Model of series queues networks for passenger at Basra International Airport

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Abstract
Large networks of queue systems represent important systems in the real world such as patients in hospital, calls in call centers, shipping containers in a seaport, and passenger terminals at airports. n this study, we deal with bottlenecks in the series queues networks in the passenger terminal before entering the stage of departure and boarding, and to know the size and absorption that passengers can reach at Basra International Airport. The search was represented statistically by studying the networks of series queues to reduce the waiting time for service performance by using statistical program packages R, as it is one of the latest and most accurate methods ,as well as the lack of calculations. Through the results, it was concluded that there are no bottlenecks at the present time for the lack of travelers due to the Corona pandemic, and it is expected in the near or distant future to increase the number of travelers Will get bottlenecks at the A2 passport stamp station.

Keywords: queues, Basra International Airport, passenger , station .

Introduction

Basra is considered one of the most important provinces of Iraq in terms of economy and geography, as it is considered the third governorate with the size of the population. As well as the largest source of oil production in Iraq, and it is the only sea outlet for trade in the country, and the population increase in Basra has a direct reflection on the number of travelers, as well as the increase in investments in the expected governorate in the Al-Faw port project, south of Basra, which links the Middle East to the continent of Europe and has positive repercussions in increasing The number of travelers is much more than it is at present.

The passenger system at airports is one of the most complex of queues models[1], as it consists of several stages and each stage has a certain number of service places and service places depend on the number of passengers. It consists of an open network of service stations [2].

For the Basra International Airport management must improve the flow of passengers at the airport and satisfy them through airport queue management solutions, understanding where problems occur is the first step in correcting problems in passenger movements.

As there is no one-size-fits-all solution for travelers and airport terminals, from the security check at the airport entry gate, the stage of cutting boarding passes, the weight of bags , then the screening stage of passports and the departure mark, so wherever you expect queue to appear throughout the airport.

In general, every facility and service on the air and land side of Basra International Airport can be considered as a queue system. Passengers, planes, bags, etc., form queues at these facilities and wait for them to be served. Flow analysis and queue theory provide information about service system request and delays experienced by users.

Data were collected from the aviation department of the Iraqi Civil Aviation Authority at Basra International Airport and the Basra Ground Services Company, which is a company responsible for providing service to passengers, as well as providing services to aircraft and the Directorate of Transport and Communications Statistics [3] in addition to field work to record arrival time and the time it takes to perform the service.

Since the issue is related to the number of passengers, passengers must enter the service system within one hour of the departure time. The average service in both terminals should be less than half an hour in order for passengers to board the plane, Because the time for moving to the departure area (the transit), registering the boarding pass, and then moving to the air bridges or buses that transport passengers to the aircraft ranges between 20-30 minutes, so passengers must be ready at least 30 minutes in advance.

The aim of the research is to know the bottlenecks in the passenger terminal before entering the departure and boarding stage and knowing the size and absorption of who can reach the airport.

The study also statistically consisted of studying queue networks to reduce the waiting time required to obtain service using packets queening.

Previous studies dealt with the problem of bottlenecks in airports during recent years and after the events of September 11th, in order to add a security screening station.

So we find the study [4] that aims to apply the theory of queue at an airport security checkpoint in order to improve the rate of passenger traffic and by using computer simulations to evaluate the performance of the system more accurately. By adjusting the parameters of the waiting list to provide a better logical improvement for travelers.

The study [5] dealt with different models of queuing networks structures at airport checkpoints, and concluded that achieving optimal performance in the open network architecture and increasing security screening personnel, it was also found that the n M / M / 1 system is better than the M / M / n system.

The study [6] suggested to use the M / Ek / 1 queue model by checking in via the Internet, in order for the boarding pass to be issued through their smartphones, and to automate the security checks of bags and passengers using electronic equipment. The update is then done on the boarding pass that contains a barcode. And through that, he can climb up with a smart boarding pass, In doing so, this proposed model achieves reduced actual waiting times and improved passenger satisfaction, as well as the discipline of the building.

The study [7] developed a simulation model capable of modeling the screening procedures within security screening checkpoints (SSCP) in detail. Potential applications were presented by increasing the number of security management personnel and reducing the number of inspection lanes. It was found that the simulation approach resulted in longer queue while SSCP helped in Make improvements in queue by focusing on problematic components .

The practical application of the model

The day of 9/24/2020 was chosen to record the number of passengers and arrival times for each passenger. 667 passengers were checked in from 5 in the morning until 7 in the evening, and the next day data for the service times were collected for 103 passengers in the first station.

