Flight Arrival Simulation

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Abstract

This paper presents a model based on the simulation to reduce serious passenger time delays. Based on the characteristic of the flights and the thinking of system optimization, this paper builds up dynamic optimizing models of the flight arrival gates. The Arena software is also used to solve this problem. This model can reduce the spent time of the passengers as much as possible. Data from an airport in Iran has been used to verify the model. The overall purpose of this simulation test is to view and observe the flow of the passengers and their cargo at airport terminal. Another purpose of this simulation test is to know that weather the passengers and their cargo flow in the terminal smoothly.

Keywords
Simulation, Arena, Operation Research, Queuing Theory.

1. Introduction

This paper reports the Flight Arrival Simulation (House, 1977) test which was conducted during the period from 20 March to 19 April 2015 of Tehran-Imam Khomeini International Airport (IKIA). The overall purpose of this simulation test was to view and observe the flow of the passengers and their cargo at airport terminal. We want to make sure that, the passengers and the cargo enter and exit the terminal smoothly, the time needed is short, and the length of the queue is reasonable. This report consists of methodology used to conduct the simulation test, the flight data which is provided in the scenario, and recommendations for some observations that were discovered during the test. The flowchart and distribution fitting techniques have been used to help analyze the scenario and evaluate the current situation of the terminal. A number of suggestions have been recommended to enhance the flow of the passengers and their cargo at the Airport.

1. Increase the capacity of each immigration officer by 2.
2. Adding one desk in the non-national queue.
3. Use different rule related to the queue (use circle technique).
4. Use e-check machine for national arrival.
5. Allow passengers from next flights to proceed to the arrival area.

The purpose of this simulation test is to know that weather the passengers and their cargo flow in the terminal smoothly. The evaluation of the terminal is based on the time which is consumed by the passenger during the period from the entrance until the exit from the terminal with the cargo. The evaluation of the terminal will be determined by the length of the queue which is generated in order to check the passenger's passport, go through the custom, and take the luggage. "An airport is an operational system comprising of a framework of infrastructures, facilities, personnel which collectively provide a service to a passenger" (Evans, Kerridge, & Loon, 2013). An airport is composed of different terminals which are divided into different zones. Each zone in the airport has its own facilities and behaviors. In this case, we will focus only on the terminal area and try to evaluate this area based on the information that is related to our case. The next section includes all information needed to conduct a simulation modeling for passenger and luggage flow inside the airport (Arrival Area).

2. Material and Methods

In the past, there were just a few aircrafts taking off from the airports and landing on the airports ground. The small number of aircrafts made the passenger's flow in the airport simple. The aircrafts are being used for tourism and business. The increase in the aircrafts and passengers numbers has made the flow of passengers inside the airport more difficult. The lack of managing the passenger's flow could lead to serious problems for example lost baggage, missing next flights, error in processing documents such as passports, and passengers and employee dissatisfaction. When the passengers and their luggage do not move through the airport in smooth way, the country, the airport reputation, passenger's satisfaction, and employee satisfaction will be negatively affected. Using simulation modeling technique can help airport operators to avoid all these problems. As it is mentioned above, the increase number in flights made the management of the flow of the passengers and their cargo difficult. A number of problems have appeared as a result of bad management inside the area:

1. Long queue of passengers in arrival check desk.
2. Delay in processing the documents.
3. Delay in delivering the luggage.
4. Lack of utilizing the resources.

The aim of this simulation model is to enhance the service in the arrival area by creating As-Is-Model for the flight arrival.

Objectives:

- Use flow chart to understand the current scenario.
- Use distribution fitting.
- Make sure the passengers and their cargo flow smoothly inside the terminal.
- Make some assessments for the utilizations of the resources inside the airport such as the employee and machines.
- Obtain the utilization of all available resources.

To develop a good simulation model, the analyst must identify the components of the simulation model. The simulation model is composed of system entities, activities, attributes, state variables, and events. The event of the system is considered to be the state that makes the system change from idle to busy (AlBazi, 2013). In our scenario, the arrival and the departure of the passengers and their make baggage affect the system and change it from idle to busy or from busy to idle. State variables are variable that define the system state (AL Bazi, 2013). In our case, the state variables are:

- The length of the queue at passport control.
- The length of the queue at custom's zones.
- The length of the queue at carousel.

The flow chart is a diagram that shows the actual system (William C House, 1977). It shows how the processes are connected to each other. The use of flow chart make helps documenting the business. It also helps analysts to understand the actual system and use it as tool to communicate between each other (William C House, 1977). In this project, we created the flow chart to:

1. Define the processes in the arrival area.
2. Analyze the processes.
3. Identify the areas than required some improvements.

