BA 406 Exam 1 Case Study

Rules are as follows:

1. You can work with anyone in class. Please create a worksheet within you solution file called: Collaborators. Within this Collaborators page please list anyone else in class or otherwise that you discussed the case with.
2. You must change the file name and properties. To do this, go to File, Click on Info, there on the right side, you will have properties, click properties, which should give you an option of Advanced Properties, Click on Advanced Properties. This will cause a pop-up window to open. Click on the Summary tab of the pop up and modify the file properties. Title will be “Exam1\_YourFullName”, for subject enter your 900 student number. For Author put your name, Company please enter FLC.

**Inventory Simulation**

The problem information and background:

Suppose that you have a small hardware store sells Bluetooth speakers for camping. Daily demand for these speakers is relatively low but is subject to some variability. Over the past 300 days, data was collected on the daily demand for these specific speakers. The demand frequency and relative frequency (probability) is given the following table.

|  |  |  |
| --- | --- | --- |
| **Demand** | **Frequency** | **Probability (Relative Freq.)** |
| 0 | 15 | 0.05 |
| 1 | 30 | 0.10 |
| 2 | 60 | 0.20 |
| 3 | 120 | 0.40 |
| 4 | 45 | 0.15 |
| 5 | 30 | 0.10 |
| **Total** | **300** | **1** |

Recall, the relative frequency is given by dividing the frequency by the total number of observations. For example, for case when the demand is equal to 0 (none bought), the frequency is 15, meaning that out of the 300 days of sales only 15 days there was no demand for the speakers. Moreover, the probability is equivalent to the relative frequency, which is nothing more than dividing the frequency of 15 by the total 300 15/300=0.05. The probability if we have 0 demand for the speaker is roughly 5% or 0.05. The same is done to determine the probabilities of the other demand amounts. The probability that in any given day there is demand for 1 speaker is 10% or 0.10.

Since, these speakers are from a third-party company, (a company who makes the speakers or a wholesaler) there is no manufacturing of the speakers in house, instead when the inventory is low a new order is placed. When an order is placed to replenish the inventory of speakers, the time between when the order is placed and when it is received (i.e., the lead time) is probabilistic. Based on the past 100 orders you have found that the lead time follows a discrete uniform distribution between 1 and 3 days. This simply means that the time it takes from when the order is placed until it arrives has equal probability of being 1 day, 2 days, or 3 days. Another way to think of this is to think that there is a .33 or 33% chance that it will arrive a day later, 2 days later or three days later.

There are currently 7 speakers in stock on the shelves of the store and there are no orders due (meaning we have not yet placed a new order. The amount we order from the third-party company is known as the “order quantity”, or Q, and the “reorder point” is known as R. The order quantity, Q, is the number of speakers we choose to order from the third-party company. For example, if I chose to place an order, I may choose to order 10 speakers as that is how many fit nicely on the store shelf. Similarly, think of R or the reorder point as being the number of speakers at which point, we know it is time to place an order to get more speakers, this is known as the reorder point. To explain this, consider the following example, suppose we set the reorder point to be 5, that would mean that the moment our speakers on the shelf are at 5 or less we place an order for Q speakers (or 10 as in previous example) from the vendor.

The goal of the case is as follows, we want to identify the order quantity, Q and the reorder point, R, that will help reduce the total monthly costs. In this case we will need to create a spreadsheet that computes the month as being 25 days long (closed on somedays). The total costs include the following three components: a fixed order cost, a holding cost, and a stockout cost.

These cost breakdown as follows: It is estimated that the fixed cost of placing an order with the speaker supplier is $20 dollars, this is not based on Q, meaning the number ordered is irrelevant, each time we place an order it costs 20 dollars. The cost of holding a speaker in stock is about $0.02 per speaker per day. Each time demand is not satisfied (i.e., this is what stockout means), the customer buys a speaker elsewhere, and the store loses the sale. It is estimated that the cost of a stockout is $8.00 per speaker. Assume that the store operates 25 days each month on average.

Note: the goal is to create a what if model that can analyze the two main decision variables (Order Quantity, Q, and the Reorder Point, R). To start use Q=10 and R=5 % and generate the simulation of a 25-day period. To help you follow the procedure below and create the spreadsheet model.

The primary goal of the case is to answer the following question: What is the optimal Q and R values, which minimize the monthly costs.

BONUS GOAL: Use the Scenario Manager and try Q= 8, 10, 12, and 14 and R= 5 and 8.

