**Module 4: Week 4 Introduction to Enterprise Analytics**

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**Instructor’s Name:** Dr Alex Huang

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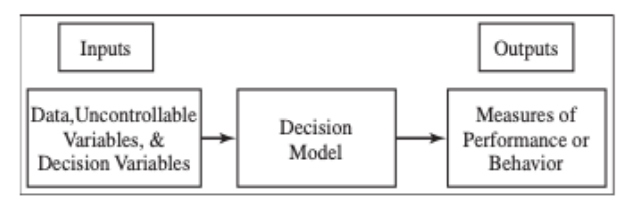


**Introduction**

This assignment is based on the concept of “Decision Modelling”. In layman’s terms a decision model is the one which is developed for understanding, examining or to make a action plan in order to make business decisions. So basically, there are three type of inputs parameters which are feeded to the decision model:

1. Data: Which includes all the capital spend, all the hardware cost and travel cost if any spend for the transportation.
2. Uncontrollable variables: It includes those variables which are variable and can change at any point of time but with a condition that they are not in the control of decision makers like for example customer demands can vary at any time and decision makers have no control on this.
3. Decision Variables: These are the one which are controllable and are selected at the discretion of decision-making team.

It can be summarized as follows in the diagram:



There is as such no mathematical formula to calculate and generalize this model. As there are following types of decision models:

1. Descriptive/ Predictive: these illustrate the relationship among parameters like regression models
2. Prescriptive: Providing best optimized process or solution for decision makers to maximize or minimize the objectives.

Now coming to our problem statement, so we have been provided with an “Inventory Management Decision Model”. So here the decisions that a manager has to face are how much additional inventory is required, when it is required and what would be the additional cost required along with the inventory cost which includes holding costs, ordering costs.

We have been provided with the scenario that the managers of a manufacturing company are not sure about the decision making for the inventory management. Yearly demand for the inventory is estimated to be nearby 15000 units and which is going to remain constant throughout the year. Per unit cost is 80 dollars. Holding cost is provided as 18% of the unit value and it is provided to us that each order is provided with the supplier cost of 220 dollars. We have been provided with the assumption that the inventory is going to be finished immediately after the order. We have been provided with the metric that the company needs to take care of meeting all the demand and it should be known ahead of time.

I would like to explain the logic and problem solution in the analysis section step by step.

**Analysis**

**Part 1:** In this section we have to use excel to prepare a decision model.

1. We have to first define our parameters for the decision model.

Data: Following would be the data parameters in our problem statement:

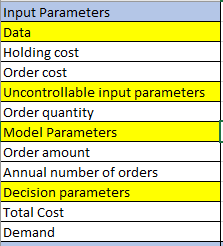
Holding cost, order cost

Uncontrollable Inputs: order quantity

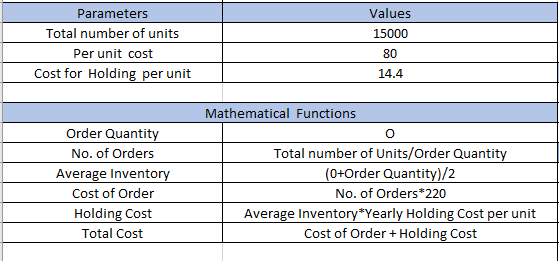
Model parameters: order amount and annual number of orders

Decision parameters: total cost and demand

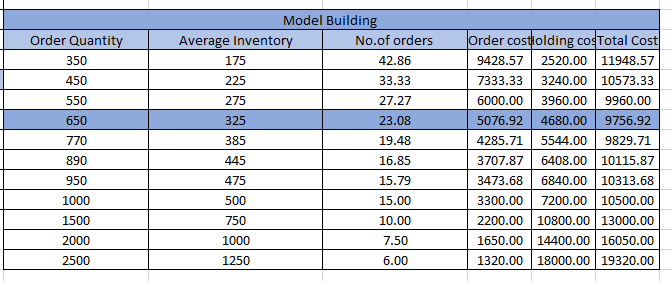
Here is the screenshot for the same from the excel file:



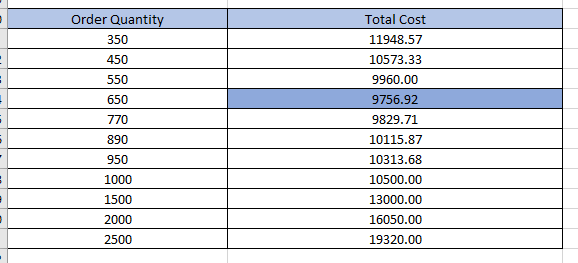
1. Now we have to provide the mathematical formulas for making calculations:



1. Now we have to build the model on the mathematical formulas we have defined above:



1. From the above model that we have build on the data set we can see that the best optimized cost is appearing for order quantity 650.

