

BASIC CONCEPTS AND FORMULA**Basic Concepts****1. Simulation**

Simulation is a quantitative procedure which describes a process by developing a model of that process and then conducting a series of organised trial and error experiments to predict the behaviour of the process over time.

2. Steps In The Simulation Process

1. Define the problem or system you intend to simulate.
2. Formulate the model you intend to use.
3. Test the model; compare its behaviour with the behaviour of the actual problem environment.
4. Identify and collect the data needed to test the model.
5. Run the simulation.
6. Analyze the results of the simulation and, if desired, change the solution you are evaluating.
7. Rerun the simulation to test the new solution.
8. Validate the simulation, that is, increase the chances that any inferences you draw about the real situation from running the simulation will be valid.

3. Monte Carlo Simulation

The Monte Carlo method employs random numbers and is used to solve problems that depend upon probability, where physical experimentation is impracticable and the creation of a mathematical formula impossible. In other words, it is method of Simulation by the sampling technique.

First of all, the probability distribution of the variable under consideration is determined; then a set of random numbers is used to generate a set of values that have the same distributional characteristics as the actual experience it is devised to simulate.

4. Steps in Monte Carlo Simulation

The steps involved in carrying out Monte Carlo Simulation are:

- (i) Select the measure of effectiveness of the problem.
- (ii) Identify the variables which influence the measure of effectiveness significantly.
- (iii) Determine the proper cumulative probability distribution of each variable selected under step (ii). Plot these, with the probability on the vertical axis and the values of variables on horizontal axis.
- (iv) Get a set of random numbers.
- (v) Consider each random number as a decimal value of the cumulative probability distribution. With the decimal, enter the cumulative distribution plot from the vertical axis. Project this point horizontally, until it intersects cumulative probability distribution curve. Then project the point of intersection down into the vertical axis.
- (vi) Record the value (or values if several variables are being simulated) generated in step (v) into the formula derived from the chosen measure of effectiveness. Solve and record the value. This value is the measure of effectiveness for that simulated value.
- (vii) Repeat steps (v) and (vi) until sample is large enough for the satisfaction of the decision maker.

Question 1

A Car Manufacturing Company manufactures 40 cars per day. The sale of cars depends upon demand which has the following distribution:

Sales of Cars	Probability
37	0.10
38	0.15
39	0.20
40	0.35
41	0.15
42	0.05

The production cost and sale price of each car are ₹.4 lakh and ₹ 5 lakh respectively. Any unsold car is to be disposed off at a loss of .2 lakh per car. There is a penalty of Re.1

16.3 Advanced Management Accounting

lakh per car, if the demand is not met. Using the following random numbers, estimate total profit/ loss for the company for the next ten days:

9, 98, 64, 98, 94, 01, 78, 10, 15, 19

If the company decides to produce 39 cars per day, what will be its impact on profitability?

Answer

First of all random numbers 00-99 are allocated in proportion to the probabilities associated with the sales of cars as given below:

Table 1

Sales of Car	Probability	Cumulative probability	Range for random numbers
37	0.10	0.10	00-99
38	0.15	0.25	10-24
39	0.20	0.45	25-44
40	0.35	0.80	45-79
41	0.15	0.95	80-94
42	0.05	1.00	95-98

Based on the given random numbers, we simulate the estimated sales and calculate the profit / loss on the basis of specified units of production.

Table 2

Day	Random Numbers	Estimated Sale	Profit (Production 40 cars / day) (₹. Lakh)	Profit (Production 39 cars / day) (₹. Lakhs)
1	9	37	$37 \times 1 - 3 \times 2 = 31$	$37 \times 1 - 2 \times 2 = 33$
2	98	42	$40 \times 1 - 2 \times 1 = 38$	$39 \times 1 - 3 \times 1 = 36$
3	64	40	$40 \times 1 = 40$	$39 \times 1 - 1 \times 1 = 38$
4	98	42	$40 \times 1 - 2 \times 1 = 38$	$39 \times 1 - 3 \times 1 = 36$
5	94	41	$40 \times 1 - 1 \times 1 = 39$	$39 \times 1 - 2 \times 1 = 37$
6	01	37	$37 \times 1 - 3 \times 2 = 31$	$37 \times 1 - 2 \times 2 = 33$
7	78	40	$40 \times 1 = 40$	$39 \times 1 - 1 \times 1 = 38$
8	10	38	$38 \times 1 - 2 \times 2 = 34$	$38 \times 1 - 1 \times 2 = 36$
9	15	38	$38 \times 1 - 2 \times 2 = 34$	$38 \times 1 - 1 \times 2 = 36$
10	19	38	$38 \times 1 - 2 \times 2 = 34$	$36 \times 1 - 1 \times 2 = 36$

There is no additional profit or loss if the company decides to reduce production to 39 cars per day.

