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# Application of Queueing Theory at Airport

Rajendra B. Patel

*Assistant Professor, R.R.Mehta Science and Commerce College, Palanpur, Gujarat*

**Abstract :** *In recent time, the air travel has become so accessible to common people due to many factors, such as low cost airlines, cheap tickets available due to cut throat competition between airlines as well as the spending capacity of the people is increased. This has very high impact on airport operations, as airports become overcrowded. In such scenario we propose a alternative technique for the airport to handle the passenger flow at check in counters.*

## INTRODUCTION

As the air travel has become more accessible to the common people, it is creating overload on the existing facilities at airports. Main issue arise at check in counters where the passengers have to go through with tedious and time consuming at long queues. It is generally observed that there are many check in counters available and each counters having their own single queue. There are counters separate for priority customers and web check in passengers for baggage drop. Many times such long queues create confusion to the passengers to select appropriate queue so that they can be served faster. Also the authority at airport also wants such arrangements that people can get fast service as so that ultimately they achieve more customer satisfaction. So that to avoid long queue and jockey behaviour, we have suggested a new method for the check in counters. Where the passengers arrive and stands in one queue and as soon as they arrive at the first place in the queue, they are directed to the vacant counter by the computerised system or by one of the staff member. As the counter vacates, the next passenger is directed to go there. Ultimately, it is observed that such system is serving the customers very fast than the normal system. We have selected one of the airport in Gujarat in India and collected the data by observation for 7 days, also we have proposed the our method and under that method we have collected the data for 7days. Then applied the queuing theory on that and analysed the data as below.

## MULTI SERVER SINGLE QUEUE MODEL : M/M/1.

The M/M/1 model is representing the arrival rate and service rate are exponentially distributed i.e. we can say the it is Poisson process. The variables and parameter definition for the model are as below

$\lambda$ = Mean arrival rate

$\mu$ = mean service rate

$\rho = \frac{\lambda}{\mu}$ which is utilization factor

The probability of zero customer in queue

$P_0 = 1 - \rho$

The probability of having n customers in queue

$Pn = P_0\rho^n$

The average number of customer in the system

$$L_S = \frac{\rho}{1-\rho} = \frac{\lambda}{\mu-\lambda}$$

The average number of customer in the queue

$$L_q = L_S\rho = \frac{\rho^2}{1-\rho} = \frac{\lambda\rho}{\mu-\lambda}$$

The average waiting time in the queue

$$W_q = \frac{L_q}{\lambda} = \frac{\rho}{\mu-\lambda}$$

The average time spent in the system including the waiting time by the customer

$$W_S = \frac{L_S}{\lambda} = \frac{1}{\mu-\lambda}$$

## MULTI SERVER MULTI QUEUE MODEL : M/M/s

The variables and parameters of the M/M/s model

 

λ = Mean arrival rate

μ = mean service rate

ρ = $\frac{\lambda}{s\mu}$ which is utilization factor

Probability of zero passengers in the airport

$$P_0 = \left[\sum_{n=0}^{s-1} \frac{(s\rho)^n}{n!} + \frac{(s\rho)^s}{s!\,(1-\rho)}\right]^{-1}$$

The probability of having n passengers in the airport

$P_n = P_0\rho^n$

The average number of passengers in the airport

$$L_S = L_q + \frac{\lambda}{\mu}$$

The average number of passengers in the queue at check in counter

$$L_q = P_s \frac{\rho}{(1-\rho)^2}$$

The average waiting time in the queue at check in counter

$$W_q = \frac{L_q}{\lambda} = P_S \frac{1}{s\mu(1-\rho)^2}$$

The average time spent in the airport for check in including the waiting time at counter

$$W_S = \frac{L_S}{\lambda} = W_q + \frac{1}{\mu}$$

## DATA ANALYSIS AND RESULTS

The data of 7 days shows the following results for the first phase, which is application of M/M/s model. The second phase of 7 days is the application of M/M/1 model. It is assumed that the arrival of the passenger follows the Poisson distribution and the passengers are served on First Come First Serve (FCFS) base at the check in counter. Also there are no priority passengers in the queue or there is separate system for priority passengers, the population of the passengers is infinite. The service rate of the check in counter is constant and does not affect by the external forces. We have taken 3 check in counters into the study for general passengers. Also the selected airport serves 4 flights per day.

The service rate μ is fixed as 20 in each case.

Table 1
Waiting Time in Different Time Slot under M/M/1

| Flight No. | λ | $L_S$ | $L_q$ | $W_S$ | $W_q$ |
|---|---|---|---|---|---|
| 1 | 19 | 19 | 18.05 | 0.95 | 1 |
| 2 | 17 | 5.66 | 4.8167 | 0.2833 | 0.3333 |
| 3 | 15 | 3 | 2.25 | 0.15 | 0.2 |
| 4 | 18 | 9 | 8.1 | 0.45 | 0.5 |

Now the application of proposed M/M/s queue and result of that is listed below.

Table 2
Waiting Time in Different Time Slot under M/M/s

| Flight No. | λ | $L_S$ | $L_q$ | $W_S$ | $W_q$ |
|---|---|---|---|---|---|
| 1 | 14 | 0.7025 | 0.0025 | 0.0502 | 0.000178 |
| 2 | 16 | 0.8042 | 0.0042 | 0.0503 | 0.000265 |
| 3 | 18 | 0.9080 | 0.0080 | 0.0504 | 0.00044 |
| 4 | 17 | 0.8563 | 0.0063 | 0.0503 | 0.00037 |

From the above results we can easily see that the waiting time is less in the proposed system. Thus we have recommended the airport to adopt this proposed system for check in counters. Airports can make arrangements to such system where only one queue is there and as soon as any check in counter vacates, next passenger will automatically go to that vacant counter.

 

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