On the third day, data on service times were recorded at the second station, Passports (departure stamp) for 112 passengers.

By looking at the number of servers in each station, it is found that the first station contains 24 servers, while the second station contains 8 servers.

Then two main sub-models have been designed, namely, the first is the initial screening stage for passports or the identity cards of travelers and comparing them with tickets for each traveler, then cutting boarding passes to the plane and weighing the bags and sending them through the conveyor belt after affixing an identification sticker to them for the purpose of loading them onto the plane, and we call this stage a stage Pieces of boarding passes, and we code them by the code A1.

Then comes the stage of checking passports by the Passport Police and verifying the validity of passports and entry visas to the countries traveling to it, symbolized by A2, and as in Figure (1) a scheme for the main service stations at Basra Airport, where each station consists of a certain number of service centers that depend on The number of passengers per flight.

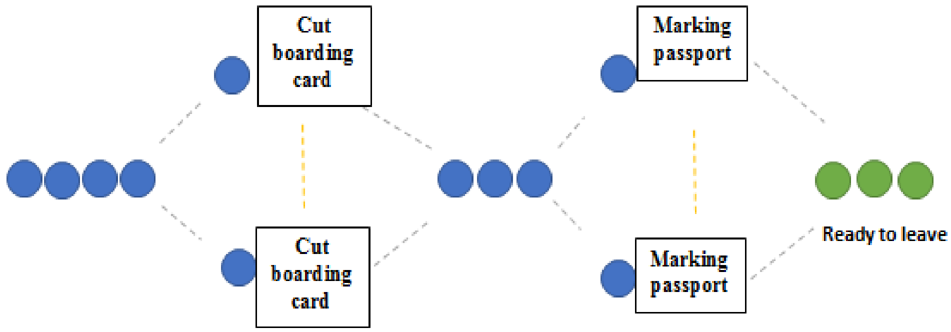

Figure (1) a diagram of the main service stations at Basra Airport

In figure (2) the flowchart of the passenger boarding network on board after completing all travel procedures, including passport visa, receipt of boarding passes, as well as travel card visas.

