

IE 305 Simulation - Term project

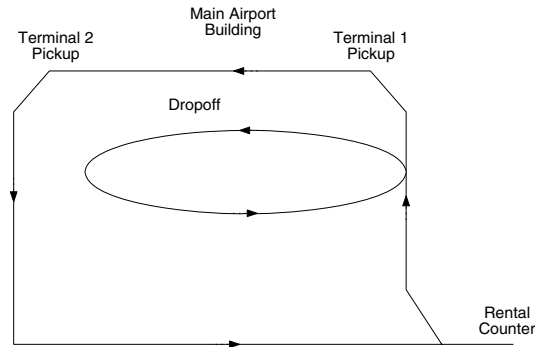
Posted: November 13, 2019

Part 1 Due date: November 29, 2019, 23.55

Part 2 Due date: December 23, 2019, 23.55

Part 3 Due date: January 2, 2019, 23.55

An airport rental car company wants to decide on a system that yields certain desired service levels at an airport. That is why the company decided to have a simulation developed to evaluate accurately several alternatives before selecting which system to implement.



A schematic of the airport is shown above. Vans are constantly circulating for transportation between the airport terminals and the rental counter. There are two pick-up points for arriving customers, Terminal 1 and Terminal 2. A van will first stop at Terminal 1 and pick up all waiting customers, provided there is room in the van. The same van will then proceed to Terminal 2 for customer pickup. Vans departing Terminal 2 go directly to the rental-counter building where the arriving customers exit and join a single line to wait for an available agent to fill out the necessary forms and receive their car keys. Once empty, the van will allow returning customers to board and takes them to the customer-drop-off point, located on the upper level of the airport. Once the van drops off the customers, it loops back to Terminal 1. (If there are no returning customers, the van proceeds directly from the rental-counter to Terminal 1.) Thus the transportation cycle is repeated.

The van speed can vary, and it is estimated to be approximately 32 km per hour for all trip segments, although it can be as low as 20 km per hour and as high as 40 km per hour on rare occasions. The travel distances between the various points are given in the following table.

Terminal 1 to Terminal 2	0.5 km
Terminal 2 to rental counter	3.2 km
Rental counter to drop-off point	2.7 km
Rental counter to Terminal 1	2.4 km
Drop-off point to Terminal 1	0.8 km

Arrival data were collected for the peak time, from 4:00 PM until 9:00 PM, so we will confine our study to that time period. The table below shows the average number of arrivals for each hour for customers arriving at Terminals 1 and 2, and returning customers at the rental counter.

Time period	Terminal 1	Terminal 2	Return
4.00-4.30	6	4	10
4.30-5.00	13	12	23
5.00-5.30	16	18	22
5.30-6.00	12	10	14
6.00-6.30	5	5	19
6.30-7.00	12	17	30
7.00-7.30	16	15	24
7.30-8.00	5	3	13
8.00-9.00	6	6	10

Although the data given in the table describe the arrival of customers who want to rent or return cars, a customer is often accompanied by other passengers. About 60% of our customers have no additional passengers. Twenty percent have 1 passenger, 15% have 2 passengers, and 5% have 3 passengers. Although this does not affect the number of cars rented, it does require additional capacity for van transportation. These data appear to be the same for all three arrival streams.

There appears to be a fair amount of variability on the time required for a customer to board and exit the transportation vans, the average time is 12 seconds for boarding, with a standard deviation of 3 seconds, and 6 seconds for exiting, with a standard deviation of 2 seconds.

Any rental agent can service both arriving and returning rental customers. A limited amount of data for check-in and checkout times have been collected, but not analyzed. These data can be found in the files `Check_In.DAT` and `Check_Out.DAT`.

Arriving and returning customers join the same queue for service. There are two types of contracts offered to customers, basic contract and golden contract. A returning customer with a golden contract is given priority in the queue for service; otherwise the queue operates according to the FIFO rule.

Total labor costs are 60 TL per hour for drivers and 57 TL per hour for rental agents. Drivers and agents can work part-time, but they are required to work for at least 3 hours between 4 PM and 9 PM. There are three types of vans that could be used for this operation, differing by their customer capacity. Operating cost for the vans depends on the type of van used. The total cost for these vans is estimated to be 1.50 TL per km for a 12-seat van, 2.25 TL per km for an 18-seat van, and 2.8 TL per km for a 30-seat van. The company does not want to mix van types at the airport, i.e., the company considers using only one van type.

Customer-survey data conclude that most customers are willing to accept reasonable delays at check in and checkout. A reasonable time for arriving customers, from the time they arrive at the van pick-up area until they have keys in hand, is 20 minutes. A reasonable time for departing customers, from car drop-off until they depart the van at customer-drop-off point, is 18 minutes. The company is willing to accept an 85% customer satisfaction rate.

From the simulation study, we would like to learn what configuration of vans and personnel (drivers and rental agents) would provide the most cost-effective solution for this peak time provided that the minimum customer satisfaction rate of 85% is achieved.

Part 1

1. Submit a report in which you must do the following.
 - (a) State all the entities, attributes, resources, system states, queues, events, activities, and delays of the system.
 - (b) Perform input analysis for the check-in and checkout times using the data in the files provided. You will use the results of your analysis as inputs to your ARENA model.
 - (c) Suggest suitable travel time distributions for the segments given in the table on page 1.
 - (d) Suggest suitable distributions for the time required for a customer to board and exit the transportation vans.

Part 2

2. (a) Submit your ARENA model (.doe) for the system. With your ARENA model, you need to submit a report, which contains the following.
 - Explain your model, for example why you use a certain module, variable, etc.
 - Give the configuration you used for the number of vans, van type, and working schedule for rental agents and drivers. You can use tables like the ones below.
 - Configuration for vans:

Number of vans	
Van type	

- Working schedule for rental agents and drivers

Time:	4 - 5 PM	5 - 6 PM	6 -7 PM	7 - 8 PM	8 -9 PM
Drivers:					
Rental agents:					

- (b) Perform pilot runs using the ARENA model. Include in your report a summary on the performance results (customer satisfaction rate and total operation cost) for 20 replications. A single replication is for one day's peak time period.

Part 3

3. At this stage, you will be given our solution ARENA model that has our choice for staffing and dispatching. Then you will prepare a report reflecting your work for the following steps.
 - (a) Perform an output analysis for performance measures using our solution model with 20 replications. Report the confidence intervals.
 - (b) Determine the minimum number of replications that ensures that the half width of the confidence interval for customer satisfaction rate is 1%.
 - (c) Propose your alternative configuration that you think is better.
 - (d) Using a paired-*t* test in the output analyzer application of Arena, conduct a statistical comparison between our design and your alternative design. You should make your comparison with sufficient number of replications to conclude statistically that one design is better/worse than the other.

GOOD LUCK