Question 2

An investment company wants to study the investment projects based on market demand, profit and the investment required, which are independent of each other. Following probability distributions are estimated for each of these three factors:

<i>Annual Demand</i>							
(Units in thousands)	25	30	35	40	45	50	55
Probability	0.05	0.10	0.20	0.30	0.20	0.10	0.05
Profit per Unit:		3.00	5.00	7.00	9.00	10.00	
Probability:		0.10	0.20	0.40	0.20	0.10	
<i>Investment required</i>							
(in thousands of Rupees):		2,750		3,000		3,500	
Probability:		0.25		0.50		0.25	

Using simulation process, repeat the trial 10 times, compute the investment on each trail taking these factors into trail. What is the most likely ret

Use the following random numbers: urn?

(30, 12, 16); (59, 09, 69); (63, 94, 26); (27, 08, 74);

(64, 60, 61); (28, 28, 72); (31, 23, 57); (54, 85, 20);

(64, 68, 18); (32, 31, 87).

In the bracket above, the first random number is for annual demand, the second one is for profit and the last one is for the investment required.

Answer

The yearly return can be determined by the formula:

$$\text{Return (\%)} = \frac{\text{Profit} \times \text{Number of units demanded}}{\text{Investment}} \times 100$$

First of all, random number 00-99 are allocated in proportion to the probabilities associated with each of the three variables as given under:

16.5 Advanced Management Accounting

Annual Demand

<i>Units in thousands</i>	<i>Probability</i>	<i>Cum. Probability</i>	<i>Random Number assigned</i>
25	0.05	0.05	00-04
30	0.10	0.15	05-14
35	0.20	0.35	15-34
40	0.30	0.65	35-64
45	0.20	0.85	65-84
50	0.10	0.95	85-94
55	0.05	1.00	95-99

Profit per unit

<i>Profit</i>	<i>Probability</i>	<i>Cum. Probability</i>	<i>Random Number assigned</i>
3.00	0.10	0.10	00-09
5.00	0.20	0.30	10-29
7.00	0.40	0.70	30-69
9.00	0.20	0.90	70-89
10.00	0.10	1.00	90-99

Investment required (in thousands of Rupees)

<i>Units</i>	<i>Probability</i>	<i>Cum. Probability</i>	<i>Random Number assigned</i>
2,750	0.25	0.25	00-24
3,000	0.50	0.75	25-74
3,500	0.25	1.00	75-99

Let us now simulate the process for 10 trails. The results of the simulation are shown in the tables given below:

<i>Trails</i>	<i>Random Number of Demand</i>	<i>Simulated demand ('000) units</i>	<i>Random No for profit per unit</i>	<i>Simulated profit per unit</i>	<i>Random Number for investment</i>	<i>Simulated investment ('000) ₹.</i>	<i>Simulated return (%) (Demand × profit per unit × 100) + investment</i>
1	30	35	12	5.00	16	2,750	6.36
2	59	40	09	3.00	69	3,000	4.00

3	63	40	94	10.00	26	3,000	13.33
4	27	35	08	3.00	74	3,000	3.50
5	64	40	60	7.00	61	3,000	9.33
6	28	35	28	5.00	72	3,000	5.83
7	31	35	23	5.00	57	3,000	5.83
8	54	40	85	9.00	20	2,750	13.09
9	64	40	68	7.00	18	2,750	10.18
10	32	35	31	7.00	87	3,500	7.00

The above table shows that the highest likely return is 13.33% which is corresponding to the annual demand of 40,000 units resulting a profit of ₹ .10/- per unit and the required investment will be ₹ .30,00,000.

