Project Report

Capacity Analysis (ET2594)

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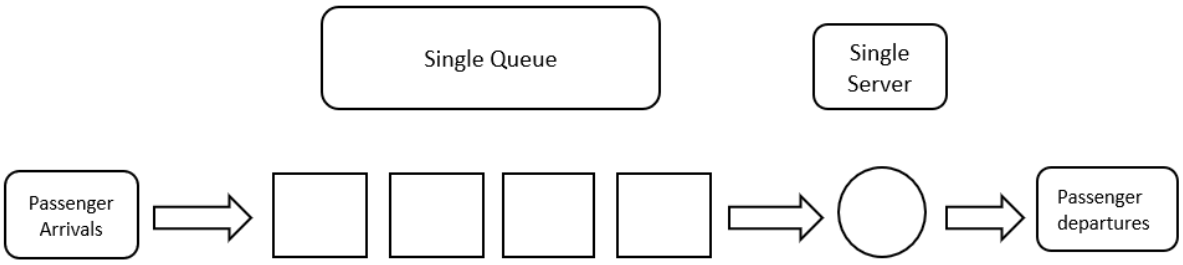
Scenario

An airport scenario with one queue line, modelled by M/G/1 queuing system. Where passengers pass through the check-in counter for checking against legality, and to drop their baggage. During this process, passengers who have baggage weight less than or equal to 30KG pass to the next step otherwise, either they must throw some stuff or pay for the extra weight which consumes more time. So, a queue disturbance occurs when a passenger has an overweight baggage.



Goal

The goal/aim of the project is to analyze

1. How often can the disturbance occur in the queue? What is the effect of occurred disturbance?
2. What is the average waiting time in queue? And how is it distributed?
3. How much time is wasted due to the occurred disturbance?

Materials Used

- Referred to the solutions of previous question papers, ongoing class problem sets and previous year projects.
- MATLAB search documentation
- Web Browser

Task:

According to the scenario, we have modelled a check-in counter using M/G/1 queuing system, in which passengers arrive at the counter for check-in process and baggage drop, where they can arrive with different baggage weight.

In this process, passengers who have baggage weight less than or equal to 30KG pass to the next step otherwise, either they must throw some stuff or pay for the extra weight which consumes more time. So, a queue disturbance occurs when the passenger has an overweight baggage, and the service time is increased.

So, to generate the baggage weight we have used randi (Uniformly distributed pseudorandom integers) and increased the service time when a passenger brings an overweight baggage.

Furthermore, we used little's law to find the expected mean waiting time of passenger in the queue, using arrival rate (lambda) and service rate (mu).

Which is from the formulae **L= lambda*W**
Where W is the meantime a passenger spends in queue.
$L = \rho^2/(1- \rho)$ where ρ = lambda/mu

Therefore w = lambda/(mu*(mu-lambda))

Then we wrote a loop to find the waiting time of each passenger in the queue and compared it to the expected mean waiting time of the passenger to check if there is a disturbance or not. In addition, we also found how much time is wasted due to occurred disturbance.

Methodology and Analysis

Implemented this task in MATLAB and used a function to import number of arrived passengers (nbrarrived) where the inputs are lambda, mu, and sim_time. And considered three events as arrival, departure, and measurement from which we can derive the fundamental model concerning the M/G/1 system.

Event 1 is for Arrival

Event 2 is for Departure

Event 3 is for Measurement

Where Event 1 indicates that there is an arrival. So, the current number of passengers gets incremented and we store these stamp time of arrivals in an array. Event 2 indicates that there is a departure. So, the current number of passengers gets decremented, and we store these stamp time of departures in an array. Event 3 shows number of passengers present at that moment of time.

Here in this scenario the arrivals are Markovian (modulated by Poisson process), service times have a general distribution. Where the arrival rate (lambda) and service rate(mu) are 7 and10 respectively.

Then we generated the baggage weight using randi in the range of 25 to 40 **randi([25,40])**

Later we increased the service time when passengers brought baggage more than 30kgs by using this loop.

```
if curr_customers==1
if bag_current>30
    event(2)=exprnd(2*(1/mu))+t;
    else
    event(2)=exprnd(1/mu)+t;
    end
end
```

So, when a passenger brings an overweight baggage, a queue disturbance occurs, and we need to find out how often does this occur and how does it effect the system.

To implement this firstly we need to find the expected mean waiting time of passenger in queue using little's theorem and then we wrote a loop to find the waiting time of each passenger to compare it to the expected mean waiting time. From the implementation, we can say that if waiting time is less than or equal to expected waiting time, the system is stable or else there is delay in the system i.e., which is caused by the disturbance.

The average waiting time can be found by performing the average of all the outcomes i.e., waiting time of each passenger in the queue. And figure 1 shows the histogram plot of waiting time in the queue.

The time wasted/delay due to the occurred disturbance can be found by performing the mean of difference of each outcome of the waiting time(w) and expected waiting time(wq).

Time_wasted=mean(w-wq)

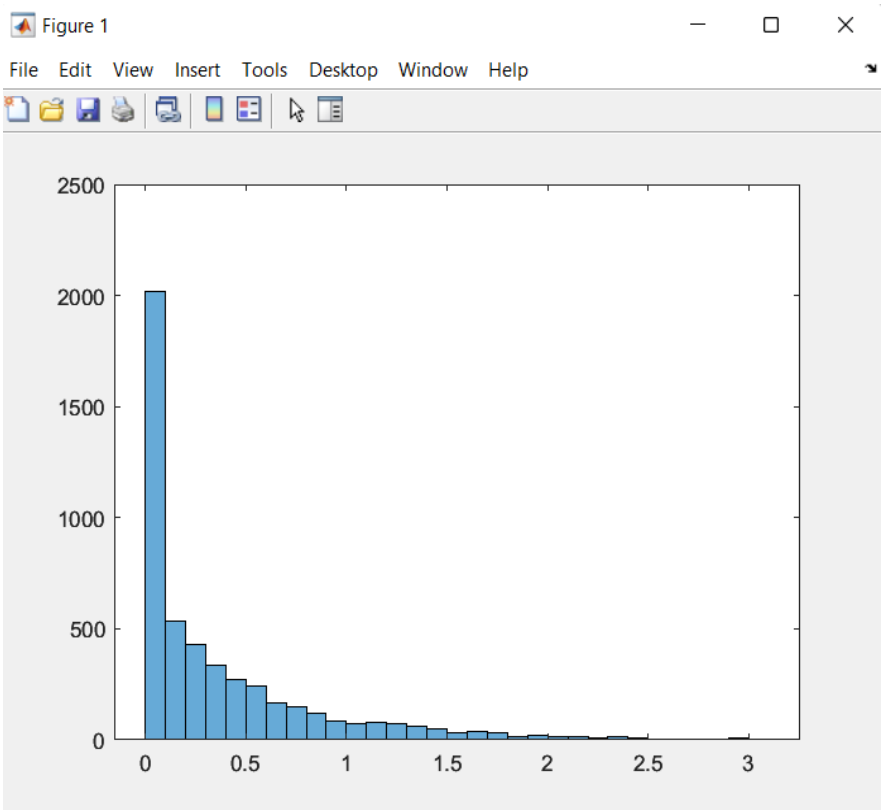


Figure1: Histogram plot of waiting time in the queue.

Conclusion

From the above results and graphs we can conclude that when a disturbance occurs due to the overweight baggage, a delay occurs in the queuing system. Signifying that waiting time of passengers in the queue increases.