This is an abstract view of the flight arrival Case. Figure 1 shows the flow of the passengers from the aircrafts to the exit door in the passport control area. As we can see from the chart, the aircraft lands on the airport first. Immediately the passengers proceed to the arrival area. Every group will have different queue. When the passenger wants to do passport check, he or she has to go one of the three available offices in the national area or one of the two available offices in the foreign area. If the check goes fine, they proceed to baggage hall. Otherwise they will go to border agency.

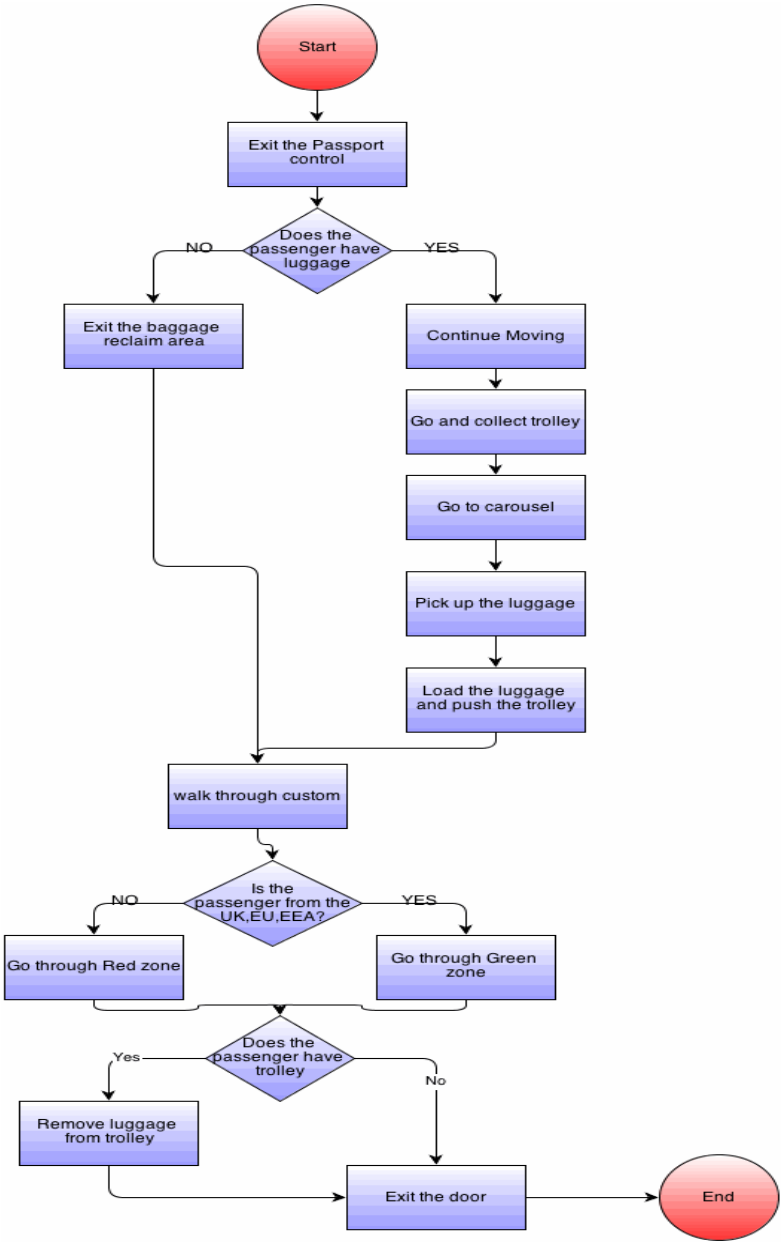

Figure 1. Flow Chart of the Passengers

Distribution fitting test can be defined as the fitting of a probability distribution for specific data. This technique allows us to select distribution that best fits to the random data and deal with uncertainty. In this project, we used distribution fitting technique because we have random data (Process times at Immigration desk). It also helps identifying the distribution that can be used to describe data.

3. Results of Simulation

First, we used the input analyzer tool to get the distribution fitting. A sample of process time 46 passengers has been collected. The collected data are entered to text file and exported to input analyzer in the Arena to get the distribution of the data. Figure 2 show the random data and the distribution of the data. As we can see BETA has the smallest square error. For that reason, we used it in our model (Santé, García, Miranda, & Crecente, 2010).

