



Simulation and Modeling Project

Merkez, 263. Sk. No:46, 48000 Menteşe/Muğla

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INTRODUCTION

Creating a simulation model of the system we are actually examining with the arena program.

MOTIVATION

- Examine a real system in details and produce solutions to observed problems.

SYSTEM SELECTION

- I examined the PTT branch in the Kötekli neighborhood in Muğla/Menteşe.

CURRENT PROCESS

- Kötekli Ptt branch is a postal organization that provides service 5 days a week between 8:30-17:00.

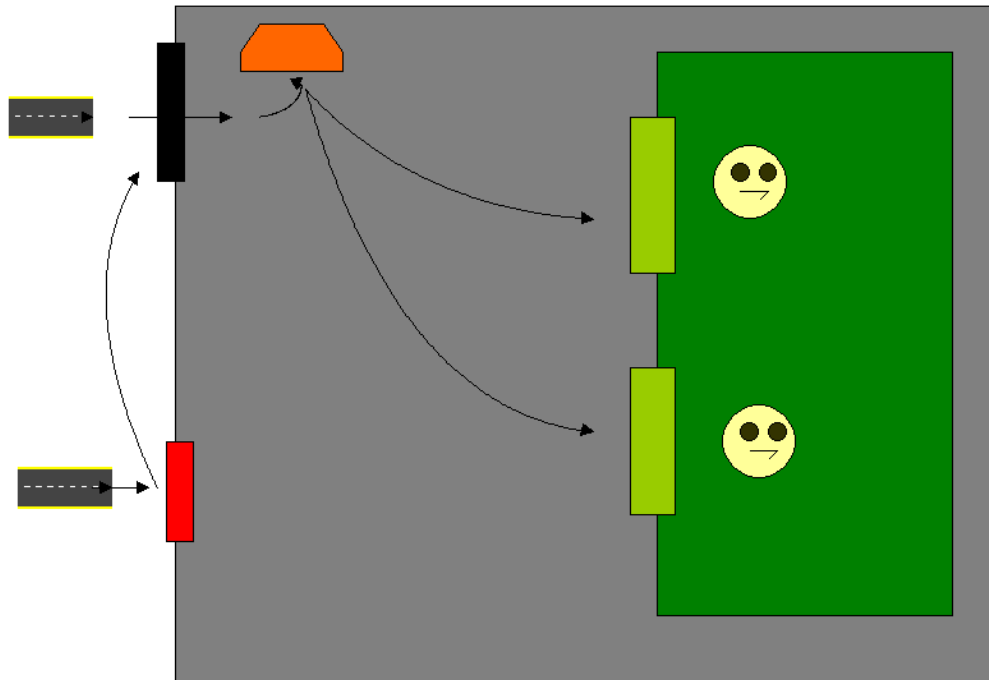
OBJECTIVES

- The purpose Of this project is to create and develop a simulation model Of Kötekli PTT, using the Arena Software. The objective Of building this project is to understand and optimize the following things: -
- Identifying the needs of the system by knowing the system.
- Reducing Wait time in queue for the customers at the PTT counter.
- Observing Wait time in queue for the customers at the queuematic.
- Observing Utilization of PTT Staff.
- Factors resulting in delay of customer service.
- Reducing the density in the waiting room.
- Increasing customer satisfaction.

PTT SYSTEM

- All customers must enter the system one by one.
- First of all, there is a queue machine in the system.
- Customers will enter the queue by taking their turns from this queue machine.
- If arriving customers are over the age of 60, they have priority in the queue. This priority is valid both at the queue machine and at the box office.
- **There are two box offices.**
- **There are two employees.**
- Only 1 customer is served by 1 staff at any given time
- Ptt branch employees provide service between 8:30 - 17:00. Employees take a lunch break between 12:30 and 13:30. At the same time, they take a 5-minute break every hour.
- Incoming customers cannot log in to the system during lunch.
- Due to the small size of the PTT branch, it accepts a maximum of 15 people. When the 16th person arrives, he cannot enter the system. As soon as a person leaves, a new person can enter the branch again.
- Incoming customers take their turn from the queue machine according to the transaction they want to make and the queue is formed accordingly.
- If the customer will carry out a cargo-related transaction, the customer's queue is assigned to counter number 2. If other transactions are to be carried out, a queue is assigned at counter number 1.
- If the customer who will send cargo must first fill out the necessary form. While filling out the form, the turn passes to the next customer and that person gets in the queue again.
- If he wants to perform two transactions at the same time, he will enter the other transaction queue first. But if there are 60+ people, that customer will be given priority in the queue.
- **There are one PTTMatik .**
- The customer comes to the PTTMatic and handles his business individually. Some customers want to log into the system for extra work.

