Minimizing Inventory Costs
by Calculating Economic Order Quantity

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1. INTRODUCTION

In this module, I will learn how to manage inventory cost. Based on the given dataset about inventory and order, I will run solver in Excel to calculate the Economic Order Quantity. In the process, I will run not only Excel solver but also what-if analysis in Excel to see how much the total cost is according to factors. In part 2, I will generate random numbers with triangular distribution. Based on that I will construct 95% confidence intervals and determine the probability distribution for each factor.

2. ANALYSIS

PART 1. Quantity Decision for Minimizing Total Cost

Understanding of key metrics

1. This is a problem of determining the order quantity to minimize the cost of the factory.
2. The factors that affect decision making are the annual demand = 15,000 units. Each unit cost is $80 and order cost is $220. Opportunity cost for holding units is 18% of the unit value, so opportunity cost is $14.4 (80 * 0.18).

(1) Define the data, Determining the properties of data

Annual Demand	15000	Uncontrollable
Unit Cost	80	Parameter
Opportunity Cost	14.4	18% of unit value
Order Cost	220	Parameter
Order Quantity	-	Decision Variable
Average Inventory level	-	Dependent variable of decision variable
Annual number of Order	-	Dependent variable of decision variable

Understanding of data

1. Annual Demand is 15,000. It is multiplied with the unit cost and used to calculate total cost.
2. Opportunity cost is estimated by the accounting department to be $14.4, which is 18% of the unit value (cost). Opportunity cost is used when calculating holding cost.
3. The order cost is $220, multiplied by the annual number of orders, and used to calculate the order cost.
4. The values described so far are all uncontrollable given values.
5. The value we want to find is Order Quantity. Values that change according to Order Quantity are Average inventory level and Annual number of orders.

(2) Develop Mathematical functions for total inventory cost

Annual Ordering Cost	= Order Cost * Number of Order
Holding Cost	= Opportunity Cost * Average level of inventory
Total Inventory Cost	= Annual Ordering Cost + Annual Holding Cost
Total Cost	= Unit value * Total Demand + Total Inventory Cost
Relation between values	1. Order Quantity = Economic Order Quantity (EOQ) 2. Number of orders = Annual Demand/Order Amount 3. Average level of inventory = EOQ/2

Explanation

1. Annual holding cost is holding cost per unit per year * average inventory level.
2. All calculations will use the concept of EOQ (Economic Order quantity).
3. EOQ = square root of: [2SD] / H
   S = Setup costs (per order, generally including shipping and handling)
   D = Demand rate (quantity sold per year)
   H = Holding costs (per year, per unit) (Shannon, 2020).
4. The annual demand / EOQ = Number of orders.
5. Average inventory level will be EOQ/2 (Melanie, 2020).
6. Since EOQ must be an integer, I will calculate it via ROUNDUP function in Excel. EOQ is usually round up. This is because EOQ is the quantity that should be ordered to meet requirements of a period at the cheapest price. If we order a lower number, we might have to reorder another lot, or place the next order faster- which might increase costs (Hardik, 20220).

(3) Implement my model on the Excel

Annual Demand	15000	Uncontrollable
Unit Cost	80	Parameter
Opportunity Cost	14.4	18% of unit value
Order Cost	220	Parameter
Order Quantity (EOQ)	678	Decision Variable
Average Inventory level	339	Dependent variable of decision variable
Annual number of Order	22.12	Dependent variable of decision variable
Annual ordering Cost	4867.3	Order Cost * Number of Order
Annual holding Cost	4881.6	Opportunity Cost * Average level of inventory
Total Inventory Cost	9748.9	Annual Ordering Cost + Annual Holding Cost
Total cost	1209748.9	Unit value * Total Demand + Total Inventory Cost

Interpretation

1. EOQ was calculated as SQRT[2 * 15,000 (annual demand) * 220 (order cost) /

14.4 (opportunity cost)]. Accordingly, the EOQ has the value 677.0032004. However, as I mentioned in Explanation, EOQ is usually roundup, so I will roundup and use 678. It makes slight difference between Annual ordering cost and annual holding cost.

2. Based on this, the average inventory level calculated is 339. And the Annual number of orders is 22.12.
3. In this case, I decided that there is no reason for the average inventory level and annual number of orders to be integers. The average inventory level is a number to manage inventory, and if it is a point that needs to be ordered, both round up and round down could be used in particular situation.
4. Also, the annual number of orders can be decided between 22nd and 23rd but considering that annual number of orders can extends to the following year, you can have either number depending on the current status of inventory, so I will use it as is.
5. But since one product cannot be divided into two, I will use the constraint of integer.

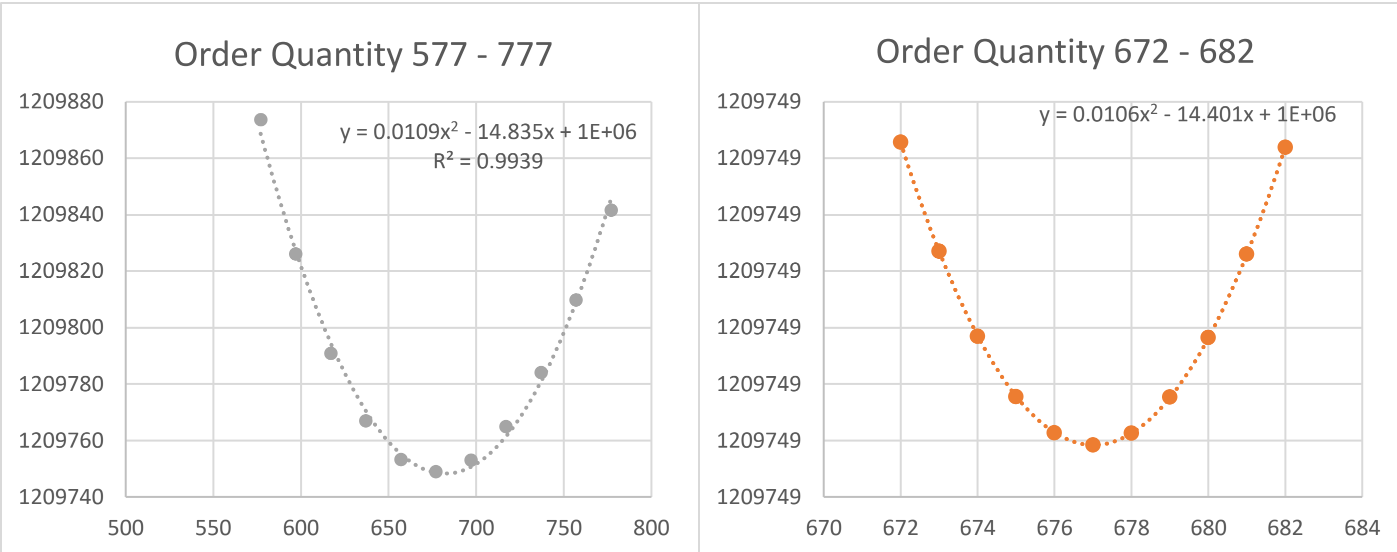
(4) Find an approximate order quantity which make the smallest total cost