To help you create the following phases:

1. Open a workbook and assure that the settings are set. Once they are set, create a worksheet named: RandomDemand.
   1. In RandomDemand develop a way to draw a random number from the demand frequency above. The following are hints to help you. Once, completed leave only the mechanism and the validation in the worksheet.
      1. Use the function RAND(), read up on it and experiment with it.
      2. Use the function Lookup(), read up on it and experiment with it.
      3. Create a cumulative distribution to lookup. Create a vector that is the lower limit of each outcome. For example, cases of 0 demand is between 0 and .05, for 1 demand it is from .05 to .15 and so on. Consider doing some research, you may look online regarding how to make a random number generator using lookup.
      4. The goal of this sheet is to learn how to draw a random number from the distribution, for example, it should return a number that can be 1,2,3,4, or 5. It should do so by using the lookup(), rand(), and some information you create. To check that it works properly, generate 1000 rows of data once you’ve figured out the function,(meaning repeat the function 1000 times) then count the outcomes it should come out such that 0s should be seen approximately 5% of the time and so on for all the other outcomes. You will see variability in the output. Hit F9 a few times to make sure. The goal of this worksheet is to determine the function that you will create a daily demand value. Hitting the F9 key will change the number.
      5. Create a line plot of the 1000 values and a histogram with the original distribution and the one obtained from the 1000 values. To create a distribution consider using the countif function. They should be close not exact but close.
2. Create a new worksheet. Name this worksheet: RandomLead
   1. In RandomLead the goal is to create the mechanism to which to generate a random lead time. The following hists will help you. All of the following should be within the worksheet.
      1. Use the function randbetween(), read up on it and experiment with it.
      2. Validate that the function works as expected, again generate 1000 values using your function. Count the outcomes and determine that each is approximately observed 33% of the time. Create a simple histogram with the outcomes as x and bar height as probability. It will not be exact; it is statistics and there will be variability, but it should be close. Specifically, for each outcome the probability should be roughly 0.3333. Once, completed this sheet should only contain the function, and the validation plot, and the 1000 samples generated, as well as the distribution.
3. Phase 1 and 2 should result in two functions and you knowing how to use them, and what information is needed to make them function correctly. Once completed, create a worksheet named: Constants
   1. Within the Constants worksheet you should incorporate the following. The distribution and name the vectors and constants as required. This should include, Order Fixed Cost, Unit Stockout Cost, Order Quantity Q, Reorder Point R, Unit Holding Cost, Max Lead Time, Min Lead Time, Beginning Inventory, and Demand Probability and Demand Outcome.
   2. Once everything has been organized and properly named you are complete with phase 3. Check the name manager to assure that all is well.
4. Phase 4 Here is where you must create a monthly model. To do this, create a new worksheet named: Monthly Sim. In Monthly Sim you will create the calculation required to simulate the inventory for the 25-day month. Thus, in this worksheet you will compute/determine the following:
   * 1. NOTE: Day 1 will be different as it is the initialization of the system.
5. Day: This is just a series of numbers going from 1 through 25.
6. Beginning inventory: This is the daily number of speakers per day
7. Units Received: This is the number of speakers you obtained from an order. These are the units that you expect to receive in a single day. To begin we assumer none are due to arrive at day 1. Day 1 is you initial day and will be slightly different than any other day.
8. Available Inventory: Is the number units on the shelve, that is for any given day this is the beginning inventory and the Unit Received from the third-party company. For example, suppose you have 10 speakers in the beginning of the day, then 10 speakers arrive from the third-party seller. Then the units available for sale are 10+10=10 speakers.
9. Demand: This is where the function developed in phase 1 of this case is used to draw a random demand from the distribution given. This function should only return a demand in the form of 0,1,2,3,4, or 5.
10. Demand Filled: This is the amount of demand that we can supply. For example, if we have demand of 4 and we have only 3 units available then the amount of demand we can fulfill is 3 as we do not have 4 speakers to fulfill the demand entirely. In this scenario we would also have a stockout of 1 speaker as we were short 1 speaker to meet the daily demand.
11. Ending Inventory: is it the difference what we had available to sell and how much demand we had. If we have 10 speakers for sale then we have a demand for that day of 3, then the ending inventory is 7.
12. Stockout: is when we are not able to fulfill the demand. That is the difference between the demand and the demand filled. If we have enough speakers to fill the demand, we will have a stockout of 0, and conversely if we are not able to fulfill the demand then we should have a positive stockout. Say we have 5 units demanded then we only have 4 available then we lost a sale, we had a stockout of speaker. Meaning we were out of stock one speaker to meet the demand. This will generate a stockout cost for the day.
13. End Inventory+Order: This is a special variable, it will be used to track all the orders that are due so that it prevents us from order too much. So that it tracks how many speakers we have in stock plus what is due from previous orders. Recall that because the lead time can take up to three days, it can take up to three days to get an order in to add to our inventory. What we don’t want to do here is place a lot of order when there are some orders that will be due to arrive soon. On day 1, we will have no orders due therefore will be just the ending inventory amount. However, for future days you will need to assure you account for orders that did come in during the day.
14. Place Order?: Is a binary that is, it is 1 if the End Inventory+Order is below our order point, otherwise this should be a zero. This variable will serve as an indicator that an order needs to be place. Think of 1 as a yes we must order more speakers and 0 if we still have sufficient speakers in stock.
15. Lead Time: this is where the function determined in phase two comes into play. Use the function to draw a random number according to the uniform distribution. The cell should only be populated by 1,2, or 3, no other outcomes are possible. This signifies that if an order is placed then this lead time variable contains the number of days the order could take to arrive.
16. Arrives on Day: This is a conditional check to determine when our order will arrive. For example, if our Place Order? Variable is a 1, then we should place an order, then we need to determine on which day it will arrive. The easiest way to think of it is as follows, on day 1 suppose you are going to need to make an order (i.e., PlaceOrder?=1), then we know that the time it will take to arrive is the Lead Time plus 1 day. Example of this is suppose we have PlaceOrder=1, and LeadTime=2, then the arrival day will be on day 4. This is because we are in day one, the day the order is placed it will take two days to get here (day 3), but we will not have it stocked until the next day resulting in day 4.
17. Holding Cost: this is the cost of holding speakers on the shelves. This is nothing more that Ending Inventory multiplied by the fixed holding cost per unit.
18. Stockout Cost: this is the number stocked out each day multiplied by the $8 stockout cost.
19. Order Cost: If we place an order (i.e., Place Order? =1) then this is a fixed cost of 20. The cost will be the same regardless of quantity of speakers ordered.
20. Total Cost: This is the sum of all the costs, the holding cost, the stockout cost, and the order cost.

