

**CENG 4513 Modeling and Simulation**  
**2021-2022 Fall Assignment 01**  
**Case Study with ARENA**

**Self service Coffee Shop**  
**Modeling Report**

**Group Members:**

**Mert Furkan Ergüden**  
**Mehmet Kubilay Elüstü**  
**Zeynep Hazal Cengiz**

## **Introduction**

This project presents ways to design a Self Service Coffee Shop system with complex elements for proper understanding and optimization of Self Service Coffee Shop worldwide using software arena (student version).

Self-service cafes are a very common coffeehouse culture around the world. With this culture, people can order in coffee shops without the need for employees such as waiters. That's why we chose the self-service cafe we live in for the simulation project assignment.

Study and research is done to design an optimal ongoing or new cafeteria using the arena. These researches are made on concrete data and the analyzed data. In order to understand the system correctly, complex conditions have been tried to be defined in an understandable way in the arena logic.

## **Problem**

Examining the customers in the Self Service Coffee shop and researching the reactions of the customers in line with their demands. The self-service coffee shop we reviewed serves every day of the week. Especially during peak working hours, the average waiting times of customers in the queue at the billing booth increase significantly. In addition, the products that customers want to buy may change their minds in case of prolongation of the supply time or in any negative situation. Especially in this case, it should be researched which product the customers turn to. As a result of this modeling, it is aimed to improve some operations.

## **Assumptions**

The exact system can never be simulated as there is always variability in real life. As a result of your observations, we performed the following stages

1. The coffee shop is open from 9AM- 12PM. For this simulation, it runs the same that situation.
2. There are 2 work shifts- Morning shift from 9AM-4PM, Afternoon shift from 4PM-12PM
3. Working workers only take breaks when they have free time. They continue to work outside of their break time.

4. Every customer who enters may not buy something, but let's assume that every customer buys something in this simulation.
5. Customer, candy, straw, cup holder, napkin etc. waits at the self-service counter with supplies. A certain time is not allocated for the customer at the self-service counter. Usually during the wait time customers collect their supplies.
6. when a customer collects his/her order, he or she leaves the system.
7. The peak hours are 7PM - 12PM. These hours when product sales are the busiest.
8. All employees in Simulation are trained employees.

## 2.Data Collection

In this area, we have classified the data we prepared while doing our project. All of our data belongs to the “**txt**” file type. In addition, we have grouped our data separately to make our data more understandable and readable. As a result of this grouping, we tabulated our data. The operation is different from regular coffee shops with counters. Customers buy products with the Self-service method.

### 2.1 Menu

General menu data list available in the self-service coffee shop. Customers can their orders in line with the data in the menu.

Menu				
Sıcak Kahveler	Soğuk Kahveler	Frappes	Smoothies	
Espresso	Ice Americano	Caramel Frappe	Green Apple Smoothie	
Double Espresso	Ice Caramel	Coco Frappe	Mango Smoothie	
Cafe Latte	Ice Caramel Macchiato	Icepuccino	Mix Smoothie	
Cappuccino	Ice Chai Latte	Mocha Frappe	Passion Smoothie	
Americano	Ice Chocolate Macchiato	White Mocha Frappe		
Filtre Kahve	Ice Filtre Kahve			
Cafe Mocha	Ice Latte			
Cafe White Mocha	Ice Mocha			
Caramel Latte	Ice White Mocha			
Pumpkin Spice Latte				

### 2.2 Time and Customers Rate

Below is the amount of coffee shop customers in hours.(customers/hours)

Time and Customers Rate	
Time	Customer Rate(Coffee shop occupancy rate)
9am - 12am	15
12am- 3pm	8
3pm-6pm	20
6pm-9pm	35
9pm-12pm	30

### 2.3 Types of Customers

Three types of customers arrive in a day about which 30% are Individuals, 40% are Pair or couples and 30% are groups of four.

Types Of Customers	Rates(%)
Individuals	30
Pair or couples	40
Groups of four	30

### 2.4 Products served at Coffee Shop

Products(Categories Of menu)	% of audience orders
Hot Coffee	50
Cold Coffee	30
Freppes	10
Smooties	10

### 2.5 Order preparation time

Average order times of each customer in Cafe. These data are stated in minutes.