Order Quantity	Total Cost	Order Quantity	Total Cost
577	1209873.64	672	1209749.11
597	1209826.04	673	1209749.02
617	1209790.86	674	1209748.94
637	1209766.93	675	1209748.89
657	1209753.23	676	1209748.86
677	1209748.85	677	1209748.85
697	1209752.98	678	1209748.86
717	1209764.91	679	1209748.89
737	1209784.01	680	1209748.94
757	1209809.71	681	1209749.01
777	1209841.50	682	1209749.11
Minimum: 677	1209748.85	Minimum: 677	1209748.85

Interpretation

1. This is the total cost using the what-if function. This is the total cost according to the order quantity change. Median value is EOQ of 677.
2. First, if you look at the table on the left, it is a graph drawn with an interval of '20' in a total of 11 sections from 577 to 777.
3. The graph on the right is a table drawn with an interval of '1' in a total of 11 sections from 672 to 682 based on 677. The lowest point is 677 in both tables.

(5) Plot of Total cost versus the Order Quantity



Interpretation

1. This is the total cost according to the order quantity change. Based on EOQ of 677.
2. First, if you look at the graph on the left, it is a graph drawn with an interval of '20' in a total of 11 sections from 577 to 777. The total cost appears the lowest at the midpoint between 650 and 700.
3. The graph on the right is a graph drawn with an interval of '1' in a total of 11 sections from 672 to 682 based on 677. The lowest point is 677.
4. However, due to the nature of the product that cannot be split, we have no choice but to use 678 as an order quantity.

(6) Excel Solver to find order quantity which make a minimum total cost

Solver Parameters

Set Objective	Total Cost (Minimum)
By Changing Variable Cells	Order Quantity
Subject to the Constraints	Order Quantity = Integer
Select solving method	GRG Nonlinear

Results of Excel Solver

Annual Demand	15000	Uncontrollable
Unit Cost	80	Parameter
Opportunity Cost	14.4	18% of unit value
Order Cost	220	Parameter

Order Quantity (EOQ)	677	Decision variable
Average Inventory level	338.5	EOQ/2
Annual number of Order	21.16	Order Cost * Number of Order
Annual ordering Cost	4874.44	Order Cost * Number of Order
Annual holding Cost	4874.40	Opportunity Cost * Average level of inventory
Total Inventory Cost	9748.85	Annual Ordering Cost + Annual Holding Cost
Total cost	1209748.8	Unit value * Total Demand + Total Inventory Cost

Interpretation

1. When using Excel solver, set as above. I also added constraints that Order Quantity must be integer.
2. The value of EOQ using the Excel solver is 677. This is the ROUND figure of 677.0032 that was first calculated with EOQ formula.
3. As you can see in the graph above. Among the integer values, the value with the lowest total cost is 677. However, I would like to make a final proposal of 678 due to the nature of inventory management.

(7) What-if Analysis by using two-way tables in Excel

1209749	216	217	218	219	**220**	221	222	223	224
70	1059036	1059057	1059078	1059098	1059119	1059140	1059161	1059181	1059202
71	1074100	1074121	1074142	1074163	1074184	1074205	1074226	1074247	1074267
72	1089164	1089185	1089206	1089228	1089249	1089270	1089291	1089311	1089332
73	1104228	1104249	1104270	1104291	1104313	1104334	1104355	1104376	1104397
74	1119291	1119312	1119333	1119355	1119376	1119397	1119419	1119440	1119461
75	1134353	1134375	1134396	1134418	1134439	1134461	1134482	1134503	1134525
76	1149415	1149437	1149459	1149480	1149502	1149524	1149545	1149567	1149588
77	1164477	1164499	1164521	1164543	1164564	1164586	1164608	1164629	1164651
78	1179538	1179560	1179582	1179604	1179626	1179648	1179670	1179692	1179713
79	1194599	1194621	1194644	1194666	1194688	1194710	1194732	1194754	1194775
80	1209660	1209682	1209704	1209727	**1209749**	1209771	1209793	1209815	1209837
81	1224720	1224742	1224765	1224787	1224810	1224832	1224854	1224876	1224898
82	1239780	1239802	1239825	1239848	1239870	1239892	1239915	1239937	1239959
83	1254839	1254862	1254885	1254907	1254930	1254953	1254975	1254997	1255020
84	1269898	1269921	1269944	1269967	1269990	1270012	1270035	1270057	1270080
85	1284957	1284980	1285003	1285026	1285049	1285072	1285094	1285117	1285140
86	1300016	1300039	1300062	1300085	1300108	1300131	1300154	1300177	1300199
87	1315074	1315097	1315120	1315143	1315166	1315189	1315213	1315235	1315258
88	1330131	1330155	1330178	1330201	1330225	1330248	1330271	1330294	1330317
89	1345189	1345212	1345236	1345259	1345283	1345306	1345329	1345352	1345376
90	1360246	1360269	1360293	1360317	1360340	1360364	1360387	1360410	1360434

Interpretation

1. Through the What if analysis, we can see how the total cost changes a lot

according to changes in Unit value and Order cost, which are Uncontrollable values.
2. According to this analysis, even only one value of Unit value & Order cost is lower than before, the total cost is low (yellow area).
3. It is important to lower the total cost within a set value through EOQ, but if company can lower the fixed values of unit cost and order cost, we can reduce the total cost significantly.