Sample Model Drawing



Real Model







COMPONENT DETAILS

The simulation model comprises of following components:

1. Entities

1.1 Old Customer

1.2 Young Customer

	Entity Type	Initial Picture	Holding Cost / Hour	Initial VA Cost	Initial NVA Cost	Initial Waiting Cost	Initial Tran Cost	Initial Other Cost	Report Statistics	Comment
1 ▶	Old Customer	 Picture.Report	0.0	0.0	0.0	0.0	0.0	0.0	<input checked="" type="checkbox"/>	
2	Young Customer	 Picture.Report	0.0	0.0	0.0	0.0	0.0	0.0	<input checked="" type="checkbox"/>	
3	Customer	 Picture.Report	0.0	0.0	0.0	0.0	0.0	0.0	<input checked="" type="checkbox"/>	
4	PTTMatik Customer	 Picture.Report	0.0	0.0	0.0	0.0	0.0	0.0	<input checked="" type="checkbox"/>	

2. Resource

2.1 Queuematic

2.2 Two seperate Staff

	Name	Type	Capacity	Schedule Name	Schedule Rule	Busy / Hour	Idle / Hour	Per Use	StateSet Name	Failures	Report Statistics	Comment
1 ▶	queumatic	Based on Schedule	Schedule Queumatic	Schedule Queumatic	Preempt	0.0	0.0	0.0		0 rows	<input checked="" type="checkbox"/>	
2	GiseCalisan_2	Based on Schedule	Schedule Employee_2	Schedule Employee_2	Ignore	0.0	0.0	0.0		1 rows	<input checked="" type="checkbox"/>	
3	GiseCalisan_1	Based on Schedule	Schedule Employee_1	Schedule Employee_1	Ignore	0.0	0.0	0.0		1 rows	<input checked="" type="checkbox"/>	
4	PTTMatik	Fixed Capacity	1		Wait	0.0	0.0	0.0		0 rows	<input checked="" type="checkbox"/>	

3. Queues

	Name	Type	Attribute Name	Shared	Report Statistics	Comment
1 ▶	Machine Works on parts.Queue	Highest Attribute Value	Priority	<input type="checkbox"/>	<input checked="" type="checkbox"/>	
2	Seize Old queumatic.Queue	First In First Out	Attribute 1	<input type="checkbox"/>	<input checked="" type="checkbox"/>	
3	Seize Age queumatic.Queue	First In First Out	Attribute 1	<input type="checkbox"/>	<input checked="" type="checkbox"/>	
4	Gise1.Queue	Highest Attribute Value	Priority	<input type="checkbox"/>	<input checked="" type="checkbox"/>	
5	Gise2.Queue	Highest Attribute Value	Priority	<input type="checkbox"/>	<input checked="" type="checkbox"/>	
6	Process PTTMatik.Queue	First In First Out	Attribute 1	<input type="checkbox"/>	<input checked="" type="checkbox"/>	

4. Attribute

	Name	Rows	Columns	Data Type	Initial Values	Comment
1 ▶	Priority			Real	0 rows	
2	Customer Arrival Time			Real	0 rows	

5. Failure

	Name	Type	Up Time	Up Time Units	Down Time	Down Time Units	Uptime in this State only	Comment
1 ▶	break5min	Time	EXPO(1)	Hours	EXPO(5)	Minutes		

6. Schedule

	Name	Type	Time Units	Scale Factor	File Name	Durations	Comment
1 ▶	Schedule Employee_1	Capacity	Halfhours	1.0		3 rows	4 hours work-1 hour break-4 hour work
2	Schedule Employee_2	Capacity	Halfhours	1.0		3 rows	4 hours work-1 hour break-4 hour work
3	Schedule Queueumatic	Capacity	Halfhours	1.0		3 rows	Does not operate 15 minutes before lunch break and 15 minutes before evening time

7. Variable

	Name	Rows	Columns	Data Type	Clear Option	File Name	Initial Values	Report Statistics	Comment
1 ▶	Kargo			Real	System		0 rows	<input type="checkbox"/>	
2	islemler			Real	System		0 rows	<input type="checkbox"/>	