Hints for all subsequent days: The daily beginning inventory of the next day will always be the ending inventory of the previous day. Units Received need to account that you may have placed an order in the past, that may be arriving on a day down the road, this is where the order quantity needs to be considered. If an order was placed on day 1 and is set to arrive on day 4, then on day four we must add the Q to the inventory (hint hint: use a fancy countif result multiplied by the Order Quantity Q). Another key change is beyond day 1 Ending Inventory+Order must also change for subsequent days. It must consider the ending inventory for the previous day minus the demand filled on what ever day you are on (not day 1) plus the number of speakers ordered the previous days. NOTE: Here consider that if we placed an order, we want to account that some number of units may be arriving soon, this will prevent us from place to many unnecessary orders. Basically, it accounts that we already have inventory coming our way. Specifically, consider the example, if the previous day’s ending inventory is 4, and we satisfied a demand (i.e., demand filled today= 4) and The previous day we decided to place an order (i.e., PlaceOrder?=1), then the End Inventory+Order is 10, this will require you using the place order \*order quatity to determine the size of the order based on the order quantity. If all has gone well the

1. When phase 4 is complete, prior to leaving this worksheet, compute the total costs across all 25 days within the sheet. That is sum up all the holding cost for the 25 day month, sum all of the stockout costs for the entire month, and sum all order costs for the entire month. Name these costs (organized in a vector): Monthly Cost Totals.
2. In another part of the MonthlySim Worksheet, create a large table. This table will be exactly 2021 rows. Label the rows 1 through 2021, This will correspond to the number of simulations carried out. In the columns you can copy the monthly costs each one, or as a vector. Remember if you get zeros when using the name, use =@Monthly\_Cost\_Totals to make sure it separates the vector. Run the data table, giving it an empty cell as the column input. This will simulate 2,021 months of this inventory system.
3. Phase 6 Create a new worksheet named SimPlay. Here is the interface and result summaries. Create the following:
   1. Create Buttons like banners where You display the average Monthly Holding Cost, the Average Stockout Cost, The average Monthly Order Cost, and the average of the monthly Total Cost. This should be linked to the original simulation. The average is taken from the 2,021 simulations.
   2. Generate a histogram for Total Monthly Costs. This can be done using the default histogram option but modify the resulting cost column to remove all decimal values (.00<-), so that the limits are not cluttered, remove the cents in the original data so it is not showing on the graph. In addition, use a gap between the bars of 25%, and remove all grid lines, label the plot, and use a bin size of 10.
   3. Create an interface section: This is where you can link the Order Quantity variable and the reorder point R. All should be linked so that when Q is changed the distribution and values change.
   4. Lastly once the interface is created choose a single-color set for your dashboard.
4. BUT WAIT THERE IS MORE: You can now run the what if model to determine the optimal combination of Q and R that reduces your average monthly cost. Try Q values of 8, 10, 12, and 14. And Try R values of 5 and 8, Which is the optimal Q&R values that minimize the Average Cost.
5. SUPER INSANO BONUS: This is optional but use the scenario manager to automate running all these scenarios for each of the Q and R values and determine the optimal Q and R on the average total cost. If you get this you get a cool, R mug or Some Coding Stickers, a genuine pat on the back from me with an actual “good job (insert name here)” said out loud in class, a recommendation letter at any point in your career from me and get this we will play a game of dice and if you win I will pay for your excel certification exam fee, a value of $75. This offer is only to the first person to come to my office and show me they have it all working with no flaws. This exam has been known to cause unwanted computer behavior such as but not limited to freezing, closing unexpectedly, on some rare occasions the dreadful wheel of despair taking your mouse over. People with soft stomachs and unwanted anxiety should not do this part of the test. That almost sounds like a drug commercial on TV. Good luck, remember to breathe and ask questions.