PART 2. Simulation with Triangular probability distribution

1,000 Random numbers			
Minimum	Maximum	Mean	Variance
13,078	16,858	15,003	642,788

Understanding of key metrics

1. I generated 1,000 random numbers in Excel using the RAND function.
2. The information we have is that annual demand has a triangular distribution. The minimum is 13,000, the maximum is 17,000, and the mode is 15,000.
3. The minimum of 1,000 created through this is 13,078, the maximum is 16,858, the mean is 15,003, and the variance is 642,788.
4. Through this random number, I will construct confidence interval and proceed the chi-square goodness-fit test. Our target variables are expected minimum total cost, the expected order quantity based on EOQ, and the expected annual number of orders.

(i) Expected minimum total cost with simulation

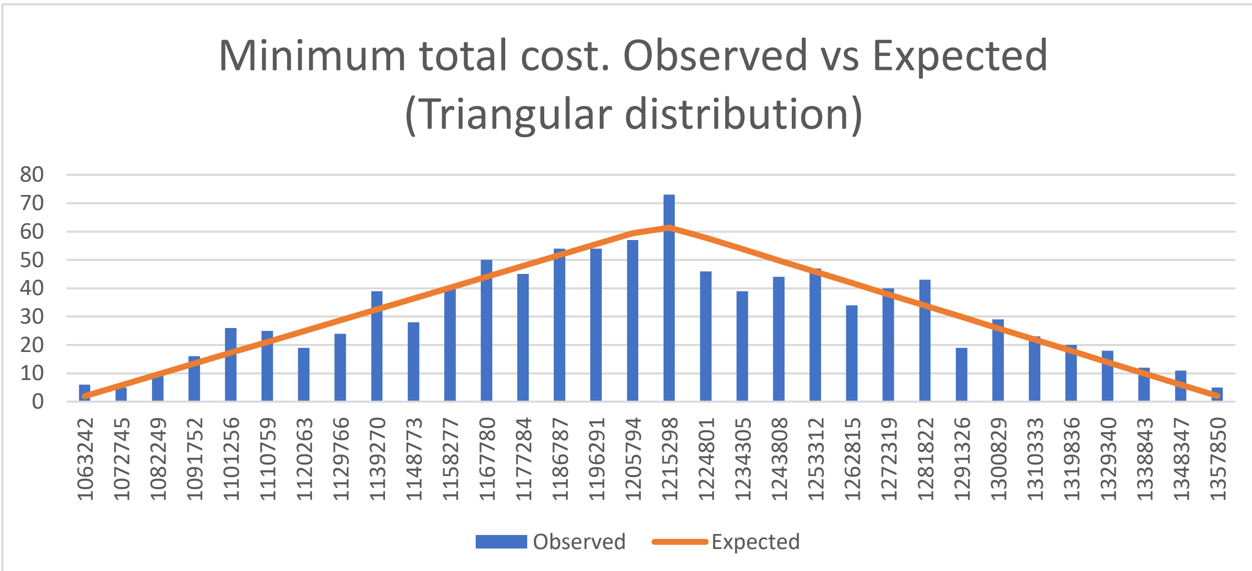
Confidence Interval			
Significance level	0.05	Mean	1,224,470.5
Standard deviation of sample	65,981		
Sample size	1,000	Confidence interval	
Margin of Error	4,089	[1,220,381 ~ 1,228,560]	

Explanation

1. I constructed a 95% confidence interval.
2. Since I do not have a population standard deviation, I use the sample standard deviation instead.
3. Another way to approach confidence intervals is through the use of something called the Error Bound. The Error Bound gets its name from the recognition that it provides the boundary of the interval derived from the standard error of the

sampling distribution (openstax, n.d.).

4. In general, sample SD can be used instead of population SD when sample size n is sufficiently large and drawn from a normal distribution. In this case, the sample size is large enough as 1000, it was extracted from the distribution of randomly generated numbers, and the population SD is unknown.



Interpretation

1. The Minimum Total Cost is derived from the annual demand which is generated by triangular distribution. I used EOQ as order quantity to calculate total minimum cost based on randomly generated annual demand.
2. As a result, the overall shape of the observed values seems like the triangular distribution.
3. Therefore, the triangular distribution is used as the method for generating theoretical probability. The three parameters of the triangular distribution, a is the minimum of values, b is the maximum, and c is calculated as 3*mean - a – b which is driven by mean = a+b+c /3 formula.
4. 1,056,201 for a, 1,362,280 for b, and 1,209,992 for c (mode).
5. The expected frequency is calculated based on the above triangular distribution parameters, and a chi-square goodness of fit test was performed by comparing it with the existing observed frequency.

Chi-squared Goodness of fit test for triangular distribution

Step 0 Finding Key-Metrics

This test is to check the distribution of minimum total costs observed

Step 1 Hypothesis.

Null: The Triangular distribution is a good fit for this distribution
Alternative: The Triangular distribution is not a good fit for this distribution

Step 2 Find the critical value.

- The p-value is α = 0.05

Step 3 Compute the test value.

Chi-squared Test Statistic:	40.87
Chi-squared P-value:	5.52404E-02
DF	28 (32-3 (parameters) – 1)

- The p-value with 1-CHISQ.DIST() and CHISQ.DIST.RT() in excel is 0.055

Step 4 Make the decision.

- There is not enough evidence to reject null hypothesis since 0.055 (p-value) > 0.05

Step 5 Summarize the results.