ABOUT DATA

DATA COLLECTION

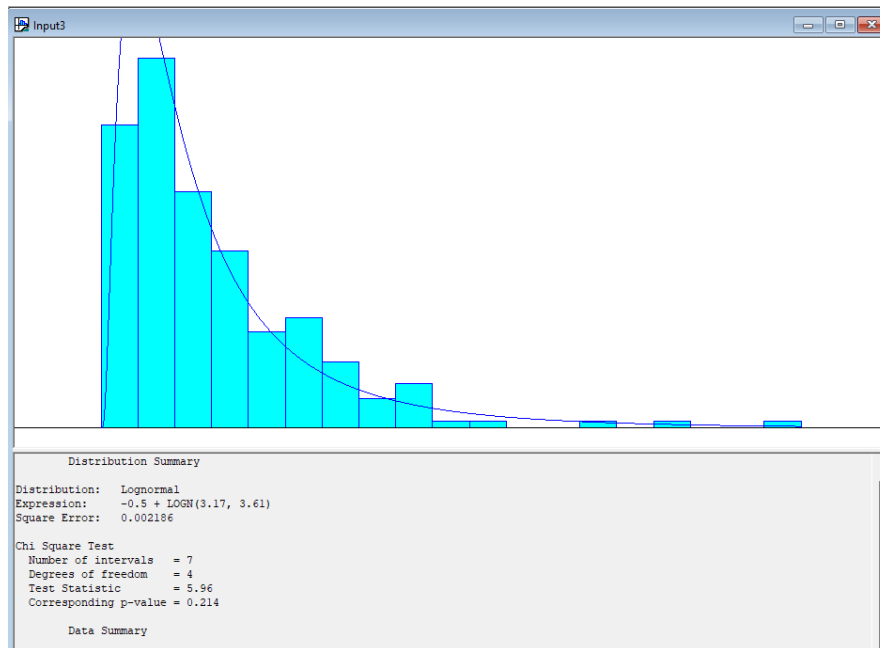
- The data for this simulation study was collected during 2 days 8:30 to 17:00 at PTT in Kötekli.
- Important observations from collected dataset:
 - 10% of total customers are over 60 years old
 - Queuing takes half a minute
 - 70% probability that there is a cargo related operations
 - 85% of people who will want to chose cargo operations will send cargo.
 - Address writing takes 3 minutes
 - 10% customers want to make second operations
 - 5% of customers using PTTMatic then log in to the system

FITTING DATA INPUT ANALYZER

- With the help of Input Analyzer in Arena, we analyzed the distribution of various data points we collected. Arena Input Analyzer finds the best fit distribution to any input data. It plots the fitted function to the dataset on the existing histogram. It also adds statistical information about the distribution selected, and test statistics for Chi-Square Goodness of Fit and Kolmogorov-Smirnov tests.
- Below are some of results obtained from the Input Analyzer in Arena for various data points collected.

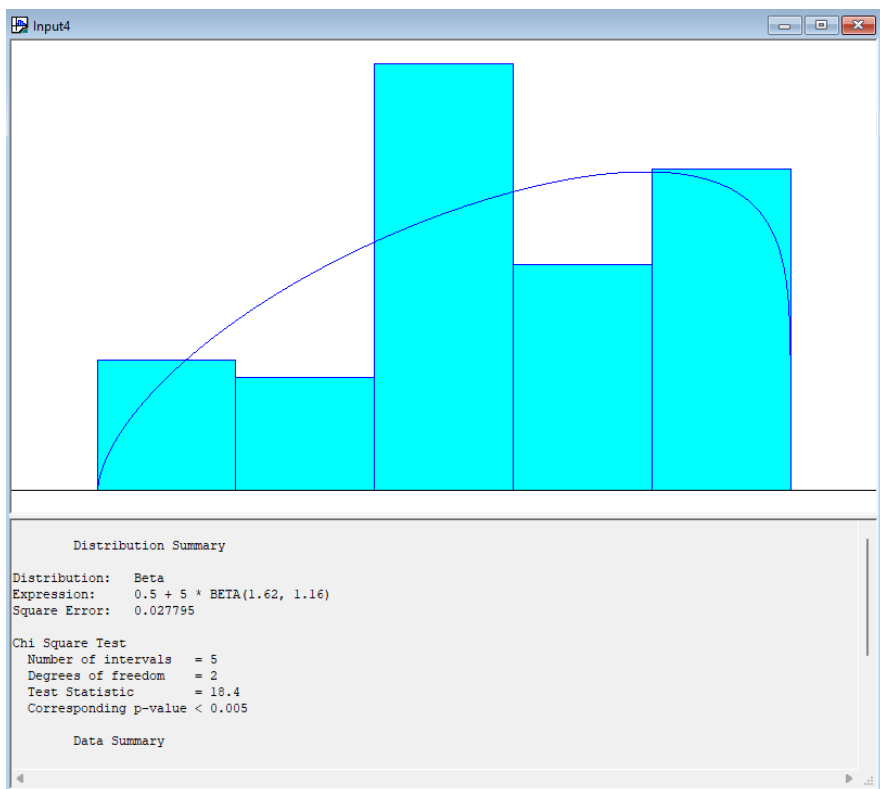
1. Customer inter arrival time for the system:

- A LOGN distribution followed



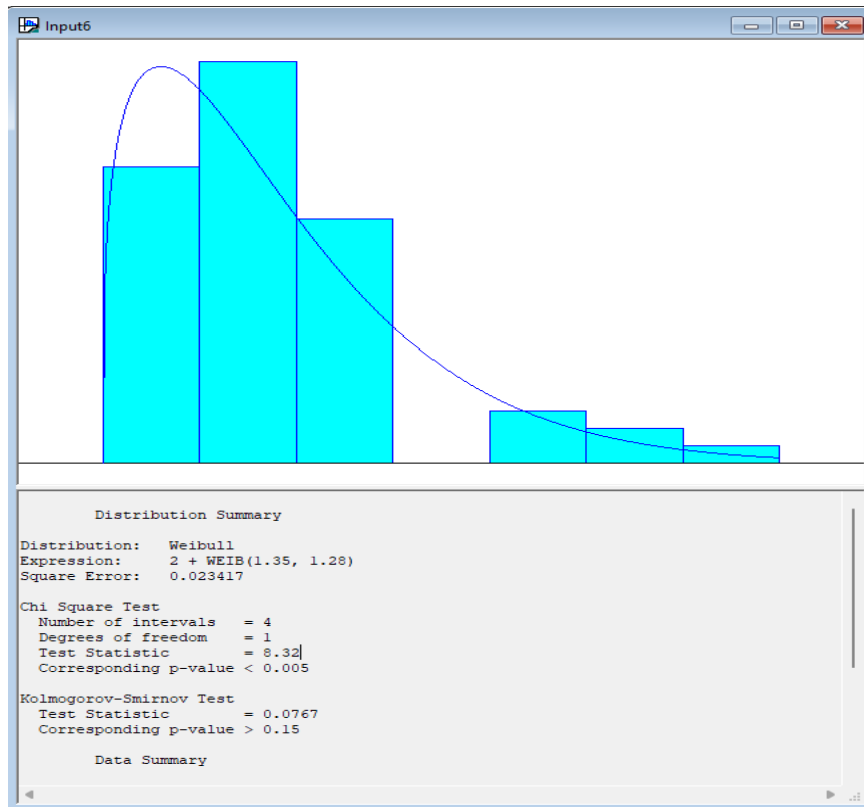
2. Time taken for cargo operations

- A BETA Distribution followed



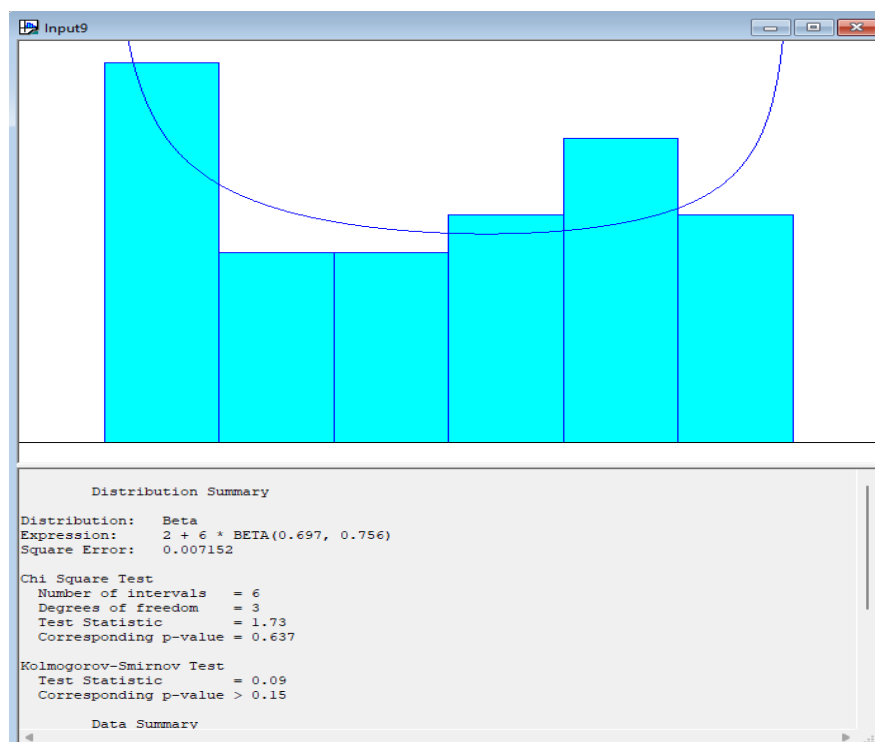
3. Time taken for normal operations

- A WEIB Distribution followed



