Inventory Model Decision Making

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Introduction:

When the situation is unclear, lending on the decision can be risky, but taking the right approach yields accurate results. Anyone can lend on the absolute right path by following the structured and clear approach. There are numerous methods for obtaining precise results, such as developing decision models, linear regression, and many others. A manufacturing company's manager is confused about the inventory decisions needed to supply demand as it arises while avoiding paying exorbitant holding costs by keeping the inventory supplied constantly. To maintain low costs and a well-balanced inventory, this project analyzes how much inventory may be maintained on hand at various demand levels. There are two sections to this project. The more disorganized the inventory, the more resources will be used, so inventory management is crucial to achieving the best results with the least amount of work. Therefore, the main objective of this project is to address the issues with inventory management by using the decision modelling methodology. The primary issues that the managers of organizations confront are that they are unsure of how much inventory they will require and when it is best to place orders. Unresolved issues, such as a lack of cash and excessive storage utilization, will arise if the issue is left unattended.

PART-I

1.**Given**, the annual demand estimation of 15000 units, which is presumed to be persistent during the year.

- The cost of each unit is $80, and the
- Annual demand is 15000.
- The holding cost is equal to $14.4, or 18% of the unit cost.
- The supplier has been given a $220 order.
- Economic Order Quantity refers to the ideal quantity to order to minimize yearly shipping and ordering.

Problem:

Describe the information, uncontrollable inputs, model parameters, and decision variables that have an impact on the overall cost of the inventory.

Economic Order Quantity = √2*AnnualDemand*OrderCosts ÷ HoldingCosts
Order quantity = 1354, since the order is double the Economic Order Quantity.
The values are shown in the picture below.

1					
	Annual Demand(D)	15000	UNCONTROLLABLE VARIABLE		
	Holding Costs(H)	14.4	PARAMETER		
	Order Costs(S)	220	PARAMETER		
	Unit Costs	80	PARAMETER		
	Cost of holding an item for one year in percentage	18			
			Economic Order Quantity(EOQ	677	
		As per the question	Quantity (Q)	1354	DECISION VARIABLE

Hence, the **uncontrollable variable** is the AnnualDemand, HoldingCosts, OrderCosts and UnitCosts are all **parameters**. **Decision variable** is the Quantity.

2. **Problem:**

Create mathematical formulas that calculate the yearly ordering cost and annual holding cost based on the typical amount of inventory held over the course of the year, then utilize those formulas to create a mathematical model for the overall cost of inventory.

To find the overall cost of the inventory, we'll have to first find out the annual holding cost and annual ordering cost, annual holding cost is demand they predicted to get annually multiplied to the order costs divided by the quantity which is 1354. Similarly, annual holding cost is calculated by the quantity which is multiplied to holding cost divided by 2. Total costs are the addition of annual holding cost and annual order cost. The values are shown as below.

Here, The objective is the total costs.

2			
	Annual Ordering Costs	2437	
	Annual Holding Costs	9749	
	Total Costs	12186	OBJECTIVE

3. **Problem:**

As per the R script file, the implementation is done as shown below.

```
> AnnualDemand <- 15000
> OrderCosts<-220
> UnitCosts<- 80
> CostofHoldingItem <- 18
> HoldingCosts<- (CostofHoldingItem/100)*UnitCosts
> HoldingCosts
[1] 14.4
> EconomicOrderQuantityEOQ<-round(sqrt((2*AnnualDemand*OrderCosts)/HoldingCosts), digits = 0)
> EconomicOrderQuantityEOQ
[1] 677
> QuantityQ<-2*EconomicOrderQuantityEOQ
> QuantityQ
[1] 1354
> AnnualOrderingCosts<-round((AnnualDemand*OrderCosts)/QuantityQ,digits = 0)
> AnnualOrderingCosts
[1] 2437
> AnnualHoldingCosts<-round((QuantityQ*HoldingCosts)/2, digits = 0)
> AnnualHoldingCosts
[1] 9749
> TotalCosts <-AnnualOrderingCosts+AnnualHoldingCosts
> TotalCosts
[1] 12186
>
```

4.**Problem:**

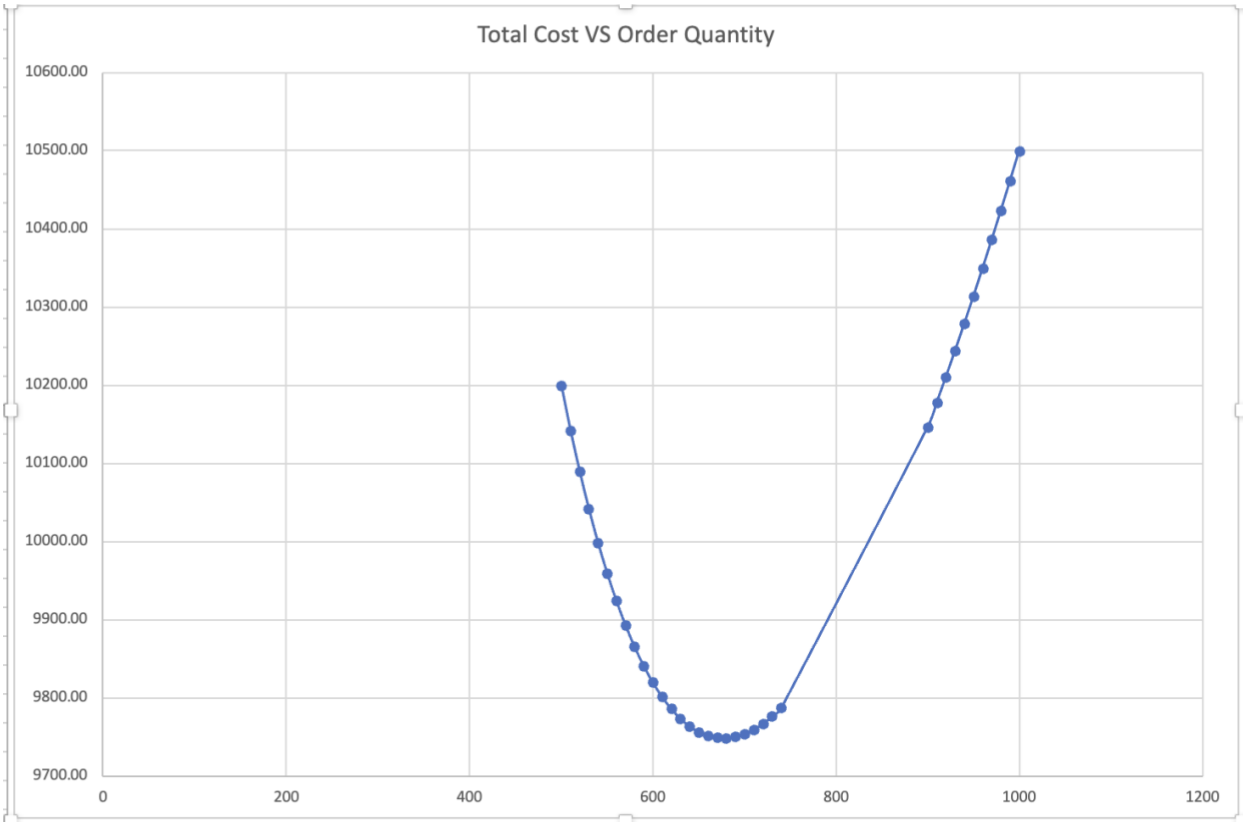
Find the exact order quantity which leads to the lowest overall cost using data tables.