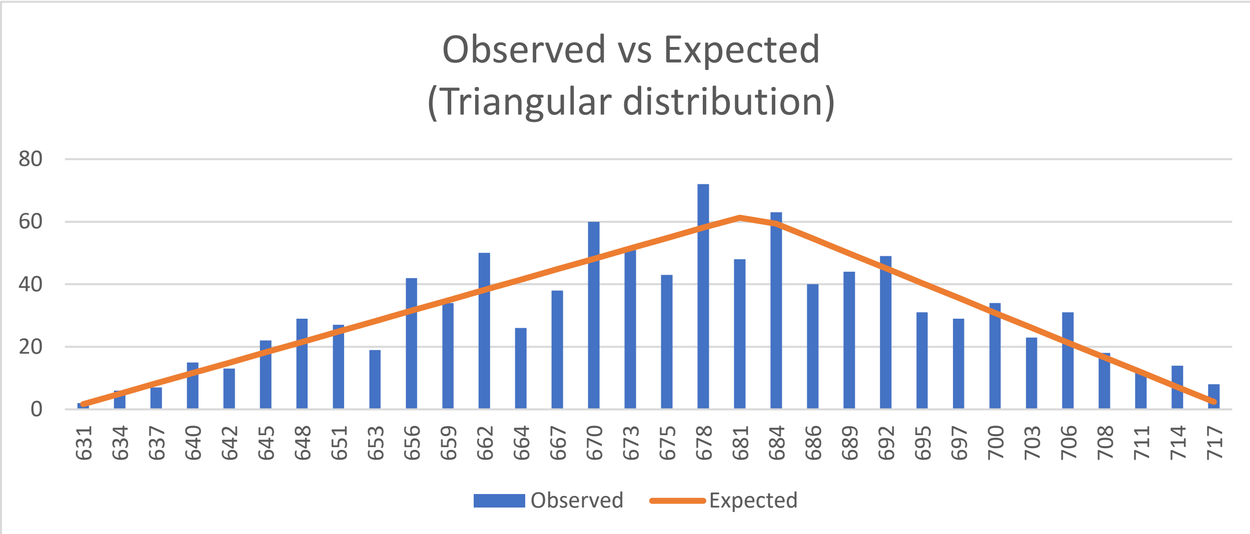
- Do not reject the null hypothesis that that minimum total costs have triangular distribution

(ii) Expected order quantity

Confidence Interval			
Significance level	0.05	Mean	675
Standard deviation of sample	18		
Sample size	1000	Confidence interval	
Margin of Error	1	[674 ~676]	

Explanation

1. I constructed a 95% confidence interval.
2. Since I do not have a population standard deviation, I use the sample standard deviation instead.
3. In general, sample SD can be used instead of population SD when sample size n is sufficiently large and drawn from a normal distribution. In this case, the sample size is large enough as 1000, it was extracted from the distribution of randomly generated numbers, and the population SD is unknown.



Interpretation

1. The Order Quantity is derived from the annual demand numbers generated by triangular distribution. I used EOQ as order quantity to calculate total minimum cost based on randomly generated annual demand.
2. As a result, the overall shape of the observed value is similar to the triangular distribution.
3. Therefore, the triangular distribution was used as the method for generating theoretical probability. The three parameters of the triangular distribution, a is the minimum of values, b is the maximum, and c is calculated as 3*mean - a – b which is driven by mean = a+b+c /3 formula.
4. 631 for a, 719 for b, and 676 for c (mode).
5. The expected frequency is calculated based on the above triangular distribution parameters, and a chi-square goodness of fit test was performed by comparing it with the existing observed frequency.

Chi-squared Goodness of fit test for triangular distribution

Step 0 Finding Key-Metrics
This test is to check the distribution of EOQ observed

Step 1 Hypothesis.
Null: The Triangular distribution is a good fit for this distribution
Alternative: The Triangular distribution is not a good fit for this distribution

Step 2 Find the critical value.

- The p-value is $\alpha = 0.05$

Step 3 Compute the test value.

Chi-squared Test Statistic:	72.46
Chi-squared P-value:	8.37612E-06
DF	28 (32-3 (parameters) – 1)

- The p-value with 1-CHISQ.DIST() and CHISQ.DIST.RT() in excel is 0.00

Step 4 Make the decision.

- There is enough evidence to reject null hypothesis since 0.00 (p-value) < 0.05

Step 5 Summarize the results.

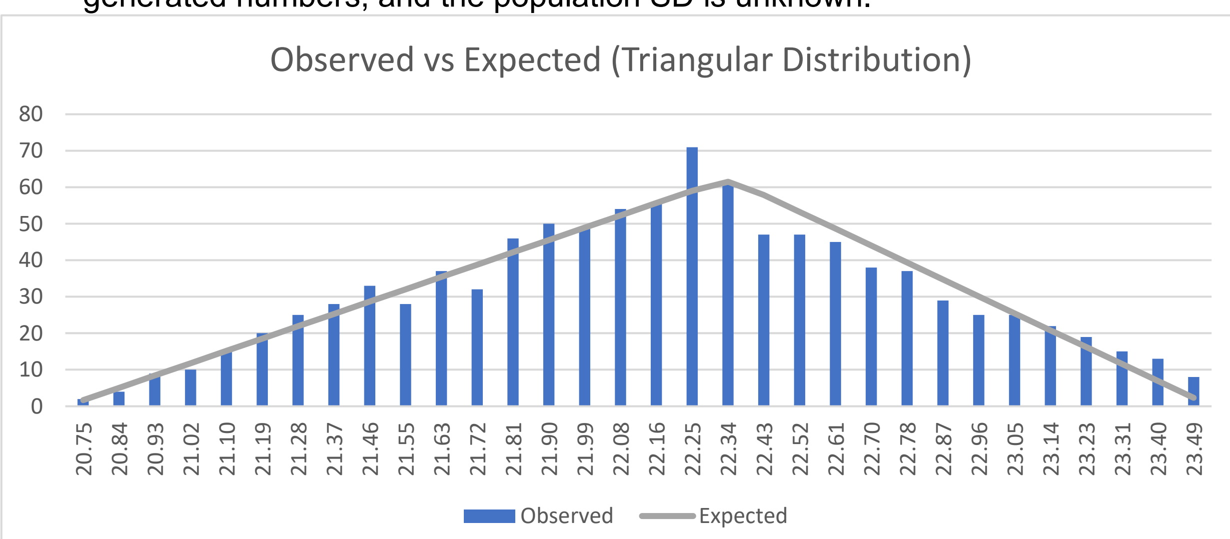
- Don't accept that the order quantity has triangular distribution.