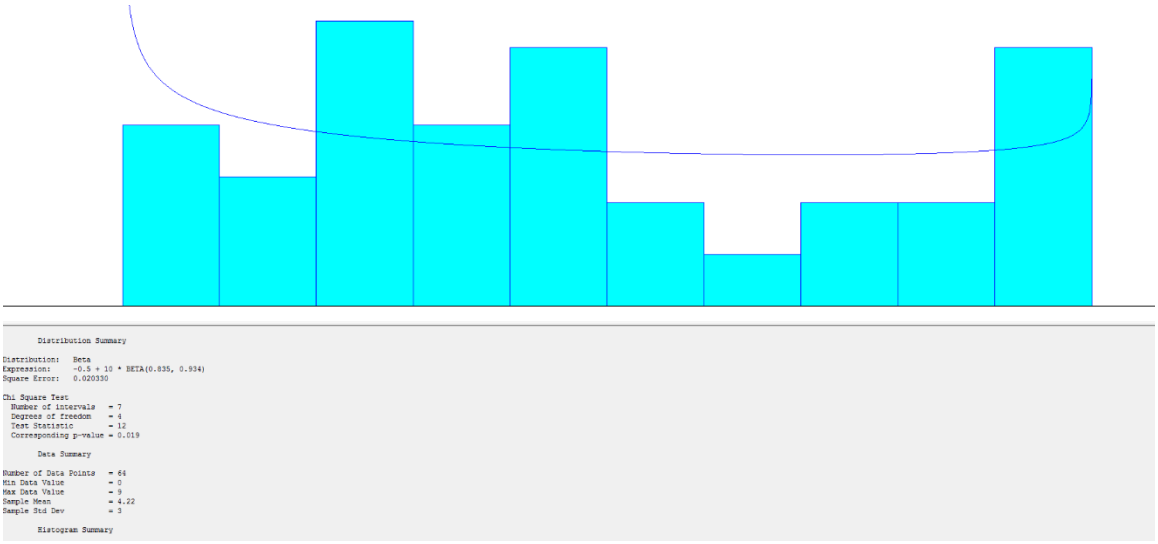

Figure 2. The results of Distribution fitting with Arena

Then, the Arena Software has been used to create the As-Is-Model. Arean allows us simulate and understand the current model by using the objects and available tools such input analyzer. In this project the model is divided into five main sections:

1. **Arrival Gate section: I**n this section, the assignment has been used to identify each flight. We also used decision model to spate the flights from each other and to have four different flights. Then we used Separate technique to create the passengers for every flight. Before that we create a process to size the arrival area. The graph shows the process at arrival gate section.
2. **Passport Control section:** In this section, we used the assignment to identify the nationality type. This assignment will be used in the decision model to get exactly the correct number of national and non-national from each flight. The decision is made here based on the conditions (assumptions in the case). Decision 3 and decision 4 were used to distribute the passengers between the offices or desks. At the end we created five processes. Each one has immigration officer to check the passport.
3. **Luggage Hall section:** In this section, the decision technique was used to identify the passengers with luggage. We created a process to show that passengers going to take trolley. We also created assignment to identify these passengers. This assignment is used in last section. The last process at this section is (Waiting at carousel). As we can resource has been used in this process.
4. **Custom section:** In this section, we used the decision technique to send distribute the passengers between the zones based on the nationality assignment that we created. This section has two resources that do not consume any resource.
5. **Exit Gate section:** We create decision model to force all passengers with trolley to take one more step before the batch process. In this process, passenger who has a trolley must release it. The last decision model was used to gather all passengers based on the flight number assignment which is created in the previous sections. Last process was created to release the arrival area and allow new passengers to enter the airport.