Question 3

A Publishing house has bought out a new monthly magazine, which sells at ₹ . 37.5 per copy. The cost of producing it is ₹ . 30 per copy. A Newsstand estimates the sales pattern of the magazine as follows:

Demand Copies	Probability
0 < 300	0.18
300 < 600	0.32
600 < 900	0.25
900 < 1200	0.15
1200 < 1500	0.06
1500 < 1800	0.04

The newsstand has contracted for 750 copies of the magazine per month from the publisher.

The unsold copies are returnable to the publisher who will take them back at cost less ₹ . 4 per copy for handling charges.

The newsstand manager wants to simulate of the demand and profitability. The of following random number may be used for simulation:

27, 15, 56, 17, 98, 71, 51, 32, 62, 83, 96, 69.

You are required to-

- Allocate random numbers to the demand patter forecast by the newsstand.

16.7 Advanced Management Accounting

(ii) Simulate twelve months sales and calculate the monthly and annual profit/loss.

(iii) Calculate the loss on lost sales.

Answer

(i) Allocation of random numbers

Demand	Probability	Cumulative probability	Allocated RN
0 < 300	0.18	0.18	00—17
300 < 600	0.32	0.50	18—49
600 < 900	0.25	0.75	50—74
900 < 1200	0.15	0.90	75—89
1200 < 1500	0.06	0.96	90—95
1500 < 1800	0.04	1.00	96—99

(ii) Simulation: twelve months sales, monthly and annual profit/loss

Month	RN	Demand	Sold	Return	Profit on sales (₹.)	Loss on return (₹.)	Net (₹.)	Loss on lost units
1	27	450	450	300	3375	12000	2175	
2	15	150	150	600	1125	2400	-1275	
3	56	750	750	--	5625	--	5625	
4	17	150	150	600	1125	2400	-1275	
5	98	1650	750	--	5625	---	5625	900
6	71	750	750	--	5625	--	5625	
7	51	750	750	--	5625	--	2175	
8	32	450	450	300	3375	1200	5625	
9	62	750	750	--	5625	--	5625	300
10	83	1050	750	--	5625	--	5625	900
11	96	1650	750	--	5625	--	5625	
12	69	750	750	--	5625		5625	
					54000	7200	46800	2100

(iii) Loss on lost sale $2100 \times 7.5 = ₹ 15750$.

Question 4

- (i) *What is simulation?*
- (ii) *What are the steps in simulation?*

Answer

- (i) Simulation is a quantitative procedure which describes a process by developing a model of that process and then conducting a series of organized trial and error experiments to product the behaviour of the process over time.
- (ii) Steps in the simulation process:
 - (i) Define the problem and system you intend to simulate.
 - (ii) Formulate the model you intend to use.
 - (iii) Test the model, compare with behaviour of the actual problem environment.
 - (iv) Identify and collect data to test the model.
 - (v) Run the simulation.
 - (vi) Analyse the results of the simulation and, if desired, change the solution you are evaluating.
 - (vii) Rerun the simulation to tests the new solution.
 - (viii) Validate the simulation i.e., increase the chances of valid inferences.

Question 5

How would you use the Monte Carlo Simulation method in inventory control?

Answer**The Monte Carlo Simulation:**

It is the earliest mathematical Model of real situations in inventory control:

Steps involved in carrying out Monte Carlo simulation are:

- Define the problem and select the measure of effectiveness of the problem that might be inventory shortages per period.
- Identify the variables which influence the measure of effectiveness significantly for example, number of units in inventory.
- Determine the proper cumulative probability distribution of each variable selected with the probability on vertical axis and the values of variables on horizontal axis.
- Get a set of random numbers.

16.9 Advanced Management Accounting

- Consider each random number as a decimal value of the cumulative probability distribution with the decimal enter the cumulative distribution plot from the vertical axis. Project this point horizontally, until it intersects cumulative probability distribution curve. Then project the point of intersection down into the vertical axis.
- Then record the value generated into the formula derived from the chosen measure of effectiveness. Solve and record the value. This value is the measure of effectiveness for that simulated value. Repeat above steps until sample is large enough for the satisfaction of the decision maker.