In the table below, the left column lists the order quantity, while the right column lists the total costs. We can see that the **order quantity of about 680 units results in the lowest overall cost, which is approximately 9749.**

Quantity	12186.06
500	10200.00
510	10142.59
520	10090.15
530	10042.42
540	9999.11
550	9960.00
560	9924.86
570	9893.47
580	9865.66
590	9841.22
600	9820.00
610	9801.84
620	9786.58
630	9774.10
640	9764.25
650	9756.92
660	9752.00
670	9749.37
680	9748.94
690	9750.61
700	9754.29
710	9759.89
720	9767.33
730	9776.55
740	9787.46
900	10146.67
910	10178.37
920	10210.96
930	10244.39
940	10278.64
950	10313.68
960	10349.50
970	10386.06
980	10423.35
990	10461.33
1000	10500.00

5.**Problem:**

To plot the total cost against the quantity of the order.



OrderQuantity is on the X-axis of the graph, and Total Cost is on the Y-axis. The graph shows that the lowest total cost is between 600 and 800 units.

6.**Problem:**

Find the order quantity that would result in the lowest overall cost by using the Excel Solver to confirm your result from step 4 above.

The following outcome is obtained using Excel Solver and the Decision variable as the Order Quantity and the Objective as the Total Cost .

6	SOLVER	
	QUANTITY	**TOTAL COST**
	677.0031968	9748.846086

7. **Problem:**

Studying the sensitivity of Total Cost to changes in the model parameters using what-if analysis with a two-way table.

	190	200	210	220	230	240	250	260	270
13.5	10965.14	11250.00	11527.82	11799.10	12064.28	12323.76	12577.88	12826.97	13071.32
13.6	11005.68	11291.59	11570.44	11842.72	12108.88	12369.32	12624.38	12874.39	13119.64
13.7	11046.07	11333.03	11612.90	11886.18	12153.32	12414.71	12670.71	12921.64	13167.79
13.8	11086.31	11374.31	11655.20	11929.48	12197.59	12459.94	12716.87	12968.71	13215.76
13.9	11126.40	11415.45	11697.36	11972.63	12241.71	12505.00	12762.86	13015.62	13263.55
14	11166.36	11456.44	11739.36	12015.61	12285.66	12549.90	12808.69	13062.35	13311.18
14.1	11206.16	11497.28	11781.21	12058.45	12329.46	12594.64	12854.35	13108.92	13358.63
14.2	11245.83	11537.98	11822.91	12101.14	12373.11	12639.22	12899.85	13155.32	13405.92
14.3	11285.36	11578.54	11864.47	12143.67	12416.60	12683.65	12945.20	13201.56	13453.04
14.4	11324.75	11618.95	11905.88	12186.06	12459.94	12727.92	12990.38	13247.64	13500.00
14.5	11364.01	11659.22	11947.15	12228.30	12503.12	12772.04	13035.41	13293.56	13546.79
14.6	11403.12	11699.36	11988.28	12270.39	12546.16	12816.01	13080.28	13339.32	13593.43
14.7	11442.11	11739.36	12029.26	12312.34	12589.06	12859.82	13125.00	13384.93	13639.90
14.8	11480.96	11779.22	12070.11	12354.15	12631.81	12903.49	13169.57	13430.38	13686.22
14.9	11519.68	11818.95	12110.82	12395.82	12674.41	12947.01	13213.98	13475.67	13732.38
15	11558.28	11858.54	12151.39	12437.34	12716.87	12990.38	13258.25	13520.82	13778.38
15.1	11596.74	11898.00	12191.83	12478.73	12759.19	13033.61	13302.37	13565.81	13824.23
15.2	11635.08	11937.34	12232.13	12519.98	12801.37	13076.70	13346.35	13610.66	13869.93

From the above table, we can observe that if the holding cost which is represented in yellow color is 13.5, then the ordering costs which is blue in color is 10965.14, similarly when the holding cost is 14, the ordering costs is 11166.36. The total cost increases by $115 for every $13 increase in the ordering cost (Approximately). Like this, the overall cost rises by around $7 for every 1% increase in the holding charges.