(iii) Expected annual number of orders

Confidence Interval			
Significance level	0.05	Mean	22.119
Standard deviation of sample	0.6155		
Sample size	1000	Confidence interval	
Margin of Error	0.0381	[22.0806 ~ 22.1569]	

Interpretation

1. I constructed a 95% confidence interval.
2. Since I do not have a population standard deviation, I also use the sample standard deviation instead.
3. In general, sample SD can be used instead of population SD when sample size n is sufficiently large and drawn from a normal distribution. In this case, the sample size is large enough as 1000, it was extracted from the distribution of randomly generated numbers, and the population SD is unknown.



Explanation

1. The Annual Order number is derived from the numbers generated by triangular distribution. The overall shape of the observed value is similar to the triangular distribution.
2. the triangular distribution is used as the method for generating theoretical probability. The three parameters of the triangular distribution are 20.653 for a, 23.516 for b, and 22.187 for c (mode).

Chi-squared Goodness of fit test for triangular distribution

Step 0 Finding Key-Metrics

This test is to check the distribution of the annual order number observed

Step 1 Hypothesis.

Null: The Triangular distribution is a good fit for this distribution

Alternative: The Triangular distribution is not a good fit for this distribution

Step 2 Find the critical value.

- The p-value is $\alpha = 0.05$

Step 3 Compute the test value.

Chi-squared Test Statistic:	66.35
Chi-squared P-value:	5.93295E-05
DF	28 (32-3 (parameters) – 1)

- The p-value with 1-CHISQ.DIST() and CHISQ.DIST.RT() in excel is 0.00

Step 4 Make the decision.

- There is enough evidence to reject null hypothesis
  since 0.00 (p-value) < 0.05

Step 5 Summarize the results.

- Don’t accept that the order quantity has triangular distributed

Interpretation for (i), (ii), and (iii)

1. On the shape of the graph, there are frequencies that jumped up steeply between bins. Therefore, it seems difficult to explain with smooth-shaped distributions that we generally think of.
2. I tried using both normal distribution and triangular distribution in the first minimum total cost analysis. However, the p-value of the normal distribution was very small. It's hard for me to find a suitable distribution, so I decided to try a triangular

distribution for (i), (ii), (iii) which is the most similar shape.

3. I guess, the reason that it is hard to find a suitable distribution is that the EOQ is driven from ROUNDUP function. Since integer is not a continuous value, it seems that there is an aspect that is difficult to express clearly with distribution.
4. This problem also occurred in the process of calculating the minimum total cost in the PART 1. If we make all values as integer, the shape of the total can be changed to a segmented shape rather than a continuous shape.
5. However, in real business, it seems that this will happen a lot. At that moment, I need to decide based on information what elements need to be constrained with integers.

3. Answers for Questions

PART 1: Quantity Decision for Minimizing Total Cost

1. Define the data, uncontrollable inputs, model parameters, and the decision variables that influence the total inventory cost

Annual Demand	15000	Uncontrollable
Unit Cost	80	Parameter
Opportunity Cost	14.4	18% of unit value
Order Cost	220	Parameter
Order Quantity	-	Decision Variable
Average Inventory level	-	Dependent variable of decision variable
Annual number of Order	-	Dependent variable of decision variable

Annual Demand is 15,000. It is multiplied with the unit cost and used to calculate total cost. opportunity cost is estimated by the accounting department to be $14.4, which is 18% of the unit value (cost). Opportunity cost is used when calculating holding cost. The order cost is $220, multiplied by the annual number of orders, and used to calculate the order cost. These are all uncontrollable given values. The decision variable is Order Quantity. Values that change according to Order Quantity are Average inventory level and Annual number of orders.

2. Develop mathematical functions that compute the annual ordering cost and annual holding cost

Annual Ordering Cost	= Order Cost * Number of Order
Holding Cost	= Opportunity Cost * Average level of inventory
Total Inventory Cost	= Annual Ordering Cost + Annual Holding Cost
Total Cost	= Unit value * Total Demand + Total Inventory Cost

Relation between values	1. Order Quantity = Economic Order Quantity (EOQ) 2. Number of order = Annual Demand/Order Amount 3. Average level of inventory = EOQ/2

Annual holding cost is holding cost per unit per year * average inventory level. All calculations will use the concept of EOQ (Economic Order quantity). EOQ = square root of: [2SD] / H.
S = Setup costs (per order, generally including shipping and handling)
D = Demand rate (quantity sold per year)
H = Holding costs (per year, per unit) (Shannon, 2020)

The annual demand / EOQ = Number of orders. Average inventory level will be EOQ/2 (Melanie, 2020). Since EOQ must be an integer, I will calculate it via ROUNDUP function in Excel. EOQ is usually round up. This is because EOQ is the quantity that should be ordered to meet requirements of a period at the cheapest price. If we order a lower number, we might have to re order another lot, or place the next order faster- which might increase costs (Hardik, 20220).

3. Implement your model on an Excel spreadsheet.

Annual Demand	15000	Uncontrollable
Unit Cost	80	Parameter
Opportunity Cost	14.4	18% of unit value
Order Cost	220	Parameter
Order Quantity (EOQ)	678	Decision Variable
Average Inventory level	339	Dependent variable of decision variable
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Total Inventory Cost	9748.9	Annual Ordering Cost + Annual Holding Cost
Total cost	1209748.9	Unit value * Total Demand + Total Inventory Cost

EOQ was calculated as SQRT[2 * 15,000 (annual demand) * 220 (order cost) / 14.4 (opportunity cost)]. Accordingly, the EOQ has the value 677.0032004. However, as I said before, EOQ is usually roundup, so I will roundup and use 678. Based on this, the average inventory level calculated is 339. And the Annual number of order is 22.12. In this case, I decided that there is no reason for the average inventory level and annual number of order to be integers. For the average inventory level both ROUNDUP and ROUND DOWN could be used. Also, the annual number of orders can be decided between 22nd and 23rd.