Question 6

A single counter ticket booking centre employs one booking clerk. A passenger on arrival immediately goes to the booking counter for being served if the counter is free. If, on the other hand, the counter is engaged, the passenger will have to wait. The passengers are served on first come first served basis. The time of arrival and the time of service varies from one minute to six minutes. The distribution of arrival and service time is as under:

<i>Arrival / Service Time (Minutes)</i>	<i>Arrival (Probability)</i>	<i>Service (Probability)</i>
1	0.05	0.10
2	0.20	0.20
3	0.35	0.40
4	0.25	0.20
5	0.10	0.10
6	0.05	-

Required:

- Simulate the arrival and service of 10 passengers starting from 9 A.M. by using the following random numbers in pairs respectively for arrival and service. Random numbers 60 09 16 12 08 18 36 65 38 25 07 11 08 79 59 61 53 77 03 10.*
- Determine the total duration of*
 - Idle time of booking clerk and*
 - Waiting time of passengers.*

Answer

Random allocation tables are as under:

Time (Mts)	Arrival (Probability)	Arrivals Cumulative Probability	Random No. allocated	Time (Mts)	Service (Probability)	Service Cumulative (Probability)	Random No. allocated
1	0.05	0.05	00-04	1	0.10	0.10	00-09
2	0.20	0.25	05-24	2	0.20	0.30	10-29
3	0.35	0.60	25-59	3	0.40	0.70	30-69
4	0.25	0.85	60-84	4	0.20	0.90	70-89
5	0.10	0.95	85-94	5	0.10	1.00	90-99
6	0.05	1.00	95-99				

Simulation of ten trails:

R. No.	Arrival Mts.	Time	Start	R. No.	Time Mts.	Finish Time	Waiting Time	
							Clerk	Passenger
60	4	9.04	9.04	09	1	9.05	4	
16	2	9.06	9.06	12	2	9.08	1	
08	2	9.08	9.08	18	2	9.10	-	
36	3	9.11	9.11	65	3	9.14	1	
38	3	9.14	9.14	25	2	9.16	-	
07	2	9.16	9.16	11	2	9.18	-	
08	2	9.18	9.18	79	4	9.22	-	
59	3	9.21	9.22	61	3	9.25	-	1
53	3	9.24	9.25	77	4	9.29		1
03	1	9.25	9.29	10	2	9.31	-	<u>4</u>
Total							<u>6</u>	<u>6</u>

In half an hour trial, the clerk was idle for 6 minutes and the passengers had to wait for 6 minutes.

16.11 Advanced Management Accounting

Question 7

State major reasons for using simulation technique to solve a problem and also describe basic steps in a general simulation process.

Answer

Reasons:

- (i) It is not possible to develop a mathematical model and solutions with out some basic assumptions.
- (ii) It may be too costly to actually observe a system.
- (iii) Sufficient time may not be available to allow the system to operate for a very long time.
- (iv) Actual operation and observation of a real system may be too disruptive.

Steps:

- (i) Define the problem or system which we want to simulate.
- (ii) Formulate an appropriate model of the given problem.
- (iii) Ensure that model represents the real situation/ test the model, compare its behaviour with the behaviour of actual problem environment.
- (iv) Identify and collect the data needed to list the model.
- (v) Run the simulation
- (vi) Analysis the results of the simulation and if desired, change the solution.
- (vii) Return and validate the simulation.

Question 8

At a small store of readymade garments, there is one clerk at the counter who is to check bills, receive payments and place the packed garments into fancy bags. The arrival of customer at the store is random and service time varies from one minute to six minutes, the frequency distribution for which is given below:

<i>Time between arrivals (minutes)</i>	<i>Frequency</i>	<i>Service Time (in minutes)</i>	<i>Frequency</i>
1	5	1	1
2	20	2	2
3	35	3	4
4	25	4	2

Simulation 16.12

5	10	5	1
6	5	6	0

The store starts work at 11 a.m. and closes at 12 noon for lunch and the customers are served on the "first come first served basis".

Using Monte Carlo simulation technique, find average length of waiting line, average waiting time, average service time and total time spent by a customer in system.