Order preparation time
1
2
1
1
3
2
2
2
1
2
1
2
3

## 2.6 Average Process Time(preparation time)

The time it takes for customers to prepare their orders after they place their orders. This time varies according to each order type and the difficulty of order preparation.

average process time	
	5
	6
	3
	5
	4
	5
	6
	6
	4
	5
	7
	7

## 2.7 Queue Waiting Time

The time data of the queue density in the coffee shop according to the order density. These data are shown in minutes.

Queue Waiting Time	
	2
	6
	3
	5
	4
	5
	6
	6
	4
	5
	7
	7

## 2.8 Sitting Time

Approximately 75% of the customers who place an order prefer to sit inside the coffee shop. But 25% of it takes his order and leaves the coffee shop.

Data showing the average sitting times of people sitting in the after Order Coffee shop. These data are shown in minutes.

Sitting Time	
	45
	10
	30
	100
	60
	50
	75
	25
	15
	28
	34
	14

## 2.9 Delivery Times

Data showing the average delivery times of prepared orders. These data are shown in minutes.

Delivery Time	
	1
	1
	1
	2
	1
	1
	2
	2
	3
	2
	1
	2

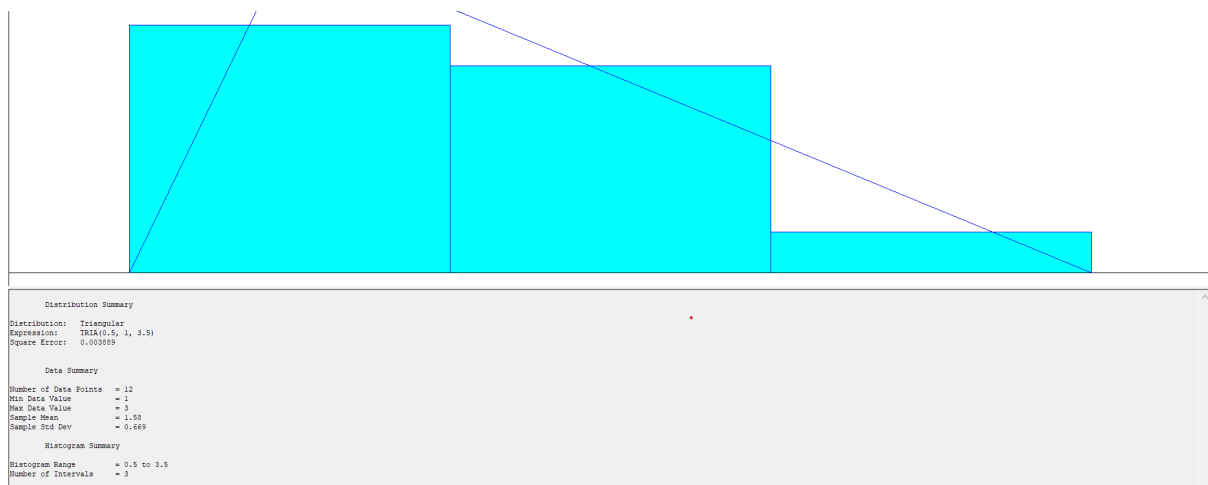
All the data we have mentioned above are the data of the model we have prepared. With these data, the model becomes more understandable and easier to implement.

### 3. Fitting Datas

We will determine the approaches by fitting the data we have prepared in this area. While fitting our data, we used the "**Input Analyzer**" application in the Arena application. With this method, we determined according to which distribution we will fit the data we have.

