

Chapter 6

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CONCLUSIONS

On study of the sample data analysis report and simulated data analysis report, it was observed that the average number of arrivals per day based on sample data for Counter Number 1 was 140, for Counter Number 2 was 27 and for Counter Number 3 was 77 customers. Simulated data report shows average number of arrivals for Counter Number 1 was 135, for Counter Number 2 was 27 and Counter Number 3 was 76.

Comparison of the above two reports indicates that the maximum number of customers come to purchase tickets from Counter Number 1 for the SAYADRI and its connecting trains. Minimum number of customers arrive for purchasing A/C and 1st Class tickets at Counter Number 2.

The analysis indicates that the computerized simulation model built for the Kolhapur Railway Reservation System is very close to the actual (real life) reservation system.

Both simulated and sample data analysis reports indicate long waiting time for Counter Number 1. Average waiting time as per simulated data is 1 hour 9 minutes 15 seconds. From sample data, it is 1 hour 8 minutes 15 seconds. Hence long queues are formed at Counter Number 1. Sample report indicates traffic intensity of 1.16 and server utilization of 78.39%. Considering the same in case of simulated data it is found that traffic intensity is 1.16 and server utilization 76.37%.

The above results indicate the server is being highly utilized. The server finds it difficult to provide satisfactory service as the server is overloaded at certain times during the

day. This leads to long queues and long waiting times per customer at Counter Number 1.

Graphs indicate that maximum number of arrivals for Counter Number 1 is on Mondays and Saturdays. The rush hours for this counter occurs twice a day, between 8 - 10 am and 2 - 3 pm, the latter period being heaviest.

In case of Counter Number 2, both sample and simulated data indicate average arrivals per day is 27. Server utilization is 18.69% (sample data) and 19.08% (simulated data). Traffic intensity is 0.24 for both sample and simulated data is observed. Average waiting time per customer for this counter is 5 minutes 23 seconds in case of sample data and 6 minutes 31 seconds in case of simulated data. Average service time in this counter was 4 minutes 13 seconds (sample data) and 4 minutes 16 seconds in case of simulated data. Average arrival gap for Counter 2 is 17 minutes 33 seconds (sample data) and 17 minutes 34 seconds (simulated data).

The above results indicate the server is being under utilized. The server is idle for long periods during the day. Average counter idle time is 5 hours 32 minutes 21 seconds per day (sample data) and 6 hours 17 minutes 20 seconds (simulated data). Maximum number of arrivals per day at this counter was on Saturday. Rush hour was between 10 and 11 am.

In case of Counter Number 3 average waiting time as per simulated data was 52 minutes 48 seconds. From sample data, it was 43 minutes 19 seconds. Hence long queues are formed at Counter Number 3. Sample report indicates traffic intensity of 0.93 and server utilization of 69.77%. Considering the same in case of simulated data it was found that traffic intensity was

0.98 and server utilization 70%. Average number of arrivals per day was 77 (sample data) and 766(simulated data).

The above results indicate that long queues are formed for reservation for Counter Number 3. The server was overloaded and highly utilized. However, comparison of average service times and average arrival gaps indicates that reservation at this counter take longer time here than at any other counter. This suggests that operation at this server was slower.

Graphs indicate that maximum number of arrivals for Counter Number 3 was on Mondays and Saturdays. The rush hours for this counter occurs twice a day, between 8 - 10 am and 2 - 3 pm, the latter period being heaviest.