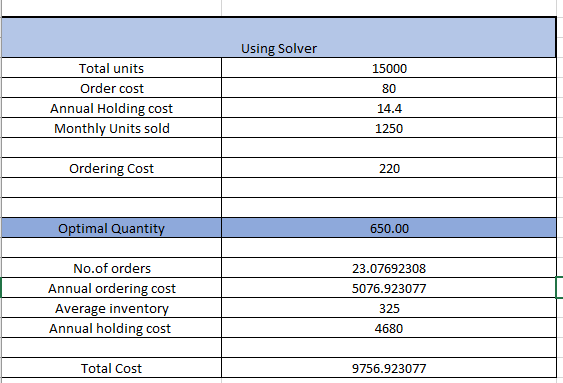


1. Plotting total cost and order quantity

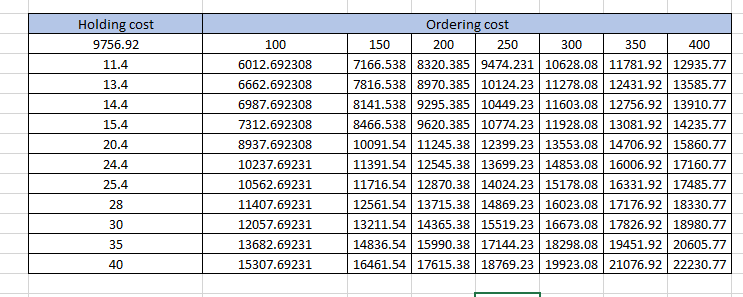


From the above plot we can conclude that the relationship between the total cost and order quantity is increasing exponentially.

1. In part 4 of this problem we can use excel solver to validate the results as follows:



1. Now we have to apply the what if analysis utilizing the two-way tables for examining the sensitivity of total cost which is going to vary in the model parameters. Here is the implementation for the holding cost and ordering cost.



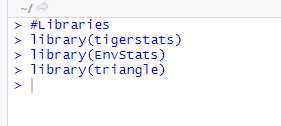
From the above results we can see the variations in the prices for the most optimal value. I have picked up the slots with a difference in values by a scale of 50. Since the annual holding cost is 14.4 so the intervals for holding cost is chosen accordingly. The sensitivity of the price can be clearly seen if we are increasing the ordering cost with a interval of 50 it is continuously increasing and also if the holding cost is increased with the scale then also the prices are increasing continuously.

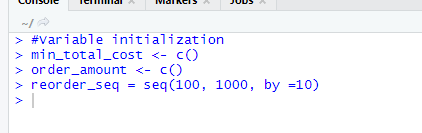
1. This I will be explaining in the conclusion part.

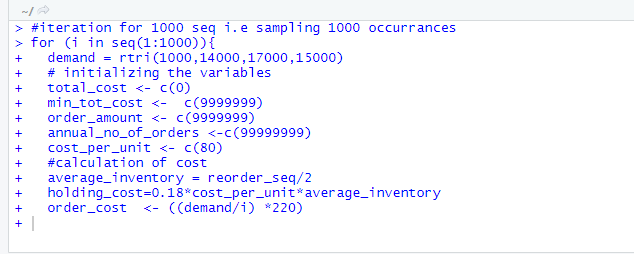
**Part 2:** We have been provided with the assumption that all the parameters are having same values provided in the part 1. Also, we have been provided with the data that triangular probability distribution is between 14000 and 17000 units and the peak value is 15000.