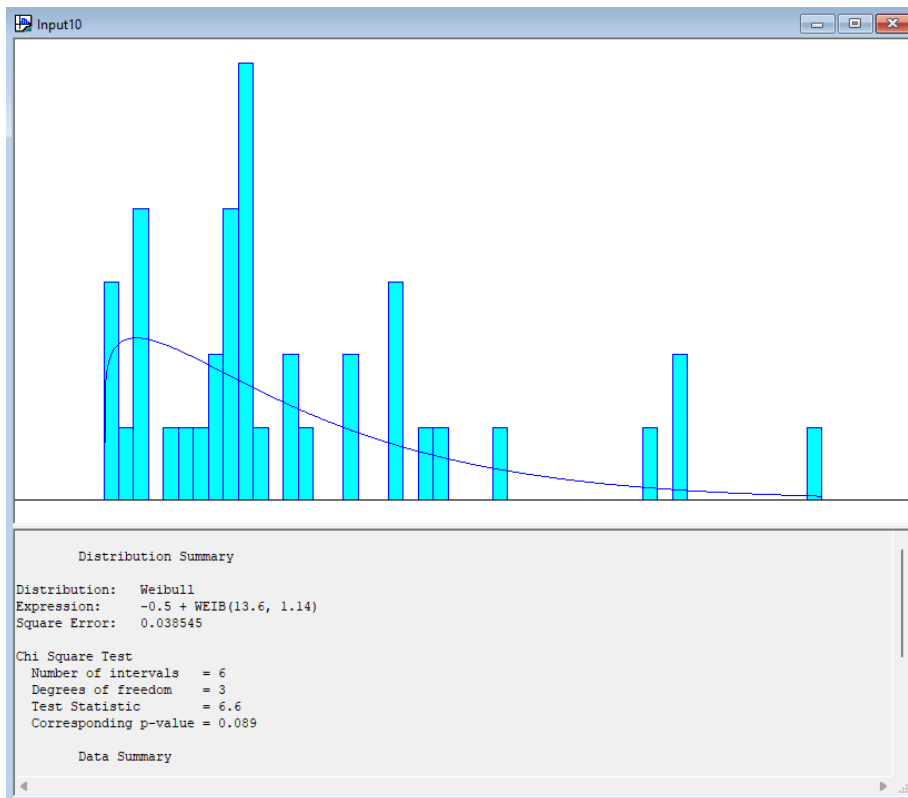
4. Time taken for a PTTMatik

- A BETA Distribution followed



5. Customer inter arrival time for PTTMatik

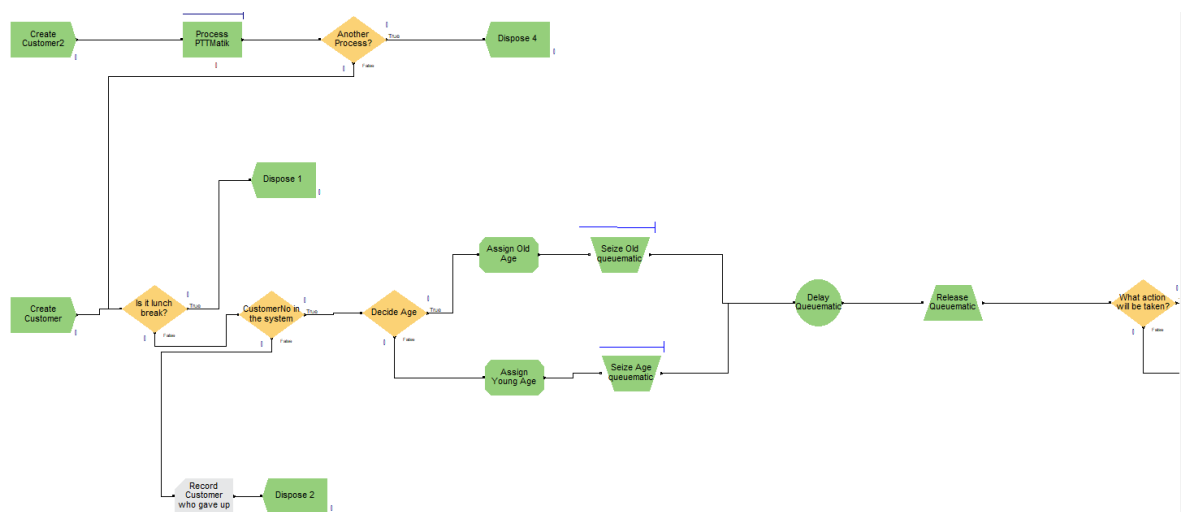
- A WEIB Distribution followed

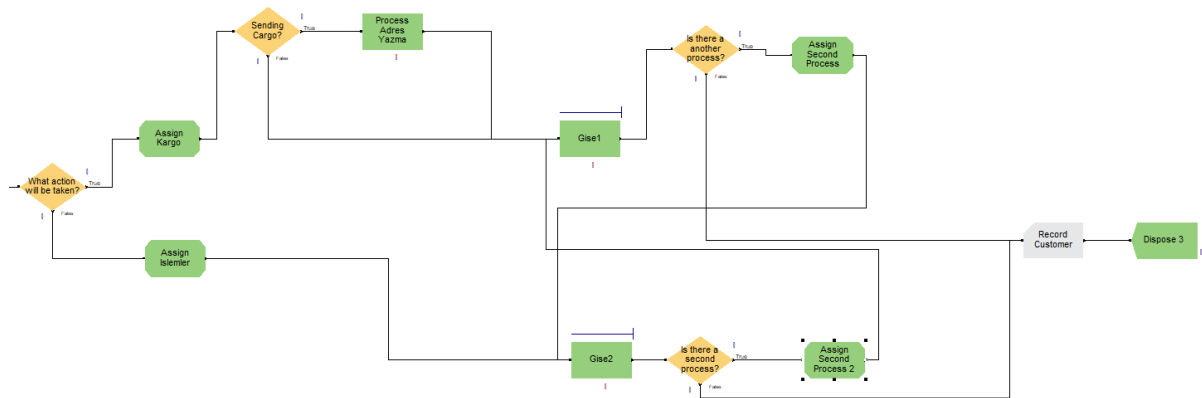