#### 3.1 Delivery Times

We fit the data showing the average delivery times of the prepared orders according to the "Triangle Distribution".



```

Distribution Summary

Distribution:   Triangular
Expression:    TRIA(0.5, 1, 3.5)
Square Error:  0.003889

Data Summary

Number of Data Points = 12
Min Data Value        = 1
Max Data Value        = 3
Sample Mean           = 1.58
Sample Std Dev        = 0.669

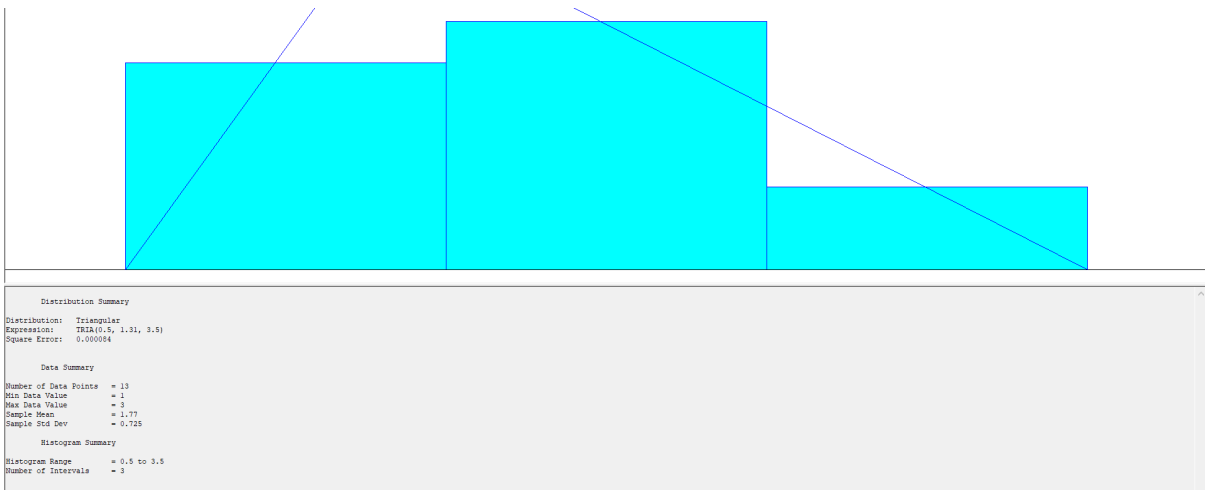
Histogram Summary

Histogram Range       = 0.5 to 3.5
Number of Intervals   = 3

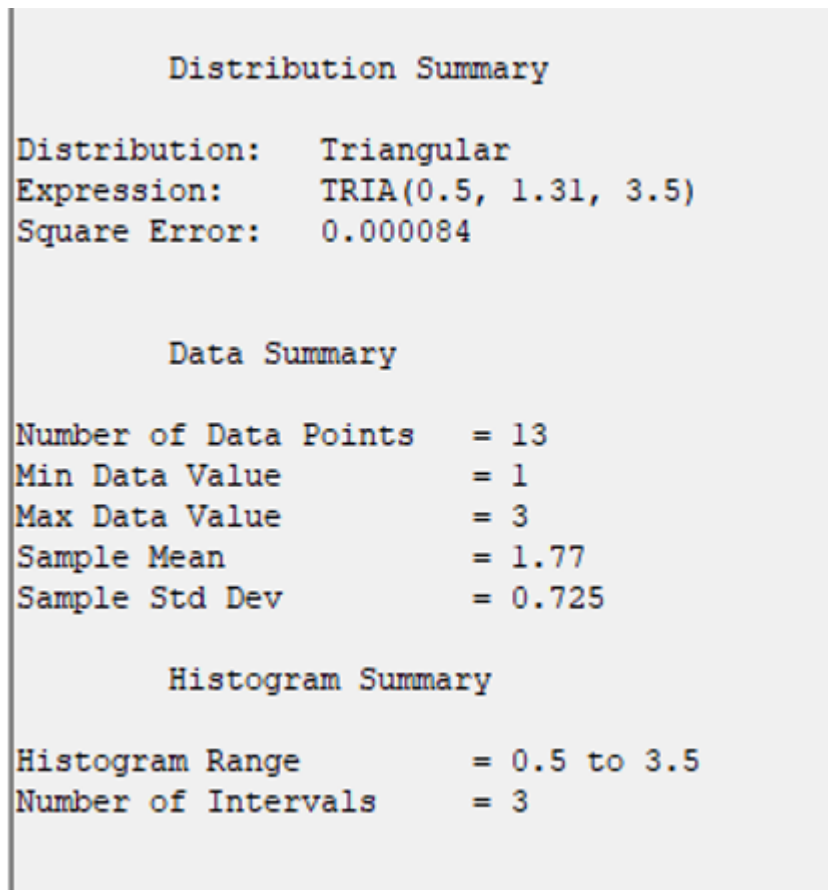
```

### 3.2 Order preparation time

We fit the data showing the order times received from the customers according to the "Triangle Distribution".