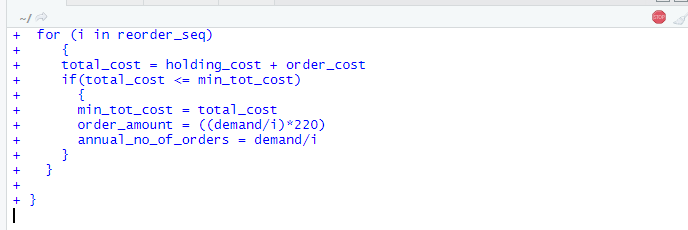
1. In this we have to do a simulation for 1000 occurrences and need to calculate the minimum total cost for each occurrence:

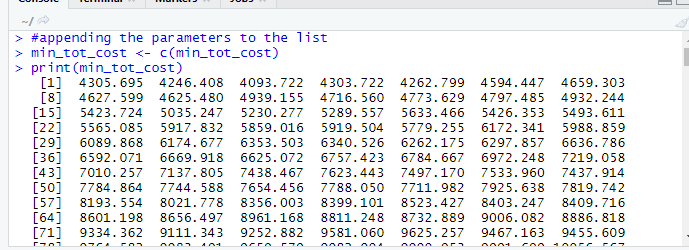
Here is the logic for the same:

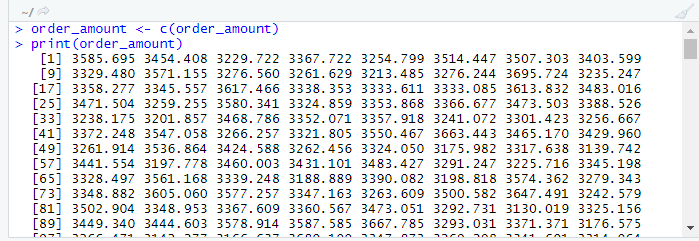


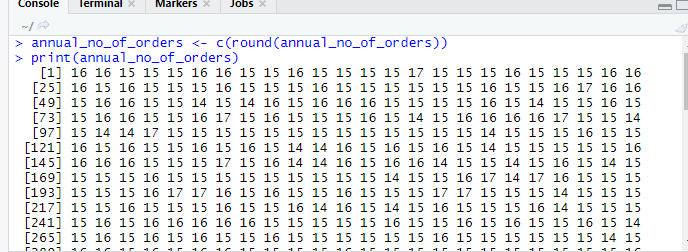


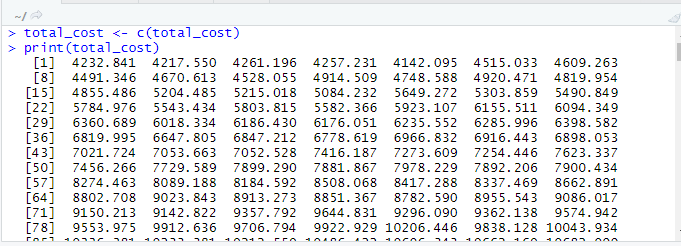


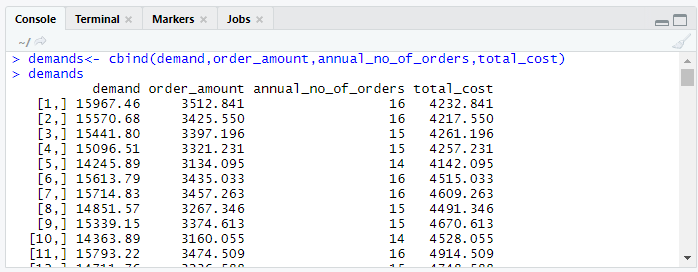






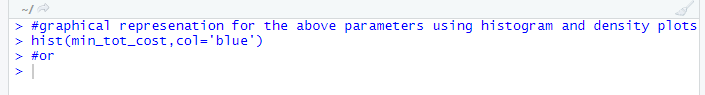


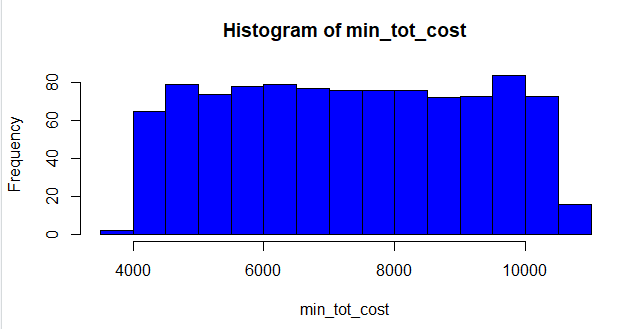


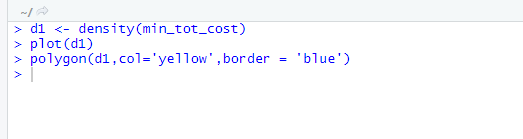


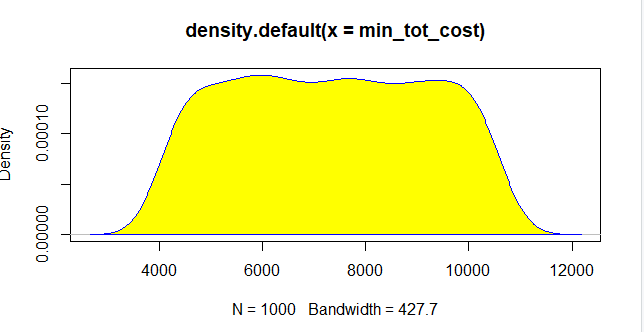
