

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

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

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

$$0.166 = 16.6\%$$

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

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

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

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

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