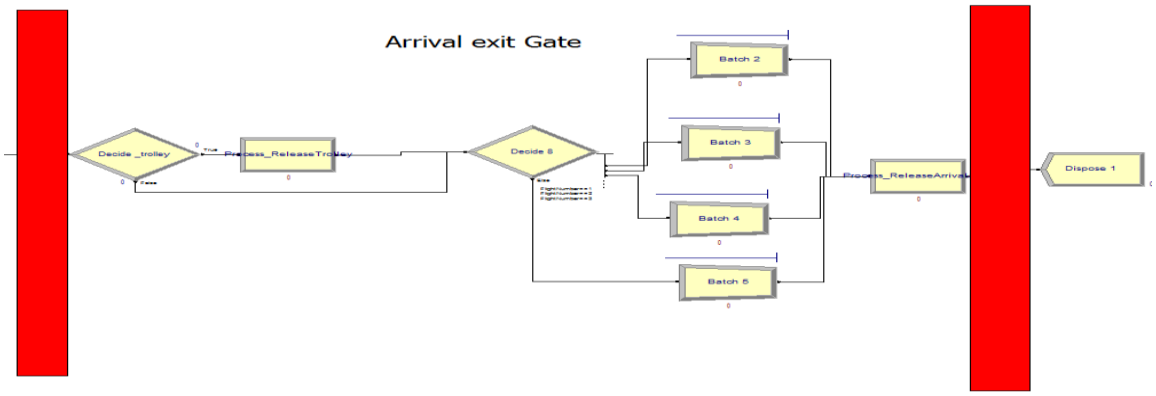

Figure 3. Exit Gate section

Figure 4 shows the waiting time of passengers at different places. As shown in the table, the longest waiting time occurs at process Seize the Arrival Area. A comparison between the five replications National Desks (A1, A2, and A3): The following graph shows the comparison between waiting time. The graph only shows the waiting time at the queues that occur at A1, A2, and A3. As shown in the graph, passengers spend a lot of time at A2 comparing with other desks. This might be due the productivity of the immigration officer at this desk A2.

Queue Detail Summary

	Waiting Time1	Waiting Time2	Waiting Time3	Waiting Time4	Waiting Time5
A1.Queue	0.36	0.24	0.25	0.21	0.26
A2.Queue	0.34	0.48	0.35	0.35	0.36
A3.Queue	0.34	0.41	0.37	0.46	0.21
Batch 2.Queue	14.27	16.74	15.86	15.17	14.65
Batch 3.Queue	12.12	11.77	10.61	9.19	10.38
Batch 4.Queue	13.08	12.58	15.68	15.45	12.93
Batch 5.Queue	7.74	6.23	7.76	5.88	5.83
I1.Queue	9.09	7.65	8.80	9.53	8.86
I2.Queue	8.16	9.51	8.21	8.47	8.41
Process_SeizeArrival	30.71	32.13	30.91	30.38	30.23
Process_Trolley.Que	0.00	0.00	0.00	0.00	0.00

Figure 4. Queue Details Summary

To improve the service system following scenarios are studied:

Scenario one: Increase the capacity of all Immigration officers by 1 and add another 100 trolley as seen in the picture below. This scenario will reduce the waiting time at each desk. The waiting time has been reduced as a result of increasing the capacity. The following table and graph shows the comparison between As-Is-Model and Scenario One. In this table we used the average for the five replications, and then we compared both averages. As you can see from the graph, the waiting time at A1, A2, and A3 have been reduced to the half by increasing the capacity for each immigration officers.

	As Is	S1
A1.Queue	0.26	0.13
A2.Queue	0.37	0.181
A3.Queue	0.35	0.171

Figure 5. The result of scenario one

Scenario two: In this scenario, we will add extra desk with one immigration officer at non-national part as seen in the below picture. This scenario will improve the resource utilizations. In table, we used the resource utilizations to compare them with As-Is-Model. When we increased extra desk the utilization reduced from 90% to 78% in IO5 and from 86% to 80 in IO6.

	As Is	S2
IO5	0.905	0.787
IO6	0.861	0.801

Figure 6. The result of scenario two

Finally the overall simulation for all scenarios: As we can see from Figure 7, scenario one is the best scenario. In scenario one, the overall simulation time is reduced from about 70 hours about 30 hours.

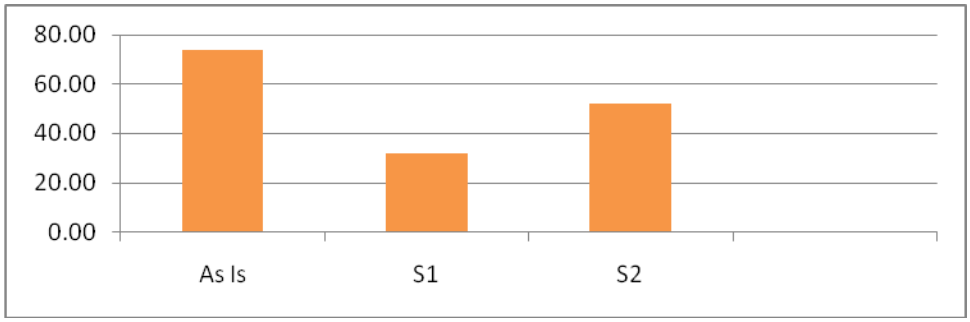

Figure 7. The overall simulation for all scenarios

4. Conclusion

This paper presents a queue simulation and attempt to model for flight serving system to minimal passengers delay. The Arena simulation software is also used to solve this problem. Compared with the traditional flight delay sequence method, this model is effective and easy to implement. It also can reduce the cost and the influence of the delay as much as possible. Additional research is planned to further examine this data. An additional technique that is also being evaluated is to begin the use of system dynamic simulation.

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