Summary:

When given the annual demand estimation of 15000 units, which is presumed to be persistent during the year. The cost of each unit is $80, and the Annual demand is 15000. The holding cost is equal to $14.4, or 18% of the unit cost. The supplier has been given a $220 order. Economic Order Quantity refers to the ideal quantity to order to minimize yearly shipping and ordering. Hence, the uncontrollable variable is the AnnualDemand, HoldingCosts, OrderCosts and UnitCosts are all parameters. Decision variable is the Quantity. To find the overall cost of the inventory, we'll have to first find out the annual holding cost and annual ordering cost, annual holding cost is demand they predicted to get annually multiplied to the order costs divided by the quantity which is 1354.Similarly, annual holding cost is calculated by the quantity which is multiplied to holding cost divided by 2. Total costs are the addition of annual holding cost and annual order cost. The values are shown as below. The graph shows that the lowest total cost is between 600 and 800 units. we can observe that if the holding cost which is represented in yellow color is 13.5, then the ordering costs which is blue in color is 10965.14, similarly when the holding cost is 14, the ordering costs is 11166.36. The total cost increases by $115 for every $13 increase in the ordering cost (Approximately). Like this, the overall cost rises by around $7 for every 1% increase in the holding charges.

Hence, to conclude as a consultant, I would advise the Vice President to set the reorder threshold at 677, at which point a 1354-unit order would need to be placed at a cost of $12186.

PART II

Problem:

Suppose that all the variables in the problem are the same as they were in part I, but that the annual demand has a triangular probability distribution with a range of 13000–17000 units and a mode of 15000 units. Performing a simulation with 1000 occurrences, and then figure out the lowest total cost per instance. Then, employ the outcomes of your simulation to:

i).
Creating a triangular distribution with a minimum of 13000, a maximum of 17000, and a mode of 15000 for the annual demand.

```
> TRI <- rtri(1000 , 13000, 17000, 15000) # Making a triangle out of the annual demand with the g
m, maximum, and mode
> TRI
   [1] 14571.02 14869.56 14840.63 14854.40 15081.62 15472.84 15566.84 14739.50 15439.72 14028.51
  [11] 15041.40 14655.56 15299.16 13778.33 14803.81 14524.42 15582.97 15873.44 15686.54 13930.19
  [21] 14858.74 13877.51 15267.63 14137.42 14099.59 15529.40 15779.20 14407.86 14772.46 14752.33
  [31] 14441.58 13739.48 15343.25 14721.87 13969.61 15350.50 15800.39 15385.23 14719.90 14800.16
  [41] 16156.33 15225.09 13981.40 15133.69 16592.58 15318.31 14884.55 15451.53 13529.79 13472.33
  [51] 14133.05 14324.30 15212.73 13725.63 14592.91 14666.81 14477.87 14480.32 16163.17 15375.42
  [61] 15485.32 15203.19 13517.49 14760.00 14723.56 15023.44 14503.64 15239.04 15655.54 16066.91
  [71] 15030.66 14746.88 15887.13 14682.25 15418.80 13586.92 15453.64 15121.51 16123.42 16259.23
  [81] 14735.27 14878.51 14516.58 16209.63 15066.12 15989.08 14753.58 14691.30 14741.34 13182.30
  [91] 14607.58 16295.85 14442.70 15685.20 15085.60 15549.15 14201.23 13847.54 14454.94 14914.65
 [101] 14658.87 15324.75 14334.15 14506.51 15151.02 15159.94 13753.12 15339.37 14967.70 14590.63
 [111] 13833.54 16111.50 14519.32 14523.96 15179.65 14296.60 13432.03 14465.11 15194.06 15376.67
 [121] 15171.77 14983.00 14225.13 15632.74 15842.18 14486.68 14225.17 15945.35 14896.97 15392.66
 [131] 15239.81 15123.00 14859.00 16021.05 15337.33 14599.00 13523.18 14923.20 16178.56 14543.25
 [141] 15011.64 14392.63 15620.86 14987.42 14400.22 15360.97 13763.13 14156.29 15342.64 16053.44
 [151] 13983.77 16072.81 15833.78 14584.56 15359.56 13997.46 15696.43 14366.20 16465.48 16089.55
 [161] 15209.95 16668.40 13439.68 14996.72 13696.05 14501.93 15255.61 13665.61 14737.40 15328.49
 [171] 15639.54 16091.90 14979.42 15404.66 13599.69 13419.49 14420.29 15853.72 15078.02 15986.85
 [181] 15066.69 14139.80 15248.86 14221.75 15348.13 14654.83 15282.81 14206.98 14738.59 15746.64
 [191] 13853.81 15634.70 14746.49 13690.70 15441.63 13962.28 14334.85 16180.86 15637.90 13919.39
```

In the previous step we have done triangular distribution for annual demand, now we need to run 1000 simulations with order quantities that are in between 450 and 1000. For the above triangular distribution for annual demand, we have generated

17000 annual demands, for each annual demand, there is a random sample order as shown below.