Arena Model

Modeling the System

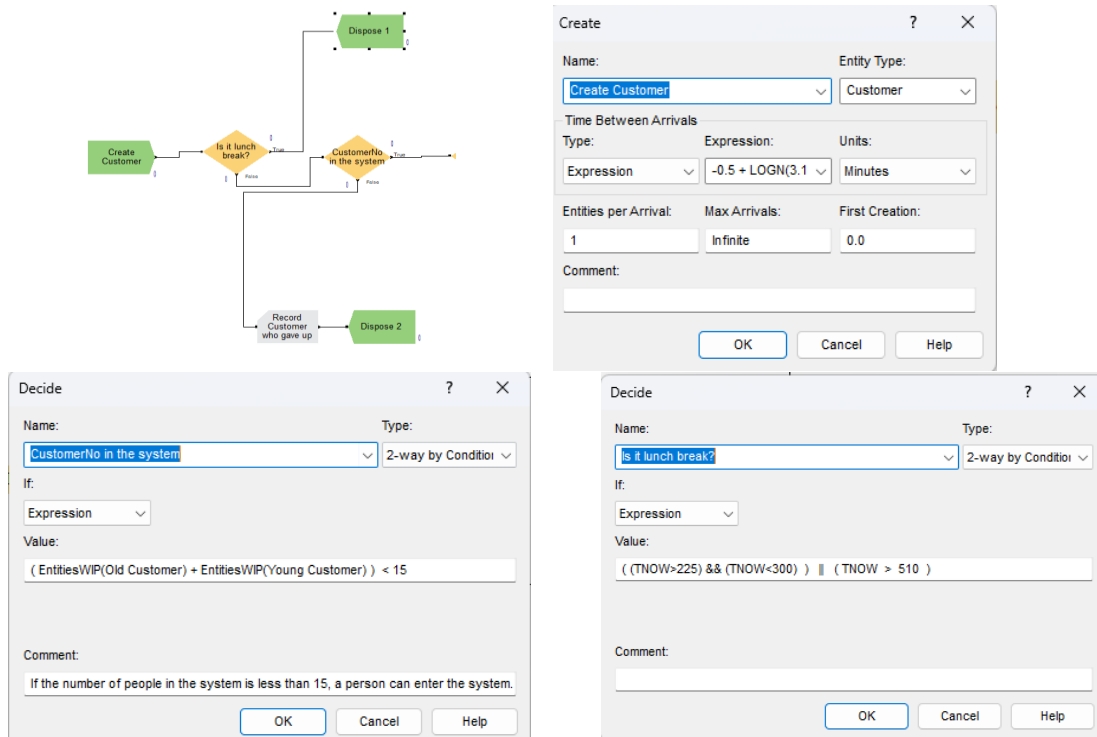
Below is the model in Arena which I used to model :



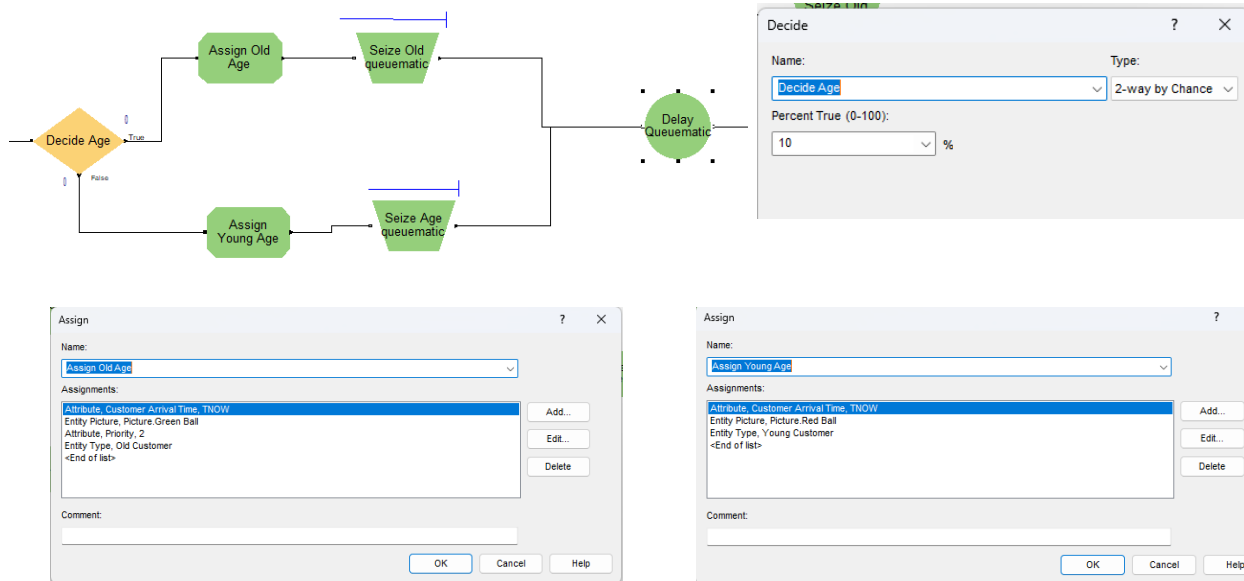


We will be discussing each of the component of our model one by one in detail.