You are given the following set of random numbers, first twenty for arrivals and last twenty for service:

64	04	02	70	03	60	16	18	36	38
07	08	59	53	01	62	36	27	97	86
30	75	38	24	57	09	12	18	65	25
11	79	61	77	10	16	55	52	59	63

Answer

From the frequency distribution of arrivals and service times, probabilities and cumulative probabilities are first worked out as shown in the following table:

Time between arrivals	Frequency	Probability	Cum. Prob.	Service Time	Frequency	Prob.	Cum. Prob.
1	5	0.05	0.05	1	1	0.10	0.10
2	20	0.20	0.25	2	2	0.20	0.30
3	35	0.35	0.60	3	4	0.40	0.70
4	25	0.25	0.85	4	2	0.20	0.90
5	10	0.10	0.95	5	1	0.10	1.00
6	5	0.05	1.00	6	0	0.00	1.00
Total	100				10		

The random numbers to various intervals have been allotted in the following table:

Time between arrivals	Probability	Random numbers allotted	Service Time	Probability	Random numbers allotted
1	0.05	00-04	1	0.10	00-09
2	0.20	05-24	2	0.20	10-29
3	0.35	25-59	3	0.40	30-69

16.13 Advanced Management Accounting

4	0.25	60-84	4	0.20	70-89
5	0.10	85-94	5	0.10	90-99
6	0.05	95-99	6	0.00	-

Simulation Work Sheet

Random Number	Time till next arrival	Arrival Time a.m.	Service begins a.m.	Random number	Service time	Service Ends a.m.	Clerk Waiting time	Customer waiting Time	Length of waiting line
64	4	11.04	11.04	30	3	11.07	04	-	-
04	1	11.05	11.07	75	4	11.11	-	2	1
02	1	11.06	11.11	38	3	11.14	-	5	2
70	4	11.10	11.14	24	2	11.16	-	4	2
03	1	11.11	11.16	57	3	11.19	-	5	2
60	4	11.15	11.19	09	1	11.20	-	4	2
16	2	11.17	11.20	12	2	11.22	-	3	2
18	2	11.19	11.22	18	2	11.24	-	3	2
36	3	11.22	11.24	65	3	11.27	-	2	1
38	3	11.25	11.27	25	2	11.29	-	2	1
07	2	11.27	11.29	11	2	11.31	-	2	1
08	2	11.29	11.31	79	4	11.35	-	2	1
59	3	11.32	11.35	61	3	11.38	-	3	1
53	3	11.35	11.38	77	4	11.42	-	3	1
01	1	11.36	11.42	10	2	11.44	-	6	2
62	4	11.40	11.44	16	2	11.46	-	4	2
36	3	11.43	11.46	55	3	11.49	-	3	2
27	3	11.46	11.49	52	3	11.52	-	3	1
97	6	11.52	11.52	59	3	11.55	-	-	-
86	5	11.57	11.57	63	3	12.00	2	-	-
20	57				54		6	56	26

$$\text{Average queue length} = \frac{\text{Number of customers in waiting line}}{\text{Number of arrivals}} = \frac{26}{20} = 1.3$$

Average waiting time per customer = $\frac{56}{20} = 2.8$ minutes

Average service time = $\frac{54}{20} = 2.7$ minutes

Time a customer spends in system = $2.8 + 2.7 = 5.5$ minutes.

Question 9

Write a short note on the advantages of simulation.

Answer

Advantages of simulation are enumerated below:

1. Simulation techniques allow experimentation with a model of the system rather than the actual operating system. Sometimes experimenting with the actual system itself could prove to be too costly and, in many cases too disruptive. For example, if you are comparing two ways of providing food service in a hospital, the confusion that would result from operating two different systems long enough to get valid observations might be too great. Similarly, the operation of a large computer central under a number of different operating alternatives might be too expensive to be feasible.
2. The non-technical manager can comprehend simulation more easily than a complex mathematical model. Simulation does not require simplifications and assumptions to the extent required in analytical solutions. A simulation model is easier to explain to management personnel since it is a description of the behaviour of some system or process.
3. Sometimes there is not sufficient time to allow the actual system to operate extensively. For example, if we were studying long-term trends in world population, we simply could not wait the required number of years to see results. Simulation allows the manager to incorporate time into an analysis. In a computer simulation of business operation the manager can compress the result of several years or periods into a few minutes of running time.
4. Simulation allows a user to analyze these large complex problems for which analytical results are not available. For example, in an inventory problem if the distribution for demand and lead time for an item follow a standard distribution, such as the poisson distribution, then a mathematical or analytical solution can be found. However, when mathematically convenient distributions are not applicable to the problem, an analytical analysis of the problem may be impossible. A simulation model is a useful solution procedure for such problems.