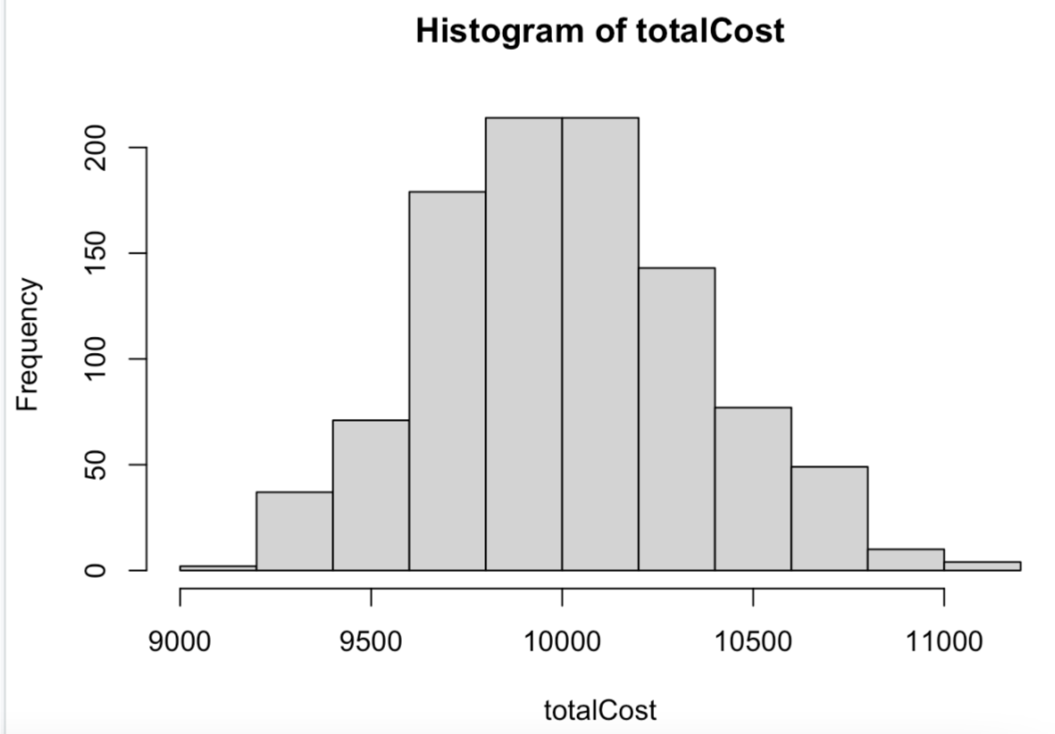
```
> orders <- sample(450:1000,1000,replace = T)  # 1000 random Order Quantities are used in the simulation
> orders
   [1]  900  632  583  480  852  496  677  922  506  957  782  659  590  952  927  477  853  734  747
  [20]  767  672  651  646  556  827  471  918  803  799  502  466  680  913  810  960  544  926  834
  [39]  630  774  642  951  699  539  948  564  712  577  495  781  787  523  792  882  798  492  793
  [58]  698  709  529  527  760  676  895  573  452  790  555  604  905  781  950  503  975  944  580
  [77]  856  492  465  587  579  652  578  729  584  709  651  649  484  828  519  821  769  867  848
  [96]  686  545  601  958  745  715  645  714  738  648  787  936  918  715  625  907  465  833  501
 [115]  883  760  893  824  673  934  898  852  762  930  911  495  771  794  628  848  727  811  696
 [134]  904  469  791  569  734  820  493  607  796  745  991  797  631  540  894  688  492  496  934
 [153]  997  790  950  515  483  570  595  876  959  599  547  644  928  897  798  751  750  455  839
 [172]  736  525  547  666  579  717  924  814  639  477  563  553  706  739  632  691  923  958  483
 [191]  677  694  645  480  774  987  932  600  609  737  748  610  579  651  886  525  762  643  850
 [210]  663  642  682  845  524  779  502  711  620  707  686  926  874  834  621  532  460  964  760
 [229]  933  475  682  502  782  581  970  584  938  601  483  985  497  653  931  709  629  511  972
 [248]  753  897  479  711  951  881  812  487  726  961  524  920  940  953  785  999  999  628  500
 [267]  789  687  632  971  785  480  659  887  537  962  918  509  715  471  475  746  726  701  787
 [286]  851  760  504  642  783  681  725  756  641  883  902  585  450  662  703  470  914  694  646
 [305]  677  598  660  627  992  905  647  867  681  883  941  793  849  910  757  908  738  734  501
 [324]  870  941  791  951  980  997  990  953  566  464  517  467  739  698  545  952  605  787  627
 [343]  877  840  615  457  903  452  636  640  943  511  986  620  488  475  591  459  734  632  608
 [362]  683  819  631  594  928  491  944  784  876  732  560  661  507  604  926  559  705  913  732
 [381]  632  498  789  750 1000  652  562  729  956  791  973  657  761  477  867  861  451  847  802
 [400]  879  461  495  823  748  812  760  949  850  646  913  713  659  712  946  974  620  483  504
 [419]  872  725  618  843  997  901  778  839  685  818  774  620  836  588  706  834  722  507  511
 [438]  881  635  925  956  554  889  845  800  993  944  800  740  912  944  775  935  537  999  634
 [457]  850  757  698  709  885  802  888  871  466  884  600  663  834  496  584  722  478  981  886
 [476]  933  769  875  668  987  988  889  521  484  743  967  518  861  598  801  914  975  725  509
 [495]  958  686  805  680  603  537  731  867  501  689  800  812  474  908  714  580  585  612  697
 [514]  467  564  995  544  882  793  885  813  653  912  532  854  870  952  962  699  963  809  604
 [533]  663  785  529  828  788  756  657  877  526  533  751  919  566  463  850  651  536  567  464
 [552]  506  730  941  907  721  863  894  481  680  631  760  621  508  764  838  496  828  660  884
 [571]  939  965  598  825  690  679  507  559  750  470  834  680  937  703  624  500  568  615  888
 [590]  678  455  611  935  774  851  774  824  519  863  690  990  864  870  703  622  932  528  608
 [609]  767  999  760  694  591  585  836  885  491  460  611  676  851  598  738  695  797  940  994
 [628]  467  672  790  985  591  485  702  581  869  799  586  923  980  454  893  691  829  677  866
 [647]  590  550  812  732  705  941  822  889  801  499  916  971  455  585  767  955  578  674  700
```

Next step, is to create a data frame on the number of orders and the triangular distribution for those orders, there are a total of 500 observations for this sample.