From the above results we can see the demand for each ordered amount and annual number of orders. Also, I have calculated the minimum total cost for each occurrence as mentioned in the problem statement.

Now in order to understand the trend of the parameters I plotted the histograms and density plots for each and the logic is as follows:

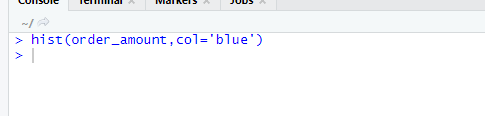


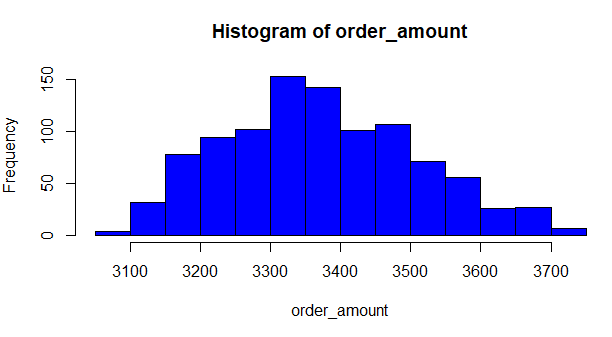


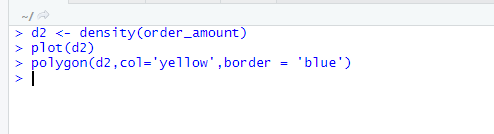


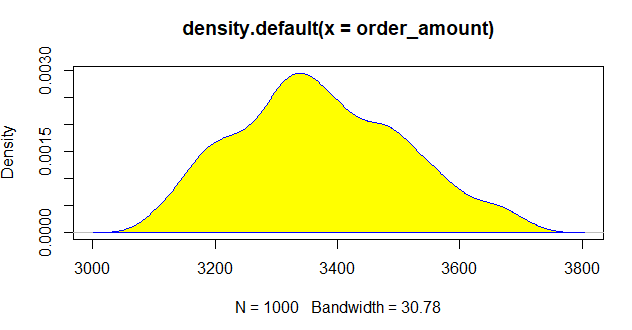


From the above plot we can observe that the behavior is distributed throughout and it is uniform too.