Question 10

What are the steps involved in carrying out Monte Carlo simulation model?

16.15 Advanced Management Accounting

Answer

Steps involved in Monte Carlo simulation are:

- (i) To select the measure of effectiveness of the problem, that is, what element is used to measure success in improving the system modeled. This is the element one wants to maximize or minimize.
- (ii) Identifying the variables which influence the measure of effectiveness significantly.
- (iii) Determining the proper cumulative probability distribution.
- (iv) To get a set of random numbers.
- (v) Consideration of each random number as a decimal value of the cumulative probability distribution. With the decimal, enter the cumulative distribution plot from the vertical axis, Project this point horizontally, until it intersects cumulative probability distribution curve.
- (vi) Recording the value generated in step(v) into the formula derived from the chose measures of effectiveness. Solve and record the value.
- (vii) Repeating steps (V) and (VI) until sample is large enough for the satisfaction of the decision maker.

Question 11

ABC Cooperative Bank receives and disburses different amount of cash in each month. The bank has an opening cash Balance of ₹ 15 crores in the first month. Pattern of receipts and disbursements from past data is as follows:

Monthly Cash receipts		Monthly Cash disbursements (₹ crores)	
₹ in Crores	Probability	₹ in Crores	P Probability
30	0.20	33	0.15
42	0.40	60	0.20
36	0.25	39	0.40
99	0.15	57	0.25

Simulate the cash position over a period of 12 months.

Required:

- (i) Calculate probability that the ABC Cooperative Bank will fall short in payments.
- (ii) Calculate average monthly shortfall.
- (iii) If ABC bank can get an overdraft facility of ₹ 45 crores from other Nationalized banks.

What is the probability that they will fall short in monthly payments?

Use the following sequence (rowwise) of paired random numbers.

1778 4316 7435 3123 7244 4692 5158 6808 9358 5478 9654 0977

Answer

Monthly Cash receipts (₹ crores)				Monthly Cash disbursements (₹ crores)			
Cash	Probability	Cumulative	R.N.	Cash	Probability	Cumulative	R.N.
30	0.20	0.20	00-19	33	0.15	0.15	00-14
42	0.40	0.60	20-59	60	0.20	0.35	15-34
36	0.25	0.85	60-84	39	0.40	0.75	35-74
99	0.15	1.00	85-99	57	0.25	1.00	75-99

	Opening	Receipt			Payment		Closing
Months	(₹ in Crores)	Random Number.	(₹ in Crores)	Total	Random Number.	(₹ in Crores)	(₹ in Crores)
1	15	17	30	45	78	57	-12
2	-12	43	42	30	16	60	-30
3	-30	74	36	06	25	39	-33
4	-33	31	42	09	23	60	-51
5	-51	72	36	-15	44	39	-54
6	-54	46	42	-12	92	57	-69
7	-69	51	42	-27	58	39	-66
8	-66	68	36	-30	08	33	-63
9	-63	93	99	36	58	39	-3
10	-3	54	42	39	78	57	-18
11	-18	96	99	81	54	39	42
12	42	09	30	72	77	57	15

- (i) In 12 months, the bank falls short of cash in 10 months to meet payment.
Thus, probability of shortfall = $10/12 = 0.83$
- (ii) Total short fall of ₹ 399 crores over 10 months
Average monthly shortfall during 10 months = ₹ 39.9 crores
- (iii) With an overdraft facility of ₹ 45 crores is available, there will be a shortfall in 5 months (4,5,6,7,8).. Therefore, probability is = $5/12 = 0.42$

Question 12

A car rental agency has collected the following data on the demand for five-seater vehicles over the past 50 days.

Daily Demand	4	5	6	7	8
No. of Days	4	10	16	14	6

The agency has only 6 cars currently.

16.17 Advanced Management Accounting

- (i) Use the following 5 random numbers to generate 5 days of demand for the rental agency
Random Nos 15, 48, 71, 56, 90
- (ii) What is the average number of cars rented per day for the 5 days ?
- (iii) How many rentals will be lost over the 5 days?