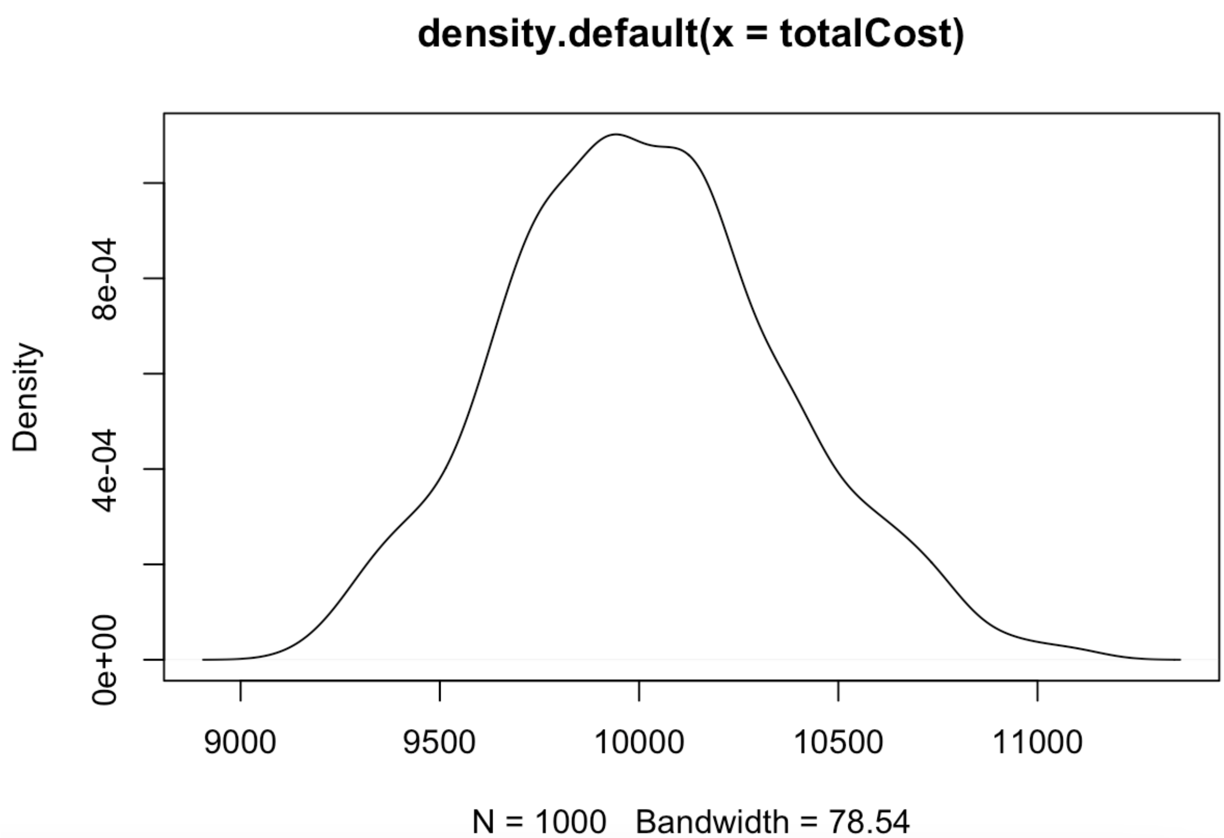
```
> orderDataFrame <- data.frame(orders ,TRI)
> orderDataFrame
   orders      TRI
1     900 14571.02
2     632 14869.56
3     583 14840.63
4     480 14854.40
5     852 15081.62
6     496 15472.84
7     677 15566.84
8     922 14739.50
9     506 15439.72
10    957 14028.51
11    782 15041.40
12    659 14655.56
13    590 15299.16
14    952 13778.33
15    927 14803.81
16    477 14524.42
17    853 15582.97
18    734 15873.44
19    747 15686.54
20    767 13930.19
21    672 14858.74
22    651 13877.51
23    646 15267.63
24    556 14137.42
```

We determine the Total Cost for the simulated data frame mentioned above.

```
> totalCost <- as.numeric( (OrderCosts*TRI/orders) + (HoldingCosts*orders)/2 ) # Total price for eac
 Quantity
> print(totalCost)
  [1] 10041.805  9726.512  9797.838 10264.267 10028.715 10434.154  9933.048 10155.418 10356.121
 [10] 10115.345  9861.995  9637.400  9952.773 10038.469 10187.711 10133.293 10160.654 10042.506
 [19]  9998.265  9518.023  9702.869  9376.990  9850.703  9597.141  9705.199 10644.846 10391.108
 [28]  9728.959  9820.311 10079.566 10173.114  9341.125 10270.769  9830.531 10113.370 10124.724
 [37] 10421.071 10063.253  9676.283  9779.563 10158.838 10369.303  9433.241 10057.818 10676.200
 [46] 10036.026  9725.557 10045.799  9577.240  9418.221  9617.189  9791.117  9928.159  9774.027
 [55]  9768.708 10100.727  9726.158  9589.599 10120.169 10203.115 10258.862  9872.922  9266.384
 [64] 10072.157  9778.626 10566.694  9726.989 10036.700 10051.150 10421.768  9857.190 10255.067
 [73] 10570.245 10332.919 10390.165  9329.660 10134.930 10304.049 10976.284 10320.150  9767.693
 [82]  9714.755  9686.942 10140.595  9880.393 10066.150  9673.049  9652.900 10185.408  9464.143
 [91]  9928.836 10277.932  9668.653 10222.497 10019.318  9925.808  9656.605  9396.184 10217.106
[100]  9768.326  9658.421  9871.046  9557.486  9638.034  9809.465  9904.248  9971.770 10285.702
[109]  9753.446  9635.902  9885.833 10970.643  9832.234  9984.988 10139.620  9610.490  9738.722
[118]  9794.844  9812.456 10346.715 10182.515 10003.250  9593.394 10394.068 10384.973 10002.526
[127]  9610.263 10134.908  9740.285 10098.979  9846.171  9941.615  9708.011 10407.727 10571.281
[136]  9755.603  9325.445  9757.693 10244.588 10039.489  9811.192  9709.063  9976.870 10462.378
[145]  9713.368  9898.849  9495.201  9920.450  9859.676 10720.769  9773.679 10510.686 10672.314
[154]  9749.523 10396.951  9687.496 10627.114  9648.851 10372.075 10347.954 10394.048 10434.750
[163]  9343.754  9759.904  9928.508 10015.171  9951.408  9410.441  9722.970 10687.577 10141.751
[172] 10109.278 10057.090 10134.060  9287.590  9267.744  9587.037 10427.494  9935.940 10104.881
[181] 10383.397  9578.921 10048.055  9514.906  9889.931  9651.763  9840.929 10031.878 10282.246
[190] 10649.981  9376.375  9953.046  9673.812  9730.903  9961.894 10218.559 10094.162 10252.983
[199] 10033.961  9461.443 10171.827  9708.299  9901.697  9972.819 10302.945  9764.506 10166.043
[208]  9948.993  9808.302  9640.233  9901.368  9896.533 10069.860  9821.572  9870.390 10192.356
[217]  9651.294  9642.889  9473.216 10157.684 10237.900 10096.210  9677.014  9463.688  9891.764
[226]  9640.501 10745.102 10264.702 10432.861  9628.503  9950.345 10445.727  9701.168  9471.881
[235] 10302.996 10047.255 10063.074  9906.700 10660.917 10547.894 10155.293  9565.392 10313.696
[244] 10228.974  9384.773 10826.893 10359.904  9718.375 10213.839  9738.350  9903.357  9916.221
[253]  9806.345  9850.341 10073.891  9471.340 10087.287 10048.773 10278.516 10190.699 10031.557
[262] 10216.234 10737.203 10491.439  9756.131 10213.163  9902.494  9772.522  9816.333 10759.451
[271]  9569.409  9752.833 10203.819 10562.444  9905.595 10058.357 10342.580 10035.988  9443.538
[280]  9660.969 10544.939  9388.685  9802.894  9878.842  9942.133 10041.929  9870.494 10275.934
[289]  9844.238 10144.024  9970.966  9254.281  9603.197  9336.806 10197.894 10144.532  9763.634
[298] 11064.092 10042.586  9684.013 10482.401 10101.893  9609.365  9762.051 10059.226  9914.161
[307] 10082.402  9920.715 10763.241 10176.716  9908.367 10455.037  9762.064  9842.967 10288.523
```