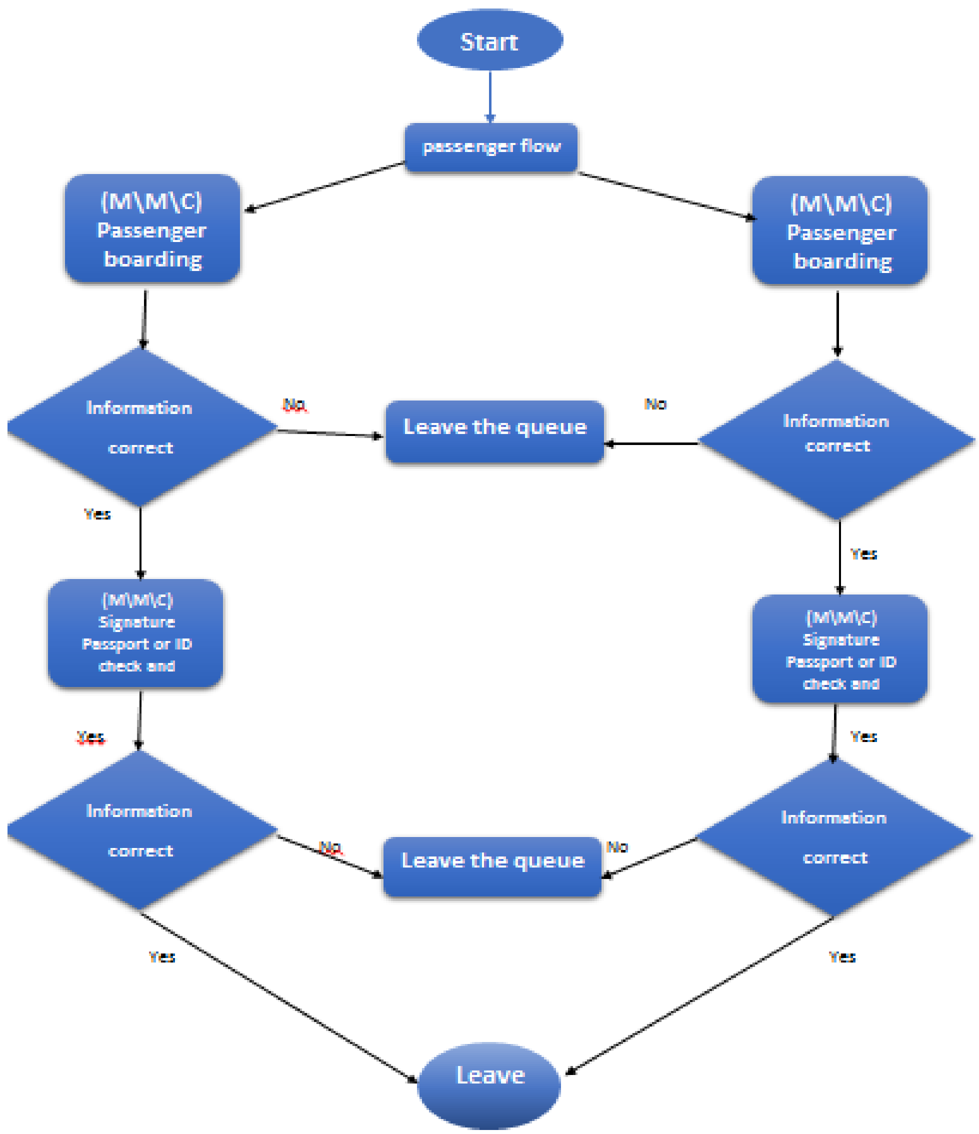

Figure (2) the passenger boarding network diagram

And since the number of passengers at the airports goes in an unknown direction or to no end. Then the hyperbolic model is the access model for both stations as follows:
The access rate is a distributed Poisson distribution Predictably is λ and It is 47,571
The service rate for each server in the first station is μ_1 and it is 29.903
The service rate for each server in the first station is μ_2 and it is 24.333
The number of servers in the first station is c_1
The number of servers in the first station is c_2

- *The probability that the system is full of passengers in station A1:*

$\rho_{A1} = \frac{\lambda}{c_1\mu_1}$ Where ρ_{A1} is the probability that station A1 is occupied

- The probability that the system is empty of passengers:

$$P_{A1(0)} = \frac{1}{\left(\sum_{K=0}^{C-1}\frac{(C\rho_{A1})^K}{K!}\right)+\frac{(c\rho_{A1})^C}{C!(1-\rho_{A1})}}$$

The average number of passengers in a boarding queue A1:

$$L_{A1(q)} = \frac{(c\rho_{A1})^c\rho_{A1}}{c!\,(1-\rho_{A1})^2}.P_{A1(0)}$$

Where $L_{A1(q)}$ the average number of passengers in A1 queue .
The average *the time queue in A1 station*
$W_{A1(q)} = \frac{L_{A1(q)}}{\lambda}$ *Where* $W_{A1(q)}$ The average *time queue in station* A1

- The probability that the system is full of passengers *in station A2:*

$\rho_{A2} = \frac{\lambda}{c_2\mu_2}$ Where ρ_{A2} is the probability that station A2 is occupied

- The probability that the system is empty of passengers *in station A2*:

$$P_{A2(0)} = \frac{1}{\left(\sum_{K=0}^{C-1}\frac{(C\rho_{A2})^K}{K!}\right)+\frac{(c\rho_{A2})^C}{C!\,(1-\rho_{A2})}}$$

The average number of passengers in a boarding queue:

$$L_{A2(q)} = \frac{(c\rho_{A1})^c\rho_{A1}}{c!\,(1-\rho_{A1})^2}.P_{A2(0)}$$

Where $L_{A2(q)}$ the average number of passengers in A2 queue .
The average *the time queue in boarding station* A2
$W_{A2(q)} = \frac{L_{A2(q)}}{\lambda}$ *Where* $W_{A2(q)}$ The average *time queue in station A2*

The Results

The R program was used and the queueing library loaded to find the results, as it was found that there are no bottlenecks in the network at the present time and that the average waiting time in the first station queue is less than 4 minutes and that the waiting time in the first station system is less than 6 minutes, while in the second station is the average waiting time queue approximately one minute. The overall average wait in the second station is just under 4 minutes. And the Figure (3) shows the graph of the distribution of waiting time in the queue Wq and System W in stations A1 and A2 of the model applied for the days specified above

