) value of (p).(3)
- The minimum cost for the quantity has been calculated as,

```
for (i in annual_number_of_orders) {

  order_Quantity=sqrt((2*i*order.cost)/holding.cost)
  order_Quantity.array=append(order_Quantity.array,order_Quantity)
  annual.order.cost=(order.cost*i)/order_Quantity
  average_annual_demand=i/12
  holding.cost.for.i=increase.cost.holding*average_annual_demand
  total.cost=holding.cost.for.i+average_annual_demand
  total_cost_array=append(total_cost_array,total.cost)
}
```

Fig.6: Code for calculating minimum cost

As can be seen in the code snippet, we have calculated, the EOQ, annual order cost, average annual demand, holding cost for the quantity and the total minimum cost. This has helped in generating minimum value for the inventory.

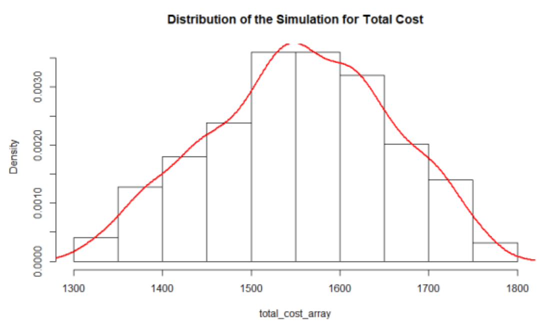

Fig.7: Probability Distribution for minimum cost

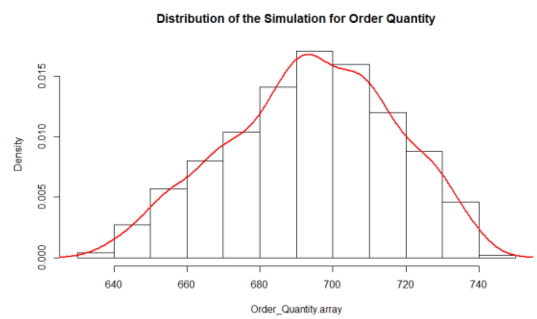

Fig.8: Distribution for order quantity

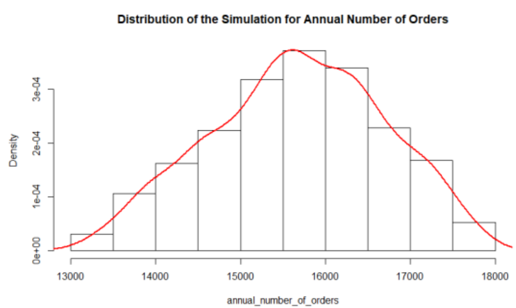

Fig.9: Distribution that fits annual number of orders

Observations: It can be interpreted that the probability distributions for minimum cost, order quantity and number of orders has a triangular probability distribution, with cost being 1600 at peak, order quantity being 700 at its peak and orders being 15500 at its peak. As can be seen, the data is distributed away from the median.

CONCLUSION

1. Considering, the decision model for inventory system, the Economic Order Quantity was calculated as one of the optimal methods for carrying out the analysis. The decision parameters were used for carrying out the what if analysis. This analysis led us to view the output results by recalculating the input variables.The minimum cost for inventory was calculated by performing simulations on the ordering quantity.
2. The qtriangular and ptriangular functions were used for calculating the Cumulative Distributive Function and the inverse problem for the same. The minimum cost was calculated for 1000 simulations in order to fetch the minimum value for the data.

3. The probability plots were plotted for the quantity and was observed that the curve showed a triangular probability distribution.
4. These simulations and implementations have helped in improving the profitability of the inventory and minimizing the cost.

Reference

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