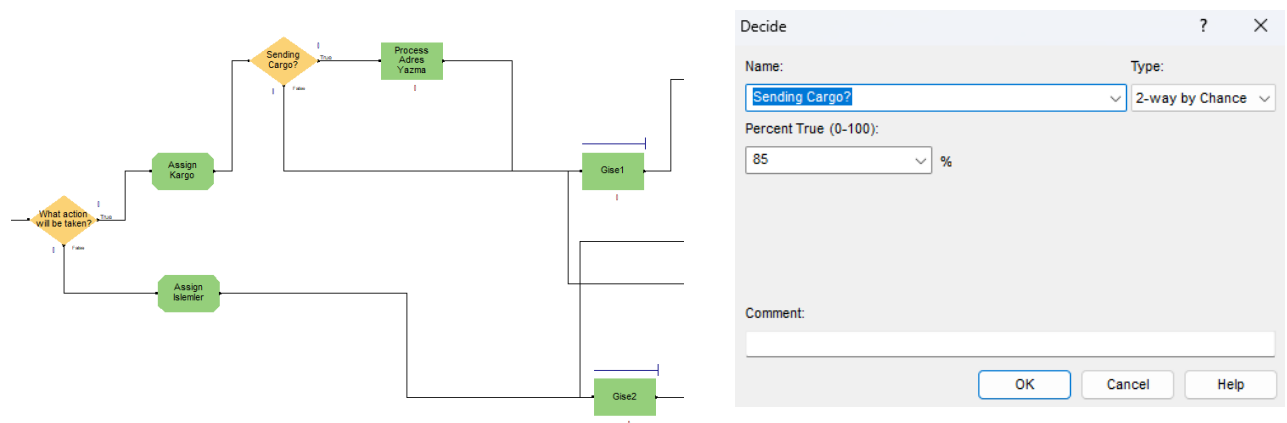
1. **Entry Area:** This is the area where the customers arrive. The customer can log in to the system if appropriate conditions are met.



2. **Queue Taking Area:** Here, if the customer is over the age of 60, he/she will be placed in the queue first. Here the customer will take a turn to make a transaction.



3. **Box Office Area :** In this area, the customer heads to the counters when it is her turn, depending on the transaction she/he will make.



Assign

Name:

Assignments:

Variable: Kargo, 1	Add...
<End of list>	Edit...
	Delete

Comment:

OK Cancel Help

Assign

Name:

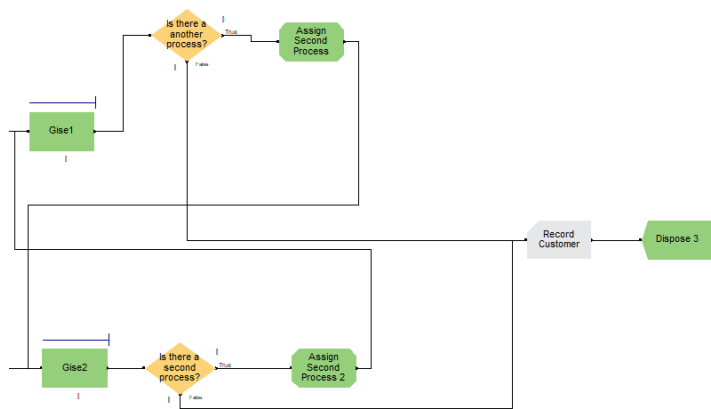
Assignments:

Variable: Islemier, 1	Add...
<End of list>	Edit...
	Delete

Comment:

OK Cancel Help

4. **Exit Area:** In this area, the customer queues again if he wants to make a second transaction. If he doesn't want it, he logs out of the system.