4. Use data tables to find an approximate order quantity that results in the smallest total cost.

Order Quantity	Total Cost	Order Quantity	Total Cost
577	1209873.64	672	1209749.11
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717	1209764.91	679	1209748.89
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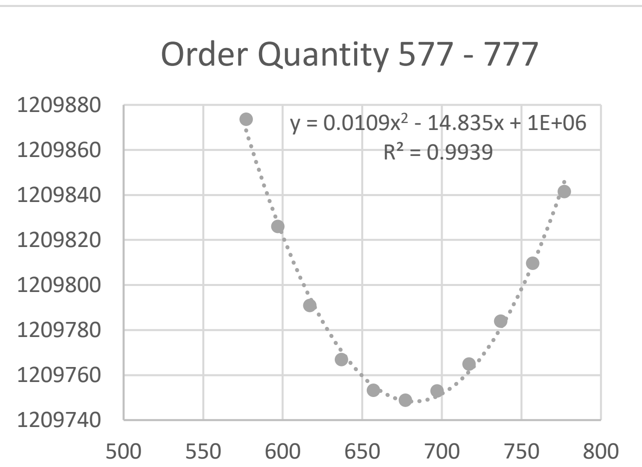
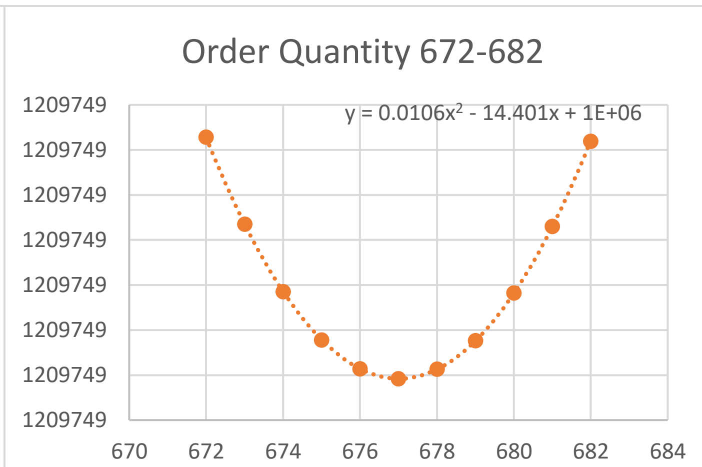
5. Plot the Total Cost versus the Order Quantity.





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6. Use the Excel Solver to verify your result of part 4 above

Solver Parameters

Set Objective	Total Cost (Minimum)
By Changing Variable Cells	Order Quantity
Subject to the Constraints	Order Quantity = Integer
Select solving method	GRG Nonlinear

Results of Excel Solver

Annual Demand	15000	Uncontrollable
Unit Cost	80	Parameter
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Average Inventory level	338.5	Dependent variable of decision variable
Annual number of Order	21.16	Order Cost * Number of Order
Annual ordering Cost	4874.44	Order Cost * Number of Order
Annual holding Cost	4874.40	Opportunity Cost * Average level of inventory
Total Inventory Cost	9748.85	Annual Ordering Cost + Annual Holding Cost
Total cost	1209748.8	Unit value * Total Demand + Total Inventory Cost

When using Excel solver, set as above. I also added constraints that Order Quantity must be integer. The value of EOQ using the Excel solver is 677. This is the ROUND figure of 677.0032 that was first calculated with EOQ formula. As you can see in the graph above. Among the integer values, the value with the lowest total cost is 677. However, I would like to make a final proposal of 678 due to the nature of inventory management.

7. <u>Conduct what-if analyses by using two-way tables in Excel</u>

1209749	216	217	218	219	**220**	221	222	223	224
70	1059036	1059057	1059078	1059098	1059119	1059140	1059161	1059181	1059202
71	1074100	1074121	1074142	1074163	1074184	1074205	1074226	1074247	1074267
72	1089164	1089185	1089206	1089228	1089249	1089270	1089291	1089311	1089332
73	1104228	1104249	1104270	1104291	1104313	1104334	1104355	1104376	1104397
74	1119291	1119312	1119333	1119355	1119376	1119397	1119419	1119440	1119461
75	1134353	1134375	1134396	1134418	1134439	1134461	1134482	1134503	1134525
76	1149415	1149437	1149459	1149480	1149502	1149524	1149545	1149567	1149588
77	1164477	1164499	1164521	1164543	1164564	1164586	1164608	1164629	1164651
78	1179538	1179560	1179582	1179604	1179626	1179648	1179670	1179692	1179713
79	1194599	1194621	1194644	1194666	1194688	1194710	1194732	1194754	1194775
80	1209660	1209682	1209704	1209727	**1209749**	1209771	1209793	1209815	1209837
81	1224720	1224742	1224765	1224787	1224810	1224832	1224854	1224876	1224898
82	1239780	1239802	1239825	1239848	1239870	1239892	1239915	1239937	1239959
83	1254839	1254862	1254885	1254907	1254930	1254953	1254975	1254997	1255020
84	1269898	1269921	1269944	1269967	1269990	1270012	1270035	1270057	1270080
85	1284957	1284980	1285003	1285026	1285049	1285072	1285094	1285117	1285140
86	1300016	1300039	1300062	1300085	1300108	1300131	1300154	1300177	1300199
87	1315074	1315097	1315120	1315143	1315166	1315189	1315213	1315235	1315258
88	1330131	1330155	1330178	1330201	1330225	1330248	1330271	1330294	1330317
89	1345189	1345212	1345236	1345259	1345283	1345306	1345329	1345352	1345376
90	1360246	1360269	1360293	1360317	1360340	1360364	1360387	1360410	1360434

Through the What if analysis, we can see how the total cost changes according to changes in Unit value and Order cost, which are Uncontrollable values. According to this analysis, in the case of Unit value 80, Order cost 220, and even one value that we first analyzed were the same, the total cost was all low. It is important to lower the total cost within a set value through EOQ, but if you can lower the fixed values of unit cost and order cost, you can reduce the total cost and the amount can increase significantly.

