Chapter One

Introduction

The waiting queue comes into existence because there exists population of elements which requires service of some kind from time to time. An element of the population requiring service is called a customer. In a queuing system customers arrive and join the queue and leave after they are serviced.

Queues are formed in various walks of life: in banks, railway reservation offices, Bus reservation offices, in shopping centers, etc. It has been desired always to provide service to the customers in an efficient way which not only reduces cost but also reduces waiting time of customers in the queue. In order to reduce the cost, the number of servers providing the service are often reduced and utilized in an optimum way. Long queues in business may cause the customers to avoid them and go to other centers where they can be serviced within much lesser time.

Time has become the most important factor for people all over the world and wherever they can they try to save on waste of time.

Thus study of queuing systems and analysis of servers performance has become an important field of study.

Scope of Study

The scope of the study is to bring light on the queuing system, their operation and their performances. This is in order to enable the customers to be serviced in a quicker way at reasonable costs for those providing the services.

This study helps in designing the servers required to provide satisfactory service to customers arriving at them. It enables the concerned to estimate the cost of servers, by knowing the minimum number of servers and the minimum required for satisfactory service. This helps in deciding the machinery, personnel, etc. involved in the system and finance required. It can also help in decision making as to whether the combination is having a reasonable rate of return on investment or not.

This study provides a basis for further investigation of other factors which are related in the queuing system.

The study is computerized since the computer can run the simulation at high speeds. It reduces the time required for the study and provides a solution in a quick way with more accuracy. Human error in repeated simple mathematical calculations is also reduced.

Objectives of the Study

Queues and congestion occur in all walks of life. In many industrial and business environments, queues are of sufficient economic significance to warrant expenditure on their studies. Following are the objectives of this present research study.

1) The main objective of the present study is to develop a computerized simulation model for Railway Reservation System in Kolhapur City with the help of the sample data collected.
2) To analyze the performance of the operation of the Reservation Office with the help of the simulation model developed.
3) To develop a computer program capable of simulating models for study in other types of queuing systems.
4) To simulate the system under observation for any required period of time.
5) To calculate statistical measures like average waiting time, average number of arrivals per day, average service times, average arrival gaps, average counter idle time, traffic intensity and counter utilization factor for both sample and simulated data.
6) Comparison and analysis of the sample data result with that of the generated data.
7) To provide suggestions and improvements in the operation of Railway Reservation System in the city in by ensuring utilization of the service facility in an optimum way.
8) To reduce cost involved in waiting time and service facilities by bringing about a balance between the two.

Methodology

There already exist mathematical solutions to queuing system problems. However, these solutions can be applied to specific situations only if the **pattern of arrival** (i.e. the way customers arrive to be serviced at the system - frequency distribution pattern of arrivals) and **service pattern** (frequency distribution of service) follow specific frequency distributions.

In most queuing systems, arrival and service patterns are purely random. It is for this reason that the method adopted for the study of the Railway Reservation System in Kolhapur is the simulation technique. The simulation technique is best suited since it does not follow any specific frequency distribution. The patterns of arrival and service taken under this method is purely random. The simulation method is applicable to all types of queues. Service and arrival patterns are calculated by means of the sample data collected.

In the simulation technique, a model of the system is built on the pattern of arrival and service times. With the help of random numbers and the model (which is an exact copy of the real life system) the queuing system can be studied for a longer period of time.

Sample data collection was started by studying the queuing system of Railway Reservation in Kolhapur City. This was done by collecting information on the type of queuing discipline and servers providing the service: i.e. numbers and operating hours.

It was found that there are three **selling counters** where tickets are issued to arriving customers. A special **token counter** opens at 8:00 am. This counter issues tokens to the selling

counters. The selling counters open at 8:30 am and close at 5:30 pm. The token counter closes at 3:00 pm. People who have taken tokens are provided service upto 5:30 pm. If the selling counters are free before 5:30 pm, they provide service to customers without tokens. All counters are closed between 12:30 and 1:30 pm for lunch.