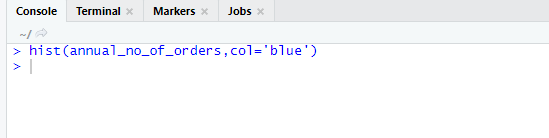


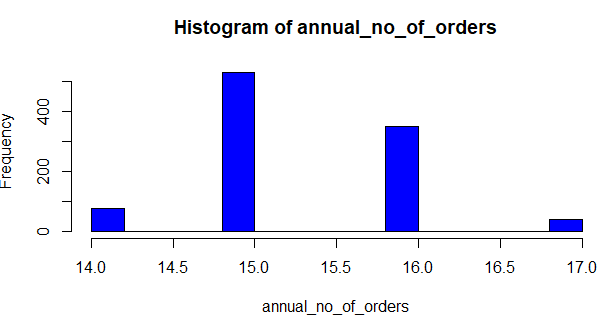


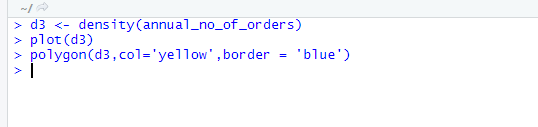


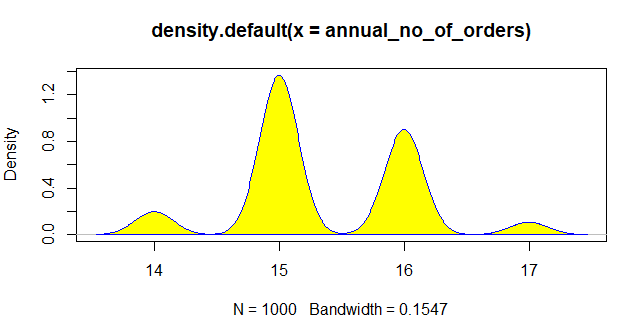


From the above plots we can conclude that the shape is nearly bell curved shaped.



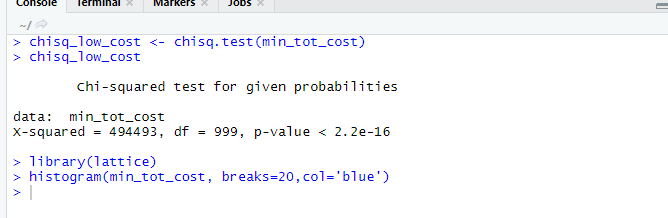


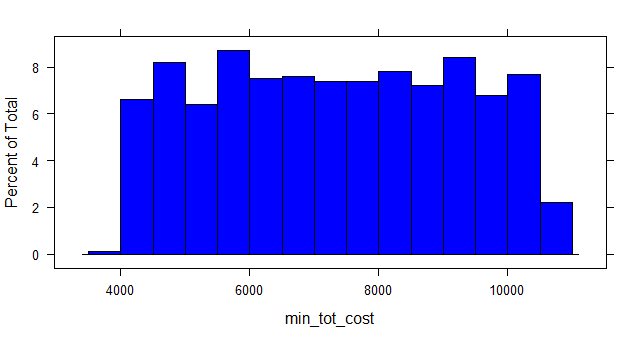


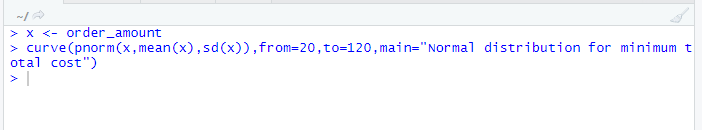


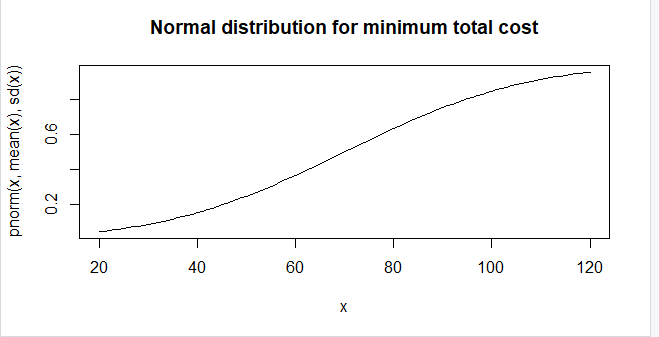
From the above plots we can conclude that the shape is non uniform distribution for annual number of orders**.**