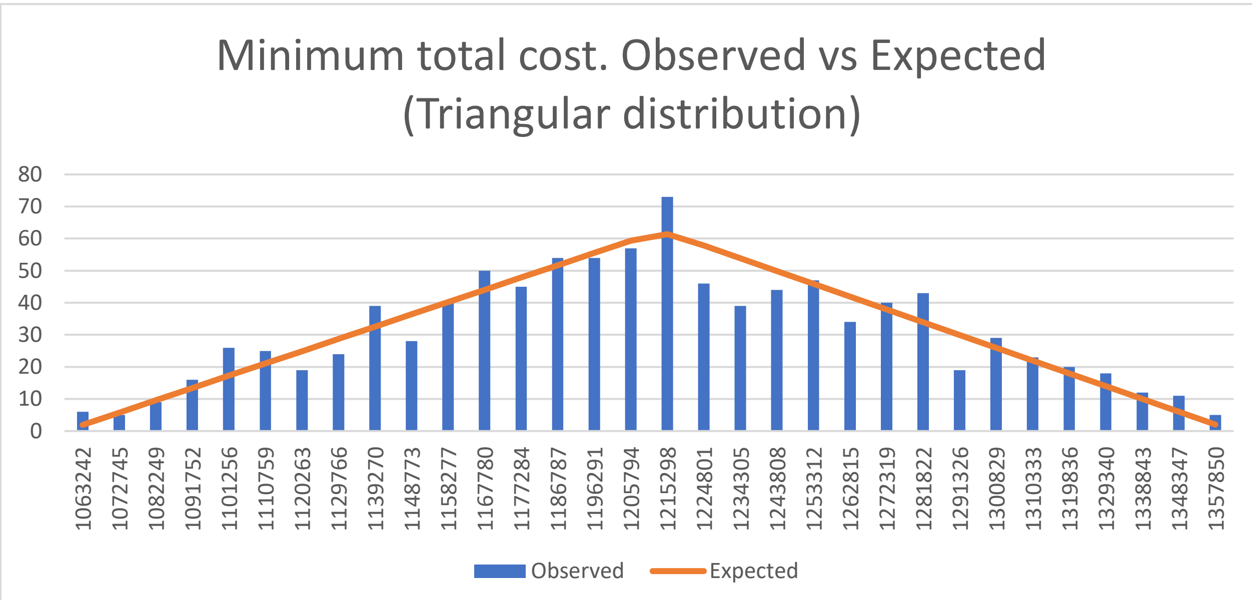
PART 2: Simulation with Triangular probability distribution

1,000 Random numbers			
Minimum	Maximum	Mean	Variance
13,078	16,858	15,003	642,788

1. <u>Estimate the expected minimum total cost by constructing a 95% confidence interval for it and determine the probability distribution</u>

Confidence Interval			
Significance level	0.05	Mean	1,224,470.5
Standard deviation of sample	65,981	Confidence interval	
Sample size	1,000	[1,220,381 ~ 1,228,560]	
Margin of Error	4,089		

I constructed a 95% confidence interval which is [1220381,1228560] for minimum total cost. Since I do not have a population standard deviation, I use the sample standard deviation instead.



3. The minimum total cost is derived from the annual demand numbers generated by triangular distribution. I used EOQ as order quantity to calculate total minimum cost based on randomly generated annual demand. The three parameters of the triangular distribution, 1,056,201 for a, 1,362,280 for b, and 1,209,992 for c (mode).

Chi-squared goodness of fit test for Triangular distribution

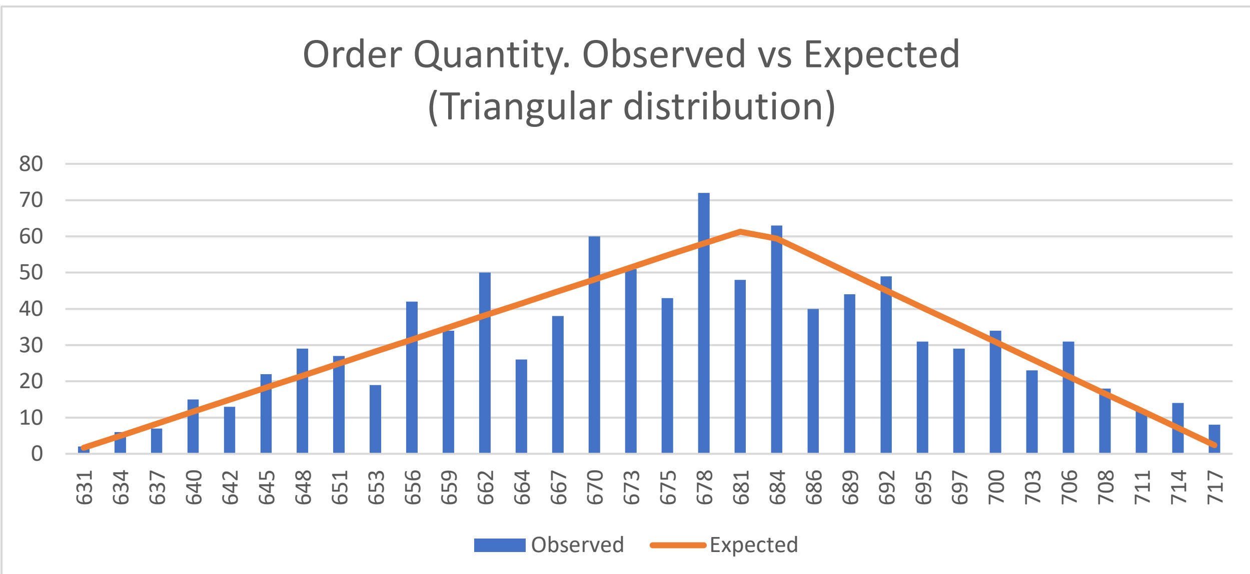
Chi-squared Test Statistic:	40.87
Chi-squared P-value:	5.52404E-02
DF	28 (32-3 (parameters) -1)