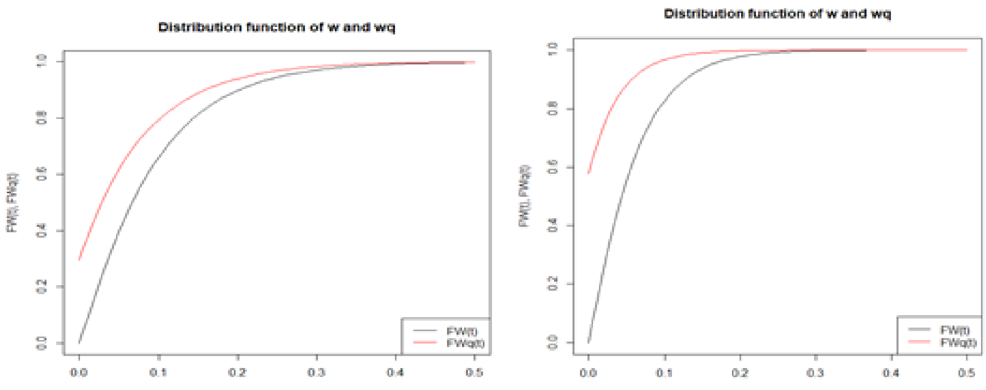

Figure (3) the distribution of waiting time in the queue Wq and System W in:
Station 1 **station 2**

The number of people in the queue, whether they are in the first or second station

$$L = L_{A1(q)} + L_{A2(q)}$$

$W = W_{A1(q)} + W_{A2(q)}$:Average queue time at both terminals

In order for the queue not to grow or the queue time to increase to large times, the probability of the service station becoming busy should be less than 1 [7]

$$\rho_{A1} < 1, \rho_{A2} < 1,$$

And the stability possibility [8] in the first station is 717 passengers per hour, given that there are 24 servers in the first station, 29.903 service time per minute. And in the second station it is 194 in hour that consider there are 8 servers and the service time is 24,333 in the second station. We conclude through stability states that the number of entrants to the system should not exceed the possibility of the second station and that station A2 is the cause of suffocation if the number of passengers reaches 194 passengers, but if the number of passengers exceeds 194, the queue will grow significantly and many passengers will be late to board the plane. .

And 192 passengers per hour is the possibility of the airport per hour if it works with all its available capacity, given that the queue time does not exceed 30 minutes.

Also in the first station there are 7 servers, sufficient to accommodate the passengers, without the queue time in both stations reaching 30 minutes, i.e. half an hour **.**

$$0.5 \geq W_{A1(q)} + W_{A2(q)}$$
$$W = W_{A1(q)} + W_{A2(q)}$$
$$W = 0.0776 + 0.3998$$
$$W = 0.4774 berhour$$
$$W = 0.4774 berhour$$

That is, approximately 28:38, twenty-eight minutes and thirty-eight seconds. Figure (4) shows the graph of the distribution of queue time in the queue Wq and System W in stations A1 and A2 for the model in case of peak absorption at Basra International Airport:

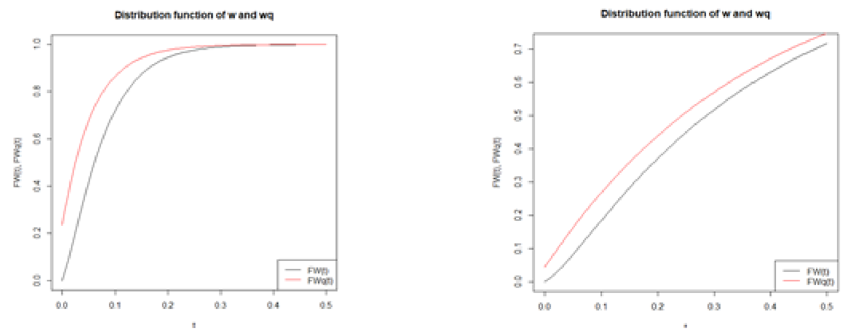

Figure (4) the distribution of waiting time in the queue Wq and System W in:
Station 1 station 2

Conclusions

1) With additional passengers, more pressure comes on airports to improve passenger flow, ensuring that customers are transported around the airport efficiently and queues are reduced. If airports fail to effectively manage the flow of passengers in and out of their terminals, customers will prefer competing airports, resulting in lower revenues and ruining reputations.
2) And since airlines have introduced online check-in, mobile boarding passes, and a self-check-in machine at airports, their use will provide you with a faster and easier person-to-person service, and it will reduce the size of queues in front of counters. Even some light-travel passengers can skip many operations at the airport and board their planes faster than usual, firstly, they don't have luggage to claim, so there is no need to wait in the queues for luggage delivery, they are able to print their boarding pass at home or use codes Boarding a mobile phone.
3) What can airport operations managers do to improve airport passenger flow and passenger satisfaction? Accelerate the passenger flow with our airport queue management solutions
4) In areas such as check-in desks, increasing customer numbers often lead to queues piling up, becoming disorganized and spreading to other areas of the airport if proper queue management systems are not in place. To improve airport passenger flow in this case, consider deploying a retractable queue bulkhead to organize queues and keep passengers in their designated section of the airport, which means the system can be brought in and removed when passenger flow decreases.

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