Histogram of totalCost
Frequency
0
50
100
150
200
9000
9500
10000
10500
11000
totalCost



density.default(x = totalCost)
Density
0e+00
4e-04
8e-04
9000
9500
10000
10500
11000
N = 1000 Bandwidth = 78.54

- As can be seen from the frequency and density graphs, the minimal total costs are distributed in a triangle.

- The Minimum Total Cost (95% CI) range is ($9308.595, $10712.58).

```
> print(meanCostSample - 1.96*sdCostSample)
[1] 9302.595
> print(meanCostSample + 1.96*sdCostSample)
[1] 10699.21
```

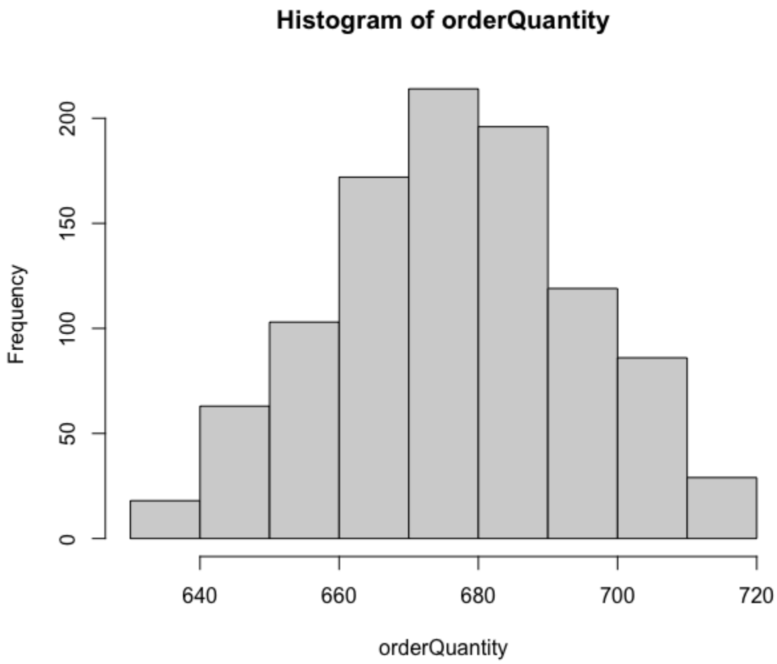
- The mean value of Minimum Total Cost (95% CI) range is $1000.9

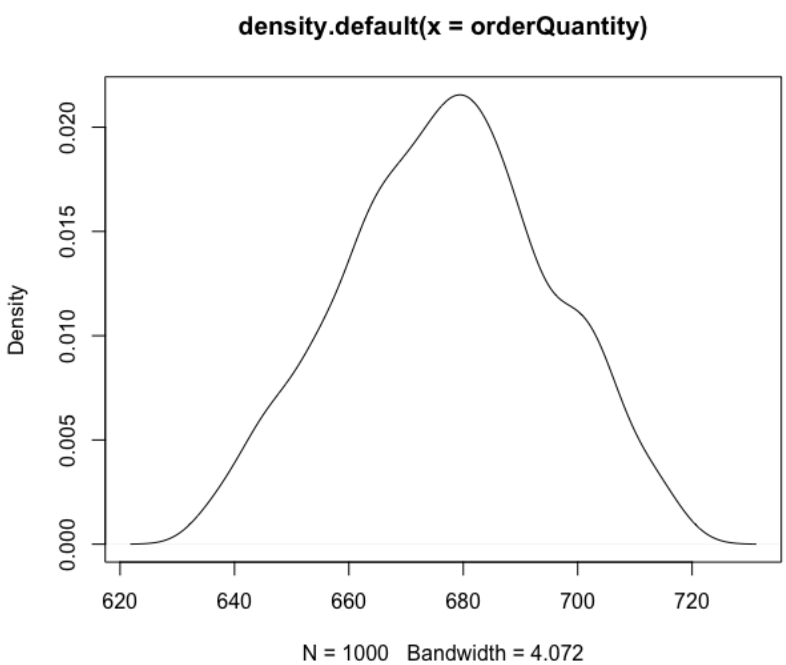
```
> meanCostSample
[1] 10000.9
```

(ii)