- Null hypothesis is 'The Triangular distribution is a good fit for this distribution'. There is not enough evidence to reject null hypothesis since 0.055 (p-value) > 0.05. Do not reject the null hypothesis that that minimum total costs have triangular distribution

2. Estimate the expected order quantity by constructing a 95% confidence interval for it and determine the probability distribution

Confidence Interval			
Significance level	0.05	Mean	675
Standard deviation of sample	18	Confidence interval	
Sample size	1000	[674 ~676]	
Margin of Error	1		

I constructed a 95% confidence interval which is [674,676] for order quantity. Since I use the sample standard deviation instead of population SD.



The Order Quantity is derived from the annual demand numbers generated by triangular distribution. I used EOQ as order quantity to calculate total minimum cost based on randomly generated annual demand. The three parameters of the triangular distribution, a is the minimum of values, b is the maximum, and c is calculated as 3*mean - a – b which is driven by mean = a+b+c /3 formula. 631 for a, 719 for b, and 676 for c (mode).

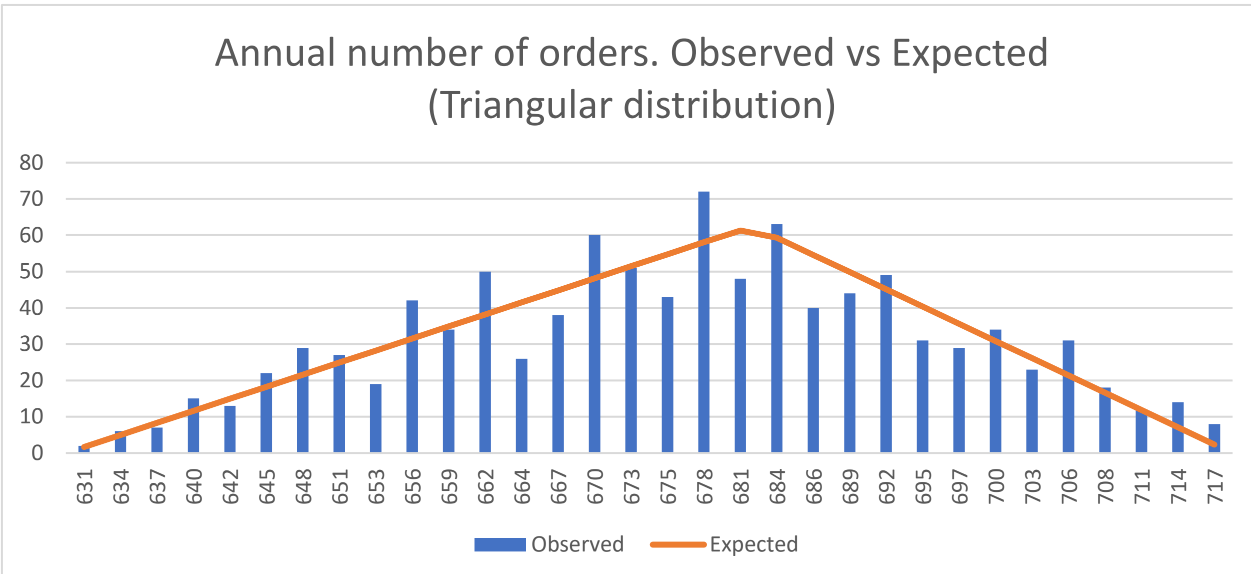
Chi-squared goodness of fit test for Triangular distribution	
Chi-squared Test Statistic:	72.46
Chi-squared P-value:	8.37612E-06
DF	28 (32-3 (parameters) – 1)

Null hypothesis is ‘The Triangular distribution is a good fit for this distribution’. There is enough evidence to reject null hypothesis since 0.00 (p-value) < 0.05. Don’t accept that the order quantity has triangular distribution.

3. <u>Estimate the expected annual number of orders by constructing a 95% confidence interval for it and determine the probability distribution</u>

Confidence Interval			
Significance level	0.05	Mean	22.119
Standard deviation of sample	0.6155	Confidence interval	
Sample size	1000	[22.0806 ~22.1569]	
Margin of Error	0.0381		

I constructed a 95% confidence interval which is [22.0806 ~22.1569] for annual number of orders. Since I use the sample standard deviation instead of population SD.



The annual number of orders is derived from the annual demand numbers generated by triangular distribution. I used EOQ as order quantity to calculate total minimum cost based on randomly generated annual demand and based on EOQ, I calculated the annual number of orders. The three parameters of the triangular distribution, 20.653 for a, 23.516 for b, and 22.187 for c (mode).

Chi-squared goodness of fit test for Triangular distribution

Chi-squared Test Statistic:	66.35
Chi-squared P-value:	5.93295E-05
DF	28 (32-3 (parameters) – 1)

Null hypothesis is ‘The Triangular distribution is a good fit for this distribution’. There is enough evidence to reject null hypothesis since 0.00 (p-value) < 0.05. Don’t accept that the order quantity has triangular distribution.

4. CONCLUSION

I think about the factors that affect total inventory cost and checked scenarios on how to achieve the minimum cost. In the process, I tried to manage inventory through the concept of EOQ. And in the process of determining the EOQ in detail, I decide how to manage it if it was an actual problem, and then proceeded with a round-up calculation. Through what-if analysis, I also notice that other costs affect a lot in total cost.

And, as previously analyzed, I created a distribution based on the limited information given, generated a new random number, and then determined what shape the distribution have. I guess, it was difficult to find a shape that followed a specific distribution, because a continuous graph shape did not come out with round up function. I need to learn how to predict the data in this case through additional learning.

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