Decide

Name:

Type:

Percent True (0-100): %

Comment:

OK Cancel Help

Assign

Name:

Assignments:

Entity Picture, Picture Blue Ball	Add...
Attribute, Priority, 1	Edit...
<End of list>	Delete

Comment:

OK Cancel Help

Record

Name:

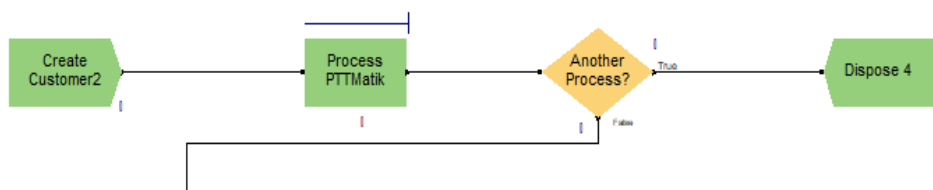
Statistic Definitions:

Time Interval, Customer Arrival Time, No, CustomerProcessTr	Add...
<End of list>	Edit...
	Delete

Comment:

OK Cancel Help

5. **PTTMatik Area:** The customer comes and handles the transaction herself via PTTMatik. If there is another transaction, it enters the system.



Create ? X

Name: Entity Type:

Time Between Arrivals

Type: Expression: Units:

Entities per Arrival: Max Arrivals: First Creation:

Comment:

OK Cancel Help

Decide ? X

Name: Type:

Percent True (0-100): %

Comment:

OK Cancel Help

Process ? X

Name: Type:

Logic

Action: Priority:

Resources: Add... Edit... Delete

Delay Type: Units: Allocation:

Expression:

☒ Report Statistics

Comment:

OK Cancel Help

Simulating the System

- Simulation model with above configurations was run for 8.30 hours window as Replication Length was set equal to 8.30 and for 1 replications.

Run Setup X

Run Speed
Run Control
Reports
Project Parameters
Replication Parameters
Array Sizes
Arena Visual Designer

Establish replication-related options for the current model. Settings include the number of simulation replications to be run, the length of the replication, the start date and time of the simulation, warm-up time length, time units, and the type of initialization to be performed between replications.

Replication Parameters

Number of Replications:

Start Date and Time:

Warm-up Period: Hours

Replication Length: Hours

Hours Per Day:

Terminating Condition:

Base Time Units:

Parallel Replications

☐ Run Replications in Parallel ☐ Disable Parallel Replications Status Dialog

Number of Parallel Processes:

Parallel Replication Input Data Files: Add

Tamam iptal Uygula Yardim

SIMULATION RESULTS and ANALYSES

- The arena software produces detailed report of Simulation model results by Entity, Queue and Resources etc.
- There is no transfer process due to the small size of the system.

Entity:

- 12 of the 12 old customers who entered the system completed their work and left. 123 of the young customers entered and 114 exited.
- While the average waiting time (Wait Time) of old customers in the system is 1.4 minutes, the average waiting time (Wait Time) of young customers in the system is 12.0 minutes.
- While the processing time (VA) of old customers is 4.8, the processing time (VA) of young customers is 4.9.
- The average ProcessTime a customer spends in the System is 16.4 minutes.
- The average transaction time of PTTMatik customers is 4.8.

Queue:

- While the Waiting Time in the tail of Box Office 1 is seen as 14.7
- The Waiting Time in the tail of Box Office2 is seen as 0.7.
- While the average number of people waiting in the queue of Box Office 1 was 2.8
- The average number of people waiting in the queue of Box Office 2 is 0.08.
- The average waiting time during PTTMatik is 2.5.

Resource:

- While the instantaneous utilization of CounterWorker_1 is 0.6, the usage of Counterworker_2 is 0.2. This shows that employee_1 works harder than employee 2. At the same time, it shows almost full work compared to the Box Office Employee_1 schedule.
- Queuematic's instantaneous utilization rate is 0.3.
- It is seen that the usage rate is low compared to the Schedule value. If we look at the * Queuematic.queue value, we see that there are not many queues with values of 0.02 (for young customer) and 0.0003 (for old customer). This shows that the number of queuematics is sufficient.
- The system could queue up to 15 people at a time. Looking at the results, it is seen that 15 people were never there at the same time. From here we can make the assumption that the system is sufficient according to the number of customers.

- When we look at the Number In and Number Out values of all customers in the system during the employees' schedules, we see that they are not completed. At the end of the system, customers are still waiting in the queue. In this case, we can say that the number of employees is not sufficient. But it seems like a value that can be ignored due to the very low number of remaining customers. In this case, when we look at the utilization value of the employees and which employee's queue the remaining customer is in, we see that they are in the queue of the person working with more utilization compared to the other. In this case, a solution suggestion can be given as follows. The other employee has less utilization. If two employees share their work, the whole problem can be eliminated. At the same time, we prevent customer service delays.
- If we look at the PTTMatik usage time and the waiting time of the customers, it is seen that the number of PTTMatik is enough.

Conclusion

- In this project, I developed and simulated a model for the Kötekli PTT at Menteşe, Muğla. I collected 8.30 hour data during peak interval and based on certain assumptions we developed a simulation model in Arena software. I simulated and analyzed the Arena results of our model. To achieve my goal of reducing the wait time of customers and to prevent customers from not completing the service in current scenario, I suggested a few changes in my original model for improvements. With the improved model we can also improve the resource utilization of the PTT and reduce inconvenience being caused to customers during peak hours.