Computer Networks Laboratory - CS 342
Lab 04 - Report - M25
Naveen Kumar A.G.- 210123075
Lakshya Kohli - 210123077
Advaitaa Arun - 210123078

Allowing the airport authorities to specify two critical parameters:
- Arrival Rate (λ): The rate at which passengers arrive at the security checkpoint.
- Service Rate (μ): The rate at which passengers are processed by the security scanner.

λ = 3 passengers/unit time
μ = 3 passengers/unit time

Data Collection and Analysis:
Iteration 1

End Arrival Time = 50 unit time

Case1. Single Server with infinite buffer - (M/M/1) : (∞ / FIFO)

    Average Waiting Time = 0.622436

    Average Queue Length =2.64789

    System Utilization = 0.681629

Case2. Single Server with finite buffer - (M/M/1) : (N / FIFO)

    N = 5

    Average Waiting Time =0.438084

    Average Queue Length = 1.80282

    System Utilization = 0.710941

Case3. Multiple Server with infinite buffer - (M/M/S) : (∞ / FIFO)

    S = 3

    Average Waiting Time = 0.00595365

Server No.	Average Queue Length	System Utilization
1	0.0422535	0.230518
2	0	0.255822
3	0	0.190677

Case4. Multiple Server with finite buffer - (M/M/S) : (N / FIFO)

N = 5, S = 3

Average Waiting Time = 0.00732099

Server No.	Average Queue Length	System Utilization
1	0.0422535	0.317608
2	0	0.197646
3	0	0.259418

Data Collection and Analysis:
Iteration 2

End Arrival Time = 100 unit time

Case1. Single Server with infinite buffer - (M/M/1) : (∞ / FIFO)

    Average Waiting Time = 1.24407

    Average Queue Length = 5.01603

    System Utilization = 0.795706

Case2. Single Server with finite buffer - (M/M/1) : (N / FIFO)

    N = 10

    Average Waiting Time = 0.569923

    Average Queue Length = 2.5

    System Utilization = 0.776085

Case3. Multiple Server with infinite buffer - (M/M/S) : (∞ / FIFO)

    S = 5

    Average Waiting Time = 0

Server No.	Average Queue Length	System Utilization
1	0	0.212639
2	0	0.137177
3	0	0.14465
4	0	0.159697
5	0	0.112909

Case4. Multiple Server with finite buffer - (M/M/S) : (N / FIFO)

N =10, S = 5
Average Waiting Time = 0

Server No.	Average Queue Length	System Utilization
1	0	0.157783
2	0	0.176899
3	0	0.12868
4	0	0.134467
5	0	0.161557

Data Collection and Analysis:
Iteration 3

Case1. Single Server with infinite buffer - (M/M/1) : (∞ / FIFO)

Average Waiting Time = 0.497857
Average Queue Length = 2.04684
System Utilization = 0.68858

Case2. Single Server with finite buffer - (M/M/1) : (N / FIFO)

N = 15
Average Waiting Time = 0.820286
Average Queue Length =3.22951
System Utilization = 0.698206

Case3. Multiple Server with infinite buffer - (M/M/S) : (∞ / FIFO)

S = 7
Average Waiting Time = 0

Server No.	Average Queue Length	System Utilization
1	0	0.0994509
2	0	0.115011
3	0	0.101245
4	0	0.121806

5	0	0.123338
6	0	0.111995
7	0	0.0964527

Case4. Multiple Server with finite buffer - (M/M/S) : (N / FIFO)

N = 15, S = 7

Average Waiting Time = 0

Server No.	Average Queue Length	System Utilization
1	0	0.104309
2	0	0.0944122
3	0	0.0992638
4	0	0.106825
5	0	0.0930365
6	0	0.0776885
7	0	0.100824

Optimization Strategies:

1. Optimization of Buffer Size:

Augmenting the buffer size (K) leads to a notable decrease in the occurrence of dropped packets and a rise in server utilization. Nonetheless, this comes at the cost of heightened average waiting times and queue lengths. Additional increments in buffer size may be contemplated if the priority lies in minimizing the number of dropped packets rather than reducing waiting times and queue size.

2. Multi-Server Configuration:

The incorporation of numerous security scanners improves the overall efficiency of the system, reducing the rates of dropped packets, average waiting times, and average queue lengths. However, this positive impact is counterbalanced by a significant decline in server utilization, leading to notable wastage of resources. The optimal outcome in our scenario appears to be reached with a configuration of 5-8 servers.

Conclusion:

The outcomes of our simulation reveal that enhancing the airport security screening process can markedly enhance both passenger satisfaction and overall airport efficiency. By fine-tuning variables like buffer size, the quantity of security scanners, and the incorporation of buffers in multi-server setups, airports can tailor their security screening procedures to adapt to fluctuating passenger volumes and diminish waiting times. These refinements are essential for guaranteeing a more seamless and efficient experience for passengers.