There are two trains from Kolhapur, the Sayadri and Mahalakshmi.

Issue counter No.1 issues tickets for the Sayadri train 2nd class reservation.

Issue Counter No.2 issues tickets for the 1st class reservation of both trains.

Issue Counter No.3 issues tickets for the Mahalakshmi train 2nd class reservation.

Although there are tickets for only these two trains one can reserve tickets for many other cities in India like Bombay, Pune, Miraj, Ahmedabad, Nagpur, Assam, Vasco, Delhi, etc. wherever quotas are available for the connecting trains linked from Miraj station. For these cities people do their reservations at the Kolhapur Railway Reservation Office.

In order to calculate arrival and service patterns, sample data was collected for a period of one week. The technique used for data collection was observation. In this method, the time when a customer arrived at the token counter was recorded (arrival time). Next the time the same customer was called to an issuing counter was recorded (call time). Lastly, the time the customer left the issuing counter was also recorded (departure time).

All these observations were recorded and tabulated for one week. On the basis of the above tabulated data, a simulation model for the queuing system was built.

The next stage of the study was to develop the computer program which would accept the collected data in order to tabulate, analyze and provide various statistical measures. This would enable the researcher to draw conclusions about the performance of operation of the Kolhapur Reservation System. However, the researcher was keen to develop a general computer program which could not only provide statistical measures to this particular study, but also be applied to a variety of other queuing problems elsewhere.

Statistical measures used to analyze performance of the queuing system are as follows:-

1) Average number of arrivals per day of customers at each counter.
2) Average waiting time per customer per counter (total waiting time of all customers divided by total number of customers entering the system, at individual counters).
3) Average service time per customer per counter (total service time of all customers divided by total number of customers entering the system, at individual counters).
4) Average arrival gaps between customer arrivals per counter (total arrival gaps of all customers divided by total number of customers entering the system, at individual counters).

5) Traffic intensity: the ratio of average service rate to average arrival.

6) Server utilization: the percentage of time server has been busy to the total time server is available for service.

The above mentioned statistical measures are sufficient to draw conclusions regarding performance and operation of the system. They can highlight the under utilization of a server or creation of long queues and long waiting time. On basis of these measures, inefficient servers, lack of facilities or shortage of servers can also be isolated and identified.

Arrival, call and departure times are recorded in HH: MM: SS format where HH = hours, MM = minutes and SS = seconds.

Example: 12:34:50 implies 12 hours 34 minutes and 50 seconds.

This format was adopted in order to simplify calculations of waiting and service times, arrival gap and counter idle times. This format is further converted into seconds. After calculation, results are reconverted to the original format.

Time accuracy is in seconds only. This is because observations by the researcher often showed arrival gaps of a few seconds and service times of a few seconds. In order to record all these activities without delay, an accurate watch was used. However, in the simulated data, accuracy was limited to minutes since the researcher felt it would not affect statistical measures significantly.

It should also be mentioned that the lunch hour period is not taken into account for statistical measures since at this time the server does not operate. If it had been taken into

consideration, the waiting times would have increased significantly, counter idle times would have altered and this would have affected the result of this study.

Simulation technique adopted is Discrete System Simulation on Event to Event Model. In this technique, the computer advances time to the occurrence of the next event, as it shifts from event to event. The system does not change in between, only those points in time are kept track of when something of interest happens to the system.

Limitations of the Study

The program developed here for simulation of queuing system is applicable to only problems of Single Stage Service type. It cannot be used for queuing systems where there are multiple stages of service and where the output of one stage is the input to the next stage.

The computer simulated model developed does not take into account costs associated with the wastage time of customer and server time.

Simulation of the system is done for a short period of time due to unavailability of computer facility and lack of computer memory to store the large volumes of data generated by the simulation program.

Certain customers come to the system after the token counter has closed. Those customers who leave the system without purchasing tickets are not taken into consideration.