1. In this we have to analyze the probability distribution for minimum total cost.



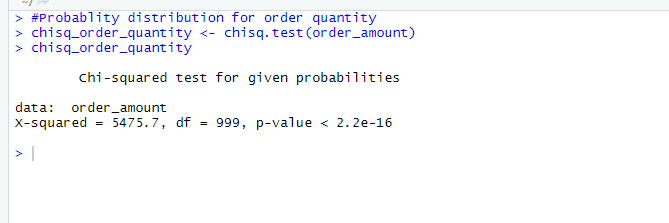


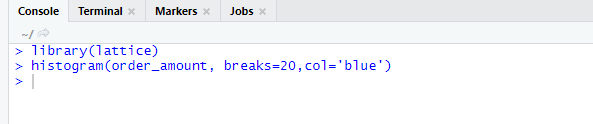


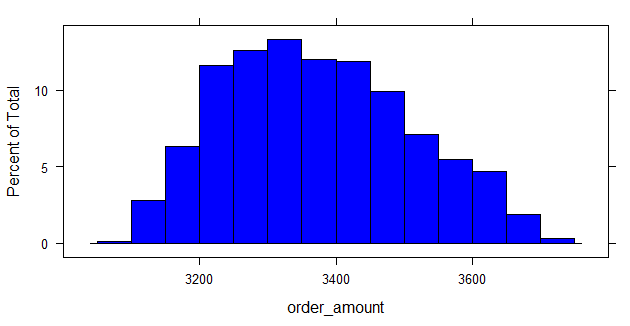


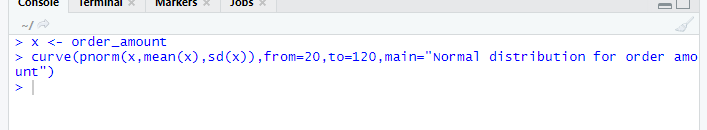
In this I did a chi-squared test for doing the analysis that is the minimum total cost showing uniform distribution or not. And our hypothesis is true as well. Since the p value is coming fine. Also plotted the pnorm curve for the same which is showing uniform distribution too. Maximum value lies between 5500 to 6000 and average number of values lies between 6000 to 8000.

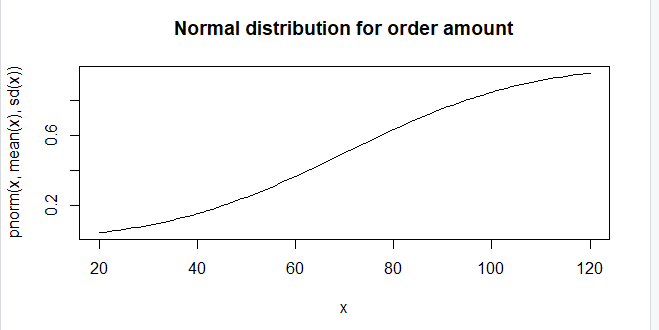
1. Probability distribution for order quantity.





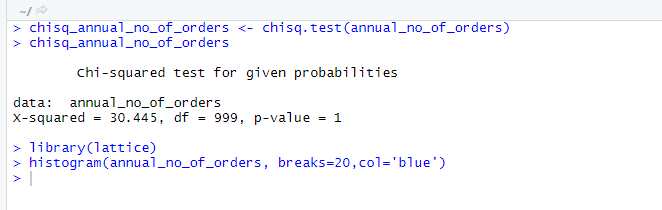


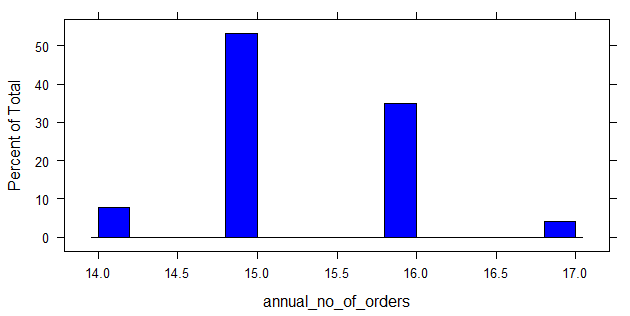


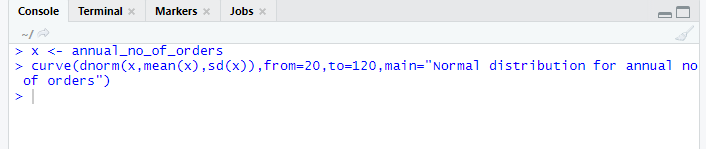


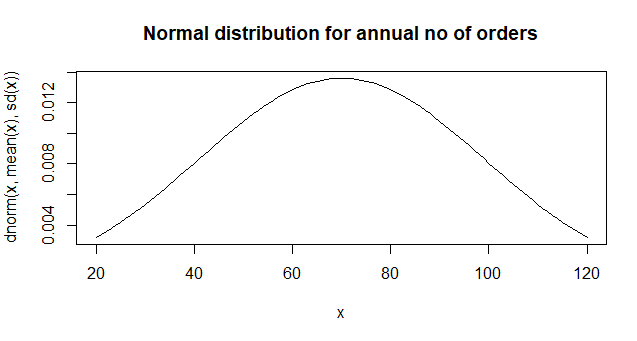
From the above results we can conclude that the order quantity is showing a bell-shaped curve and the hypothesis is also true. From the pnorm curve we can conclude that the distribution is normal. The maximum value lies between 3300 to 3400.

