Cairo University
Faculty of Computers and Artificial Intelligence

Department: Operations Research and Decision Support.
Course Name: Systems Modeling and Simulation.
Course Code: DS331/DS241.
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Car Dealer

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Problem formulation & Objectives

Problem formulation:

This problem talks about a store and a car showroom. It compares the number of cars that must be present in the showroom and the store to achieve the highest profit for the owner of the showroom and store. Because if a large inventory is required, profits will decrease due to the cost of storage. Also, the place cannot accommodate more than 15 cars in the showroom and warehouse together. Also, if cars are ordered less than the daily selling limit, it will reduce profits and cause customer dissatisfaction.

Objectives:

1. Analyzing the car dealer's inventory and showroom system.
2. Estimating the average ending units in the showroom and inventory.
3. Determining the number of days when a shortage condition occurs.
4. Calculating the average net profit for the car dealer.
5. Comparing the theoretical average demand and lead time with the experimental data.
6. Investigating the impact of different review period values on net profit.

System component:

System:

- The entire setup involving the car dealer, showroom, inventory, and the ordering process.

Entity:

- **Car Dealer**: Represents the main actor in the system who manages the showroom, inventory, and ordering process.
- **Showroom**: A physical location where customers can closely inspect cars.
- **Inventory**: The storage facility for cars.

Attributes:

- **Maximum Showroom Capacity**: The maximum number of cars that can be displayed in the showroom.
- **Maximum Inventory Capacity**: The maximum number of cars that can be stored in the inventory.

- **Lead Time**: The time taken for an order to be placed and received.
- **Review Period (N):** The period after which the inventory is revised, and an order is placed.

Activities:

- **Placing an Order**: The action taken by the car dealer to restock cars in the inventory and showroom.
- **Receiving Cars**: The process of getting the ordered cars into the inventory.
- **Filling Showroom**: The process of filling the showroom to its maximum capacity after receiving an order.
- **Selling Cars**: The activity of selling cars from the showroom and, if necessary, from the inventory.
- **Inspecting Cars**: Customers inspecting cars in the showroom.

Event:

- **Demand Occurrence**: Random events representing the number of cars demanded per day.
- **Lead Time Completion**: The event when the lead time is completed, and the ordered cars are received.

States:

- **Inventory Level:** The current number of cars in the inventory.
- **Showroom Occupancy:** The number of cars currently displayed in the showroom.
- **Order Status:** The status of the placed order (pending, shipped, received).
- **Lost Opportunity:** The state when there are no cars available to meet a certain demand.

System Analysis:

The system analysis involves analyzing the cumulative distribution tables for the demand and lead time distributions. These tables provide information about the probabilities associated with different demand and lead time values. Additionally, a calendar table for a specific period (e.g., 10 days) can be created to simulate the inventory management system and track the changes in inventory and showroom levels over time.

1- Cumulative Distribution Tables:

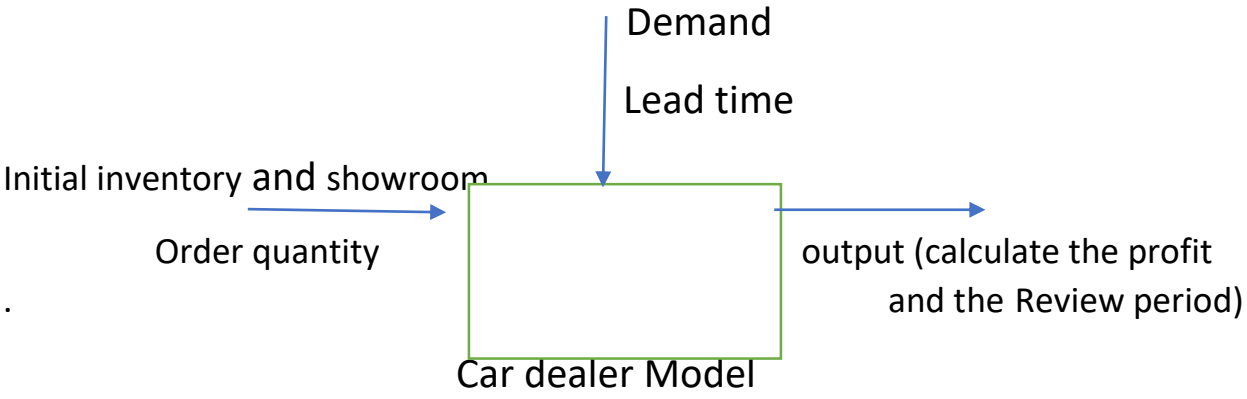
Demand	Probability	Cumulative distribution	Random digit assignment
0	0.2	0.2	0 – 0.2
1	0.34	0.54	0.2 – 0.54
2	0.36	0.90	0.54 – 0.90
3	0.1	1	0.90 – 1

Lead time (Days)	Probability	Cumulative distribution	Random digit assignment
1	0.40	0.40	0 – 0.40
2	0.35	0.75	0.40 – 0.75
3	0.25	1	0.75– 1