SAMPLE DATA VERSUS SIMULATED DATA

STATISTICAL MEASURES FOR COUNT NO: 1	SAMPLE DATA DURATION 1 WK.	SIMULATED DATA DURATION 6 WEEKS
TOTAL NO OF ARRIVAL OF CUST. :	980	5672
AVERAGE NO OF ARRIVAL / DAY :	140	135
AVERAGE WATING TIME/CUSTOMER :	1 H. 8 M. 15 S	1 H. 9 M. 15 S.
AVERAGE SERVICE TIME/CUSTOMER:	3 M. 22 S	3 M. 24 S.
AVERAGE ARRIVAL GAP	2 M. 54 S	2 M. 56 S.
AVERAGE COUNT.IDLE TIME/DAY :	6 M. 18 S	22 M. 46 S.
TRAFFIC INTENSITY	1.16	1.16
SERVER UTILISATION	78.39%	76.37%
STATISTICAL MEASURES FOR COUNT NO: 2	SAMPLE DATA DURATION 1 WK.	SIMULATED DATA DURATION 6 WEEKS
TOTAL NO OF ARRIVAL OF CUST. :	186	1128
AVERAGE NO OF ARRIVAL / DAY :	27	27
AVERAGE WATING TIME/CUSTOMER :	5 M. 23 S	6 M. 31 S.
AVERAGE SERVICE TIME/CUSTOMER:	4 M. 13 S	4 M. 16 S.
AVERAGE ARRIVAL GAP	17 M. 33 S	17 M. 34 S.
AVERAGE COUNT.IDLE TIME/DAY :	5 H. 44 M. 12 S	6 H. 17 M. 20 S.
TRAFFIC INTENSITY	0.24	0.24
SERVER UTILISATION	18.69%	19.08%
STATISTICAL MEASURES FOR COUNT NO: 3	SAMPLE DATA DURATION 1 WK.	SIMULATED DATA DURATION 6 WEEKS
TOTAL NO OF ARRIVAL OF CUST. :	541	3188
AVERAGE NO OF ARRIVAL / DAY :	77	76
AVERAGE WATING TIME/CUSTOMER :	43 M. 19 S	52 M. 48 S.
AVERAGE SERVICE TIME/CUSTOMER:	5 M. 25 S	5 M. 32 S.
AVERAGE ARRIVAL GAP	5 M. 49 S	5 M. 40 S.
AVERAGE COUNT.IDLE TIME/DAY :	42 M. 7 S	1 H. 5 M. 39 S.
TRAFFIC INTENSITY	0.93	0.98
SERVER UTILISATION	69.77%	70.%

SAMPLE DATA VERSUS SIMULATED DATA

QUEUE LENGHT FOR COUNT NO : 1	SAMPLE DATA DURATION 1 WK.	SIMULATED DATA DURATION 6 WEEKS
LONGEST QUEUE LENGHT	53	65
AVERAGE QUEUE LENGHT	17	16
QUEUE LENGHT FOR COUNT NO : 2	SAMPLE DATA DURATION 1 WK.	SIMULATED DATA DURATION 6 WEEKS
LONGEST QUEUE LENGHT	5	5
AVERAGE QUEUE LENGHT	0	0
QUEUE LENGHT FOR COUNT NO : 3	SAMPLE DATA DURATION 1 WK.	SIMULATED DATA DURATION 6 WEEKS
LONGEST QUEUE LENGHT	25	36
AVERAGE QUEUE LENGHT	6	7

SUGGESTIONS

On the basis of sample and simulated data analyses and the simulation model developed in this thesis, the following suggestions can be made in order to improve the performance of the reservation system of Kolhapur City.

- 1) The Railway authorities should try to minimize the waiting time of customers arriving at Reservation Counters 1 and 3.
- 2) Service facility at Counter Number 2 was under-utilized. This should be rectified as to improve server utilization.
- 3) Operation of Counter Number 3 for reservations should be monitored in order to identify causes leading to long average service time. This will help in improving service at this counter.
- 4) A public service organization like the Railways should consider computerizing the reservation system in order to improve overall efficiency. In the automated system service times will be far shorter than the present manual system.
- 5) Token counter should be opened 10 minutes before the ticket issue counters. This will reduce the average waiting time per customer, especially, waiting times of customers arriving in the early parts of the day. Now token counters open 30 minutes before. This automatically increases customer wait time by half an hour.

- 6) Computer simulation model can be modified to take into consideration costs associated with customer wait times plus costs of service facilities.
- 7) Token counter issues could be transferred to Counter Number 2 since the latter was under utilized. Then the token counter can be used to take some of the load off counters number 1 or 3.

SCOPE FOR FURTHER STUDIES

Simulation techniques is a suitable technique for its analysis, study and solving of queuing problems. There exists a vast scope for study in this field.

As mentioned earlier, this study has covered only single stage server system with special reference to the Kolhapur Railway Reservation.

This study can be further extended to a multi stage server system with areas of application like industrial processing, transportation, banking system, etc.

Under this study cost factors have not been taken into consideration. These costs are cost of customer wait time and that of the server.

In future studies, the cost factor can be taken into consideration.