Single-server Queue (A Grocery)

A small grocery store has only one checkout counter. Customers arrive at this checkout counter at random from 1 to 8 minutes apart. Each possible value of inter arrival time has the same probability of occurrence. The service times vary from 1 to 6 minutes with the probabilities shown in table 2. The problem is to analyze the system by simulating the arrival and service of 6 customers.

Table.1 Distribution of arrived time

Interarrival time (Min)	1	2	3	4	5	6	7	8
Probability	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125

Table-2 Distribution of service time

Service time (Min)	1	2	3	4	5	6
Probability	0.10	0.20	0.30	0.25	0.10	0.05

Random digit for arrival are: 913, 727, 15, 948, 309.
Random digit for service time are: 84, 10, 74, 53, 17, 79.

1) The average waiting time for a customer
2) The probability that a customer has to wait in the queue
3) The fraction of idle time of the server
4) The average service time
5) The average time between arrivals
6) The average waiting time of those who wait
7) The average time a customer spends in the system

Use the following sequence of random number

Solution:

Calculate arrival and service time table and get the random number assignment

Time between arrival	**Probability**	**Cumulative Probability**	**Random digit assignment**
1	0.125	0.125	00-125
2	0.125	0.250	126-250
3	0.125	0.375	251-375
4	0.125	0.500	376-500
5	0.125	0.625	501-625
6	0.125	0.750	626-750
7	0.125	0.875	751-875
8	0.125	1.000	876-000

Calculate service time distribution and assign a random number

Service Time	Probability	Cumulative Probability	Random digit assignment
1	0.10	0.10	00-10
2	0.20	0.30	11-30
3	0.30	0.60	31-60
4	0.25	0.85	61-85
5	0.10	0.95	86-95
6	0.05	1.00	96-00

Determining time between arrivals

Customer	Random digit	Time between arrival
1	-	-
2	913	8
3	727	6
4	015	1
5	948	8
6	309	3

Determining service time

Customer	Random digit	Service time
1	84	4
2	10	1
3	74	4
4	53	3
5	17	2
6	79	4

Simulation Table

Customer	IAT	Arrival Time	Service time	Time service begins	Waiting time	Time service ends	Time spent in systems	Idle time of server
1	-	0	4	0	0	4	4	0
2	8	8	1	8	0	9	1	4
3	6	14	4	14	0	18	4	5
4	1	15	3	18	3	21	6	0
5	8	23	2	23	0	25	2	2
6	3	26	4	26	0	30	4	1
			18		3		21	12

Average waiting time $= \frac{Total\ time\ customer\ wait\ in\ \text{queue}}{Number\ of\ customers} = \frac{3}{6} = 0.5\ min$

Probability customer has to wait in queue$= \frac{Total\ number\ of\ customers\ wait\ in\ \text{queue}}{Number\ of\ customers} = \frac{1}{6} = 0.166 = 16.6\%$

Probability of idle time$= \frac{Total\ idle\ time}{Total\ run\ time} = \frac{12}{30} = 0.4 = 40\%$

Average service time $= \frac{Total\ service\ time}{Number\ of\ customers} = \frac{18}{6} = 3$

Average time between arrival$= \frac{Sum\ of\ time\ between\ arrival}{Number\ of\ arrival - 1} = \frac{26}{5} = 5.2\ mins$

Average waiting time for those who wait$= \frac{3}{1} = 3$

Average time customer spent in system$= \frac{\text{Total time spent in systems}}{Total\ customers} = \frac{21}{6} = 3.5\ mins$