2- Simulation table (for 10 customers):

Day	Start inventor	Start showroom	RN Demand	Demand	Ending inventory	Ending showroom	Order quantity	RN Lead	Lead time	N
1	3	4	74	2	1	4	5	-	2	1
2	1	4	3	0	1	4	5	-	1	2
3	5	5	89	2	3	5	7	0.7	2	3
4	3	5	22	1	2	5	7	-	1	1
5	9	5	68	2	7	5				2
6	7	5	93	3	4	5	6	0.95	3	3
7	4	5	24	1	3	5	6		2	1
8	3	5	36	1	2	5	6		1	2
9	8	5	98	3	5	5	5	0.15	1	3
10	10	5	65	2	8	5	5	-	2	1

Experimental Design Parameters:



1- Inventory Policy:

Different inventory policies (e.g., reorder point and order quantity).

2- Lead Time:

Variation in lead time (e.g., normal distribution with different mean and standard deviation).

3- Review Period (N):

Vary the review period (e.g., N = 3, 4, 5 days).

4- Car Display Showroom Size:

Vary the size of the car display showroom (e.g., 3 cars, 5 cars).

5- Order Quantity:

Different order quantities when replenishing inventory.

6- Demand Distribution:

Experiment with different demand distributions.

Justification of Experiment Parameters Values:

1- Inventory Policy:

Evaluate the impact of various inventory policies on the system's performance. Test different reorder points and order quantities to find an optimal balance between holding costs, stockouts, and order costs.

2- Lead Time:

Assess the sensitivity of the system to changes in lead time. A more unpredictable lead time could result in higher holding costs and stockouts.

3- Review Period (N):

Investigate how the frequency of reviewing and updating inventory levels affects the system's performance. A shorter review period may reduce stockouts but could increase ordering costs.

4- Car Display Showroom Size:

Examine the impact of showroom size on customer satisfaction and potential lost opportunities. A larger showroom might attract more customers but could also increase holding costs.

5- Order Quantity:

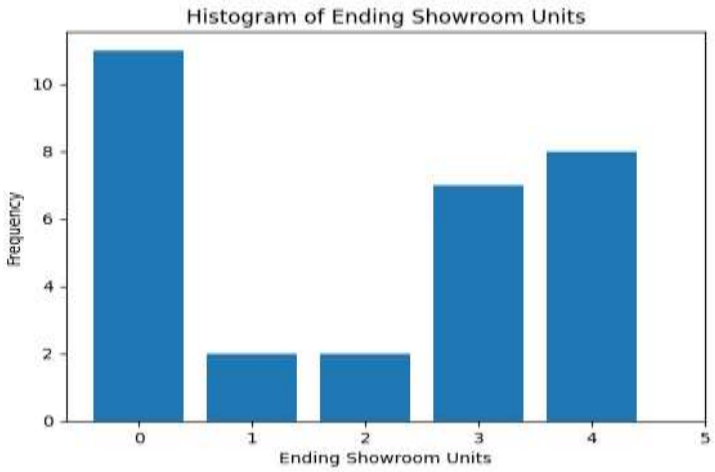
Explore the effects of varying order quantities on costs and customer satisfaction. Larger order quantities may reduce ordering costs but increase holding costs.

6- Demand Distribution:

Evaluate how different demand patterns affect the overall system performance. For example, test scenarios with higher variability in demand to assess the robustness of the inventory system.

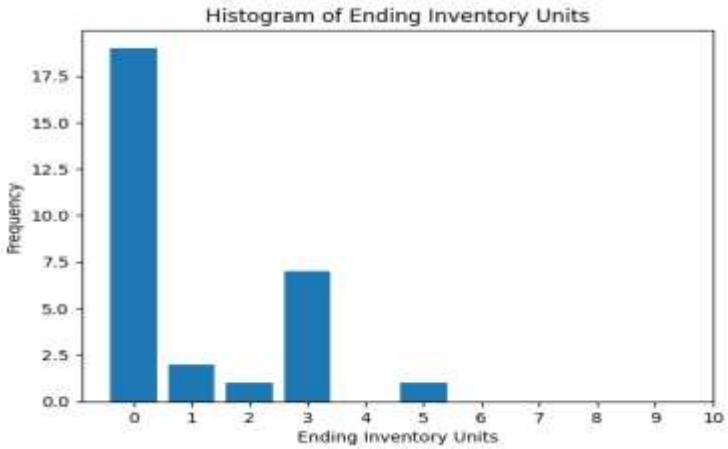
Results Analysis:

➔ Average Ending Showroom Units: 2.2333333333333334

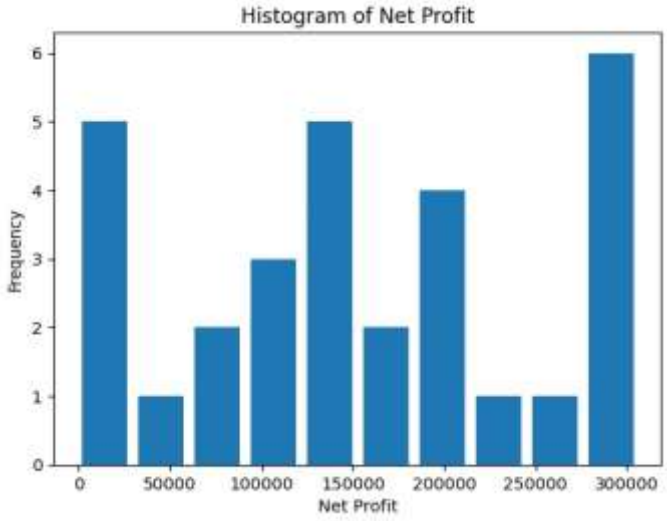


➔ Average Ending Inventory Units: 1.0

➔ Number of Days with Shortage: 7



➔ Average Net Profit: 170066.66666666666



1- The average ending units in the showroom and inventory:

The average ending in the showroom = sum total ending showroom / num of days

The average ending in the showroom = (4+4+5+5+5+5+5+5+5+5) / 10 = 4.8

That's mean the most of the time the showroom was full because 4.8 is near of 5

The average ending in the inventory = sum total ending inventory / num of days

The average ending in the inventory = (1+1+3+2+7+4+3+2+5+8) / 10 = 3.6

That's mean the most of the time the inventory was empty because 3.6 is fare than 10

2- The number of days when a shortage condition occurs:

It is zero most of the time in this case

Because the period during which the order is returned to fill the warehouse is three days, and the maximum possible order is three cars. So, It is difficult to have an order when the inventory and the showroom is empty. We can see that on the table and on the output.

3- The average net profit for the car dealer:

Calculating the net profit for each day based on the number of cars sold, holding expenses, and order costs will allow us to determine the average net profit for the car dealer.

profit per day= (number of sold cars * 10000) -(20000* M)-(1000*N)

M: will be 1 or 0 if I order in this day or not.

N: is the sum of the cars in the showroom and the inventory.

The average net profit for the car dealer= sum of profit per days/num of days

The average profit for day 1= (2*10000)- (20000*1) -(1000*(4+1)) = -5000

The average profit for day 2= (0*10000)- (20000*0) -(1000*(4+1)) = -5000

The average profit for day 3= (2*10000)- (20000*1) -(1000*(5+3)) = -8000

The average profit for day 4= (1*10000)- (20000*0) -(1000*(5+2)) = 3000

The average profit for day 5= (2*10000)- (20000*0) -(1000*(7+5)) = 8000

The average profit for day 6= (3*10000)- (20000*1) -(1000*(4+5)) = 1000

The average profit for day 7= (1*10000)- (20000*0) -(1000*(3+5)) = 2000

The average profit for day 8= (1*10000)- (20000*0) -(1000*(2+5)) = 3000

The average profit for day 9= (3*10000)- (20000*1) -(1000*(5+5)) = 0000

The average profit for day 10= (2*10000)- (20000*0) -(1000*(5+8)) =7000

The average net profit for the car dealer= sum of profit per days/num of days

The average net profit for the car dealer =(-5000+-5000+-8000+3000+8000+1000+2000+3000+0+7000) / 10=6000/10=600

So for the previse example the average net profit for the car dealer is 600

4-Does the theoretical average demand of the demand distribution match the experimental one?

If we will think about it every time we will run the code we will have a deferent output but because the condition of Cumulative is always same the resalt also will be the same.

By comparing the theoretical average demand, derived from the given demand distribution, with the actual experimental data, we can determine if they align. This comparison will help validate the accuracy of the demand distribution and assess its suitability for predicting customer demand.

5- Does the theoretical average lead time of the lead time distribution match the experimental one?

Similar to the demand analysis, we can compare the theoretical average lead time, derived from the given lead time distribution, with the observed lead time in the experimental data. This evaluation will help assess the accuracy of the lead time distribution and its applicability in estimating order arrival times.

6- Is there a better value for the review period variable N to maximize the car dealer's net profit?

By varying the review period (N) and analyzing its impact on the car dealer's net profit I think we should increase N from 3 to 5 because our demand is gust 0,1,2 or 3 and that is not mush and most of the time I order less than 2 in the time

With probability more than 0.90 and we pay a lot to storge our cars.

so if we will make N =5 that's will decrees our profit

Conclusion:

In this study, we examined the inventory management system of a car dealer's showroom and inventory. We considered a scenario where the showroom had a maximum capacity of 5 cars, and the inventory could hold up to 10 cars. The demand for cars per day followed a specific distribution, and the cars were sold from the inventory first before resorting to the showroom. Orders were placed to replenish the inventory and showroom, with the showroom being filled first, followed by the inventory. The lead time for receiving orders was a random variable. Our objective was to investigate various performance metrics and provide insights to maximize the car dealer's net profit.