After determining the total cost for the simulated data frame, Utilizing the values of the triangularly distributed annual demand, we determine the order quantity.

```
> orderQuantity <- as.numeric(sqrt(2*TRI*OrderCosts/HoldingCosts))
> orderQuantity <- round(orderQuantity,digits = 0)
> orderQuantity
  [1] 667 674 673 674 679 688 690 671 687 655 678 669 684 649 673 666 690 696 692 652 674 651 683 657
 [25] 656 689 694 664 672 671 664 648 685 671 653 685 695 686 671 672 703 682 654 680 712 684 674 687
 [49] 643 642 657 662 682 648 668 669 665 665 703 685 688 682 643 672 671 678 666 682 692 701 678 671
 [73] 697 670 686 644 687 680 702 705 671 674 666 704 678 699 671 670 671 635 668 706 664 692 679 689
 [97] 659 650 665 675 669 684 662 666 680 681 648 685 676 668 650 702 666 666 681 661 641 665 681 685
[121] 681 677 659 691 696 665 659 698 675 686 682 680 674 700 685 668 643 675 703 667 677 663 691 677
[145] 663 685 648 658 685 700 654 701 696 668 685 654 693 663 709 701 682 714 641 677 647 666 683 646
[169] 671 684 691 701 677 686 645 640 664 696 679 699 679 657 683 659 685 669 683 659 671 694 651 691
[193] 671 647 687 653 662 703 691 652 705 671 679 691 695 661 704 689 660 669 686 687 684 663 679 677
[217] 669 668 656 705 678 679 652 656 669 636 714 711 694 640 691 690 665 653 669 688 657 682 694 688
[241] 674 664 683 710 651 712 674 670 684 647 687 637 651 672 666 654 650 676 683 668 648 705 701 677
[265] 676 678 680 679 680 713 654 648 707 717 671 647 690 671 653 640 686 645 679 686 684 680 681 682
[289] 682 700 692 637 661 648 686 676 672 699 697 672 681 669 667 677 698 683 699 686 706 678 687 712
[313] 678 654 678 679 686 641 693 657 689 635 658 648 676 679 697 670 690 688 658 665 659 698 656 667
[337] 650 672 666 645 671 687 647 691 658 677 690 678 660 679 662 681 699 654 702 703 675 705 666 675
[361] 719 663 717 673 664 677 696 689 680 685 692 706 678 668 679 685 676 645 670 703 695 663 693 684
[385] 661 692 663 688 676 707 700 687 681 665 665 706 686 693 664 676 685 680 690 666 672 666 643 672
[409] 706 690 696 669 676 656 673 676 708 676 667 715 676 688 701 702 644 683 661 696 667 673 675 678
[433] 707 689 670 671 669 698 703 710 689 688 702 682 685 713 677 715 696 679 689 667 687 672 653 661
[457] 681 714 705 691 694 679 679 641 671 682 700 657 674 677 661 667 658 684 647 686 710 688 683 709
[481] 638 700 664 646 690 680 675 685 680 673 655 711 676 697 658 669 701 683 697 711 679 698 678 646
[505] 671 653 679 670 638 658 673 692 655 665 636 676 688 678 679 703 702 706 679 717 667 662 702 662
```


Histogram of orderQuantity
Frequency
0
50
100
150
200
640
660
680
700
720
orderQuantity


density.default(x = orderQuantity)
Density
0.000
0.005
0.010
0.015
0.020
620
640
660
680
700
720
N = 1000 Bandwidth = 4.072

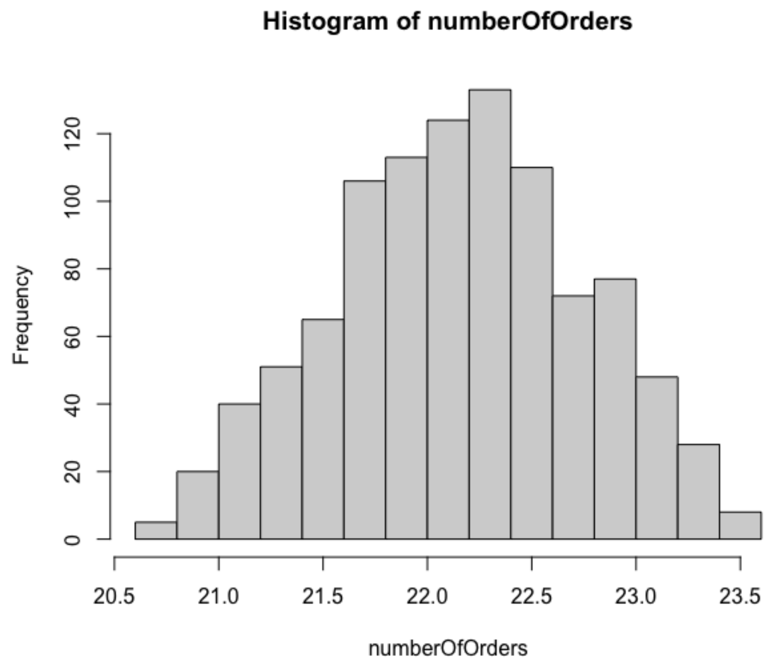
Plotting follows with the calculated Order Quantity values. We can see that the Order Quantity is triangularly distributed from the said frequency and density charts. The Order Quantity = 95% CI range (639.372, 714.926).