Answer

Daily demand	Days	Probability	Cumulative probability	Random No.	Day	Demand	Rented	Rental lost
4	4	0.08	0.08	00.07	1	5	5	
5	10	0.20	0.28	08-27	2	6	6	
6	16	0.32	0.60	28-59	3	7	6	1
7	14	0.28	0.88	60-87	4	6	6	
8	<u>6</u>	<u>0.12</u>	1.00	88-99	5	8	<u>6</u>	<u>2</u>
	<u>50</u>	<u>1.00</u>					<u>29</u>	<u>3</u>

Average no. of cars rented = $\frac{29}{5} = 5.8$

Rental lost = 3

EXERCISE

Question 1

An investment company wants to study the investment projects based on market demand profit and the investment required, which are independent of each other. Following probability distributions are estimated for each of these three factors.

Annual demand

(units in thousands)	25	30	35	40	45	50	55
Probability	0.05	0.10	0.20	0.30	0.20	0.10	0.05
Profit per unit	3.00	5.00	7.00	9.00	10.00		
Probability	0.10	0.20	0.40	0.20	0.10		

Investment Required

(In thousand of rupees)	2,750	3,000	3,500
Probability	0.25	0.50	0.25

Using simulation process, repeat the time 10 times, compute the investment on each that taking these factors into trial. What is the most likely return?

Use the following random numbers:

(30, 12, 16) (50, 09, 69) (63, 94, 26) (27, 08, 74)
 (64, 60, 61) (28, 28, 72) (31, 23, 57) (54, 85, 20)
 (64, 68, 18) (32, 31, 87)

In the bracket above, the first random number is for annual demand, the second one is for profit and the last one is for the investment required.

Answer

Highest likely return is 13.33% which is corresponding to the annual demand of 40,000 units resulting a profit of ₹ .10/- per unit and the required investment will be ₹ .30,00,000.

Question 2

A retailer deals in a perishable commodity. The daily demand and supply are variables. The data for the past 500 days show the following demand and supply:

Supply		Demand	
Availability (kg.)	No. of days	Demand (kg.)	No. of days
10	40	10	50
20	50	20	110
30	190	30	200
40	150	40	100
50	70	50	40

The retailer buys the commodity at ₹ .20 per kg and sells it at ₹ .30 per kg. Any commodity remains at the end of the day, has no saleable value. Moreover, the loss (unearned profit) on any unsatisfied demand is ₹ .8 per kg. Given the following pair of random numbers, simulate 6 days sales, demand and profit.

(31, 18); (63, 84); (15, 79); (07, 32) (43, 75); (81, 27)

The first random number in the pair is for supply and the second random number is for demand viz. in the first pair (31, 18), use 31 to simulate supply and 18 to simulate demand.

Answer

net profit of the retailer = ₹ .400

16.19 Advanced Management Accounting

Question 3

A book-store wishes to carry *Systems Analysis and Design* in stock. Demand is probabilistic and replenishment of stock takes 2 days (i.e., if an order is placed in March 1, it will be delivered at the end of the day on March 3). The probabilities of demand are given below:

Demand (daily):	0	1	2	3	4
Probability:	0.05	0.10	0.30	0.45	0.10

Each time an order is placed, the store incurs an ordering cost of ₹ .10 per order. The store also incurs a carrying cost of ₹ .050 per book per day. The inventory carrying cost is calculated on the basis of stock at the end of each day. The manager of the book-store wishes to compare two options for his inventory decision:

- A. Order 5 books, when the inventory at the beginning of the day plus orders outstanding is less than 8 books.
- B. Order 8 books, when the inventory at the beginning of the day plus orders outstanding is less than 8 books.

Currently (beginning of the 1st day) the store has stock of 8 books plus 6 books plus 6 books ordered 2 days ago and expected to arrive next day. Using Monte-Carlo simulation for 10 cycles, recommend which option the manager should choose?

The two digits random numbers are given below:

89, 34, 78, 63, 81, 39, 16, 13, 73

Answer

Option A: Carrying Cost = $39 \times 0.50 = ₹ .19.50$

Ordering Cost = $4 \times 10 = ₹ .40.00$

Total Cost = ₹ .59.50

Option B: Carrying Cost = $45 \times 0.50 = ₹ .22.50$

Ordering Cost = $2 \times 10 = ₹ .20.00$

Total Cost = ₹ .42.50

Since Option B has lower cost, Manager should order 8 books.