1. Probability distribution for the annual number of orders.









From the above results we can see that the distribution is non uniform. Also the hypothesis is coming as per our observations. As we can see from the histogram most of the number of orders lies near 15 so this is the maximum value for annual number of orders.

1. This I am going to explain in conclusion section.

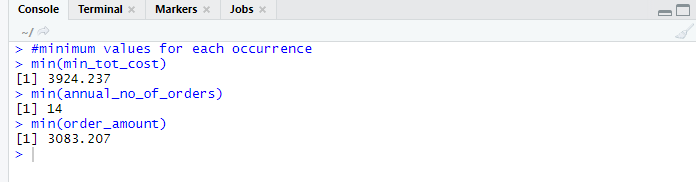
**Conclusion**

1. From the results of the first problem statement I would like to explain to the vice president that the most optimal value for the order quantity is 650 and the total cost is nearby 9756.92. So, we studied the trends for this price and based on the same we found that the ordering cost is also varying for this specific range of the amount. Here is the trend for the same:



So, we have to maintain a average inventory of 325 and the average number of orders are 23 for the same and with this we can have the minimum prices running between 9700 to 10000. As with this we are able to meet the demand and maintain the demand ahead of time.

1. From the results obtained for 1000 occurrences we can observe that the most optimal values are as follows for all the parameters:



So, the most optimal value for the minimum total cost is 3924.237 for annual order value of 14 and the order amount is 3083.207.

So, to the vice president I would present this data so that the decision model can be prepared based on the above data that we have observed and now we can decide how much we can order for additional inventory cost, cost of holding inventory and cost of ordering.

# References

1. <https://s3.us-east-1.amazonaws.com/blackboard.learn.xythos.prod/5a3148150d016/19678550?response-content-disposition=inline%3B%20filename%2A%3DUTF-8%27%27ALY6050%2520Week%25204%2520-%2520Winter%25202020%2520Huang.pdf&response-content-type=application%2Fpdf&X-Amz-Algorithm=AWS4-HMAC-SHA256&X-Amz-Date=20200205T203817Z&X-Amz-SignedHeaders=host&X-Amz-Expires=21600&X-Amz-Credential=AKIAIL7WQYDOOHAZJGWQ%2F20200205%2Fus-east-1%2Fs3%2Faws4_request&X-Amz-Signature=bb771bd6b023931c6c2e39d1716b5bcc0188c7b67c2c2f05d1f6766e08997d55>
2. <https://s3.us-east-1.amazonaws.com/blackboard.learn.xythos.prod/5a3148150d016/19678548?response-content-disposition=inline%3B%20filename%2A%3DUTF-8%27%27Week%25204%2520-%2520Jupyter%2520Notebook.pdf&response-content-type=application%2Fpdf&X-Amz-Algorithm=AWS4-HMAC-SHA256&X-Amz-Date=20200205T012359Z&X-Amz-SignedHeaders=host&X-Amz-Expires=21600&X-Amz-Credential=AKIAIL7WQYDOOHAZJGWQ%2F20200205%2Fus-east-1%2Fs3%2Faws4_request&X-Amz-Signature=70fbebd88cad424719cb97a2e0857448c521d646540baf13c84c612388a3d8e3>
3. “Chi-Square Test of Independence in R.” *STHDA*, [www.sthda.com/english/wiki/chi-square-test-of-independence-in-r](http://www.sthda.com/english/wiki/chi-square-test-of-independence-in-r).
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5. <http://ceur-ws.org/Vol-2093/paper1.pdf>
6. IgnacioIgnacio 5, and bgoldstbgoldst 27.8k44 gold badges2727 silver badges5353 bronze badges. “Create an Empty List to Fill It up with Lists in R.” *Stack Overflow*, 1 Mar. 1965, stackoverflow.com/questions/29307810/create-an-empty-list-to-fill-it-up-with-lists-in-r.