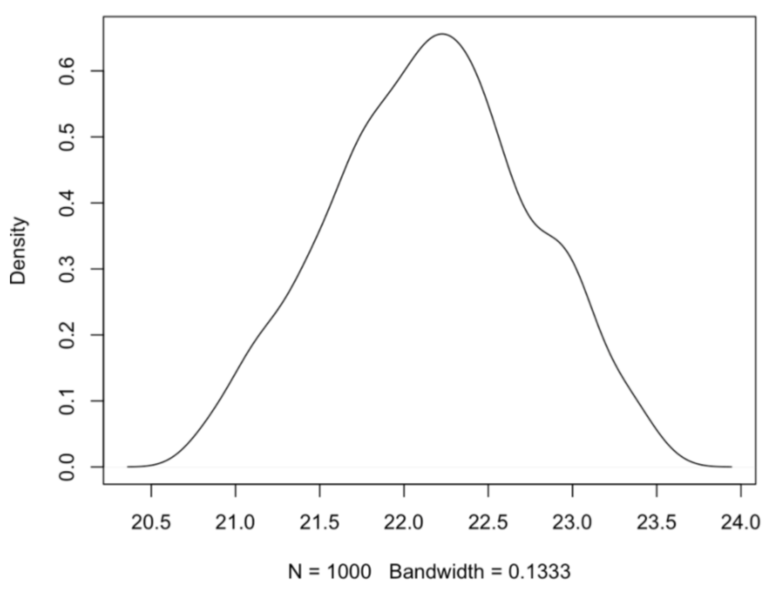
```
> print(meanOrderQuantity - 1.96*sdOrderQuantity)
[1] 641.7466
> print(meanOrderQuantity + 1.96*sdOrderQuantity)
[1] 712.3534
```

```
> meanOrderQuantity
[1] 677.05
```

(iii) Calculating a 95% confidence interval to estimate the annual number of orders:
Using the annual demand and QO values, we determine the annual number of orders. Annual demand / QO = Number of Orders

```
> numberOfOrders <- as.numeric(TRI/orderQuantity)
> numberOfOrders
  [1] 21.84561 22.06166 22.05146 22.03917 22.21152 22.48960 22.56064 21.96647 22.47412 21.41757
 [11] 22.18495 21.90667 22.36720 21.23010 21.99675 21.80844 22.58401 22.80666 22.66841 21.36533
 [21] 22.04561 21.31723 22.35378 21.51814 21.49328 22.53904 22.73660 21.69859 21.98283 21.98559
 [31] 21.74937 21.20290 22.39891 21.94019 21.39298 22.40949 22.73437 22.42744 21.93726 22.02404
 [41] 22.98198 22.32418 21.37829 22.25543 23.30419 22.39518 22.08389 22.49132 21.04166 20.98493
 [51] 21.51149 21.63791 22.30606 21.18153 21.84567 21.92348 21.77123 21.77492 22.99170 22.44587
 [61] 22.50774 22.29206 21.02254 21.96429 21.94272 22.15847 21.77724 22.34463 22.62362 22.91998
 [71] 22.16912 21.97747 22.79359 21.91381 22.47639 21.09770 22.49438 22.23751 22.96783 23.06274
 [81] 21.96016 22.07494 21.79667 23.02504 22.22142 22.87422 21.98745 21.92731 21.96921 20.75953
 [91] 21.86763 23.08194 21.75106 22.66648 22.21738 22.56771 21.54966 21.30391 21.73675 22.09578
[101] 21.91161 22.40460 21.65280 21.78155 22.28091 22.26129 21.22395 22.39324 22.14157 21.84226
[111] 21.28236 22.95085 21.80078 21.80775 22.29024 21.62875 20.95480 21.75204 22.31140 22.44770
[121] 22.27866 22.13146 21.58594 22.62336 22.76175 21.78449 21.58599 22.84434 22.06959 22.43828
[131] 22.34576 22.23970 22.04599 22.88721 22.39026 21.85478 21.03138 22.10844 23.01359 21.80398
[141] 22.17377 21.70834 22.60616 22.13800 21.71979 22.42478 21.23940 21.51412 22.39801 22.93349
[151] 21.38191 22.92840 22.74969 21.83317 22.42271 21.40284 22.64997 21.66848 23.22352 22.95228
[161] 22.30198 23.34510 20.96673 22.15173 21.16854 21.77466 22.33618 21.15419 21.96333 22.41007
[171] 22.63319 22.95563 22.12617 22.45578 21.08479 20.96796 21.71731 22.77833 22.20621 22.87104
[181] 22.18953 21.52177 22.32630 21.58080 22.40602 21.90557 22.37600 21.55839 21.96512 22.68968
[191] 21.28081 22.62620 21.97689 21.16027 22.47690 21.38174 21.65385 23.01687 22.63083 21.34876
[201] 23.08251 21.96818 22.22083 22.63477 22.73668 21.60546 23.02355 22.56478 21.59130 21.92267
[211] 22.45625 22.49929 22.38205 21.73013 22.22371 22.17090 21.89373 21.84888 21.47070 23.08111
[221] 22.16726 22.25318 21.35127 21.48237 21.90954 20.80554 23.34700 23.28636 22.70329 20.94488
```


Histogram of numberOfOrders
Frequency
0
20
40
60
80
100
120
20.5
21.0
21.5
22.0
22.5
23.0
23.5
numberOfOrders


Density
0.0
0.1
0.2
0.3
0.4
0.5
0.6
20.5
21.0
21.5
22.0
22.5
23.0
23.5
24.0
N = 1000   Bandwidth = 0.1333

```
> print(meanNumberOfOrders - 1.96*sdNumberOfOrders)
[1] 21.00258
> print(meanNumberOfOrders + 1.96*sdNumberOfOrders)
[1] 23.31354
```

```
> meanNumberOfOrders
[1] 22.15806
```

CONCLUSION:

I would advise the Vice President of Operations to set the reorder point to 677 in my capacity as a consultant. Since 677 is the ideal order quantity. Depending on the annual demand, the minimum price would be between 9700 and 1000. In the future, the Annual Demand with a Mode of 15000 would most likely be set at 15000. The manufacturing company would anticipate receiving 22 orders each year.

References:

Economic Order Quantity: What Does It Mean and Who Is It Important For? (2022, March 17). Investopedia. https://www.investopedia.com/terms/e/economicorderquantity.asp

Mukhopadhyay, S. (2022, June 18). *EOQ (Economic Order Quantity)*. WallStreetMojo. https://www.wallstreetmojo.com/eoq-formula/

Run Simulations - MATLAB & Simulink. (n.d.). https://www.mathworks.com/help/simulink/run-simulation.html