Question 4

A bakery shop keeps stock of a popular brand of cake. Previous experience indicates the daily demand as given here:

Daily demand:	0	10	20	30	40	50
Probability:	0.01	0.20	0.15	0.50	0.12	0.02

Consider the following sequence of random numbers;

R. No. 48, 78, 19, 51, 56, 77, 15, 14, 68, 09

Using this sequence, simulate the demand for the next 10 days. Find out the stock situation if the owner of the bakery decides to make 30 cakes every day. Also, estimate the daily average demand for the cakes on the basis of simulated data.

Answer

Daily average demand of the basis of simulated data = 220

Question 5

A company trading in motor vehicle spares wishes to determine the level of stock it should carry for the item in its range. Demand is not certain and replenishment of stock takes 3 days. For one item X, the following information is obtained: (7 Marks)

Demand (unit per day)	Probability
1	.1
2	.2
3	.3
4	.3
5	.1

Each time an order is placed, the company incurs an ordering cost of ₹ . 20 per order. The company also incurs carrying cost of ₹ . 2.50 per unit per day. The inventory carrying cost is calculated on the basis of average stock.

The manager of the company wishes to compare two options for his inventory decision.

- (A) Order 12 units when the inventory at the beginning of the day plus order outstanding is less than 12 units.
- (B) Order 10 units when the inventory at the beginning of the day plus order outstanding is less than 10 units.

Currently (on first day) the company has a stock of 17 units. The sequence of random number to be used is 08, 91, 25, 18, 40, 27, 85, 75, 32, 52 using first number for day one.

You are required to carry out a simulation run over a period of 10 days, recommended which option the manager should chose.

16.21 Advanced Management Accounting

Answer

Option I

Carrying cost (94.5 × 2.50) = ₹ .236.25

Ordering cost (2 × 20) = ₹ .40.00

₹ .276.25

Option II

Day	Random no.	Opening Stock	Demand	Closing Stock	Order placed	Order in	Average stock
1	08	17	1	16	-	-	16.5
2	91	16	5	11	-	-	13.5
3	25	11	2	09	10	-	10.0
4	18	09	2	07	-	-	8.00
5	40	07	3	04	-	-	5.50
6	27	04	2	02	-	10	3.00
7	85	12	4	08	10	-	10.00
8	75	08	4	04	-	-	6.00
9	32	04	3	01	-	-	2.50
10	52	01	3	-	-	10	0.50
							75.5

Carrying cost (75.5 × 2.50) = ₹ .118.75

Ordering cost (2 × 20) = ₹ .40.00

₹ .228.75

Option II is better.

(ii) Assuming Karam must wait until Param completes the first item before starting work. Will he have to wait to process any of the other eight items? Explain your answer, based upon your simulation.

Answer

Cumulative frequency distribution for Param is derived below. Also fitted against it are the eight given random numbers. In parentheses are shown the serial numbers of random numbers.

10	4	01 (2)	00 (7)	03 (8)
20	10			
30	20	14 (1)		
40	40			
50	80	44 (4)	61 (5)	

60	91	82 (6)
70	96	95 (3)
80	100	

Thus the eight times are: 30, 10, 70, 50, 60, 10 and 10 respectively.

Like wise we can derive eight times for Karam also.

Col-1	Col-2	Col-3	(2× Col-2)		
10	4	8			
20	9	18	13 (7)		
30	15	30	25 (4)		
40	22	44	36 (1)	34 (8)	41 (6)
50	32	64	55 (3)		
60	40	80	76 (2)		
70	46	92			
80	50	100	97 (5)		

(Note that cumulative frequency has been multiplied by 2 in column 3 so that all the given random numbers are utilized).

Thus, Karam's times are: 40, 60, 50, 30, 80 40, 20 and 40 seconds respectively.

Param's and Karam's times are shown below to observe for waiting time, if any.

1	2	3	4
Param	Cum. Times	Karam Initial	Karam's cumulative time with 30 seconds included
30	30	40	70
10	40	60	130
70	110	50	180
50	160	30	210
50	210	80	290
60	270	40	330
10	280	20	350
10	290	40	390

Since col. 4 is consistently greater than Co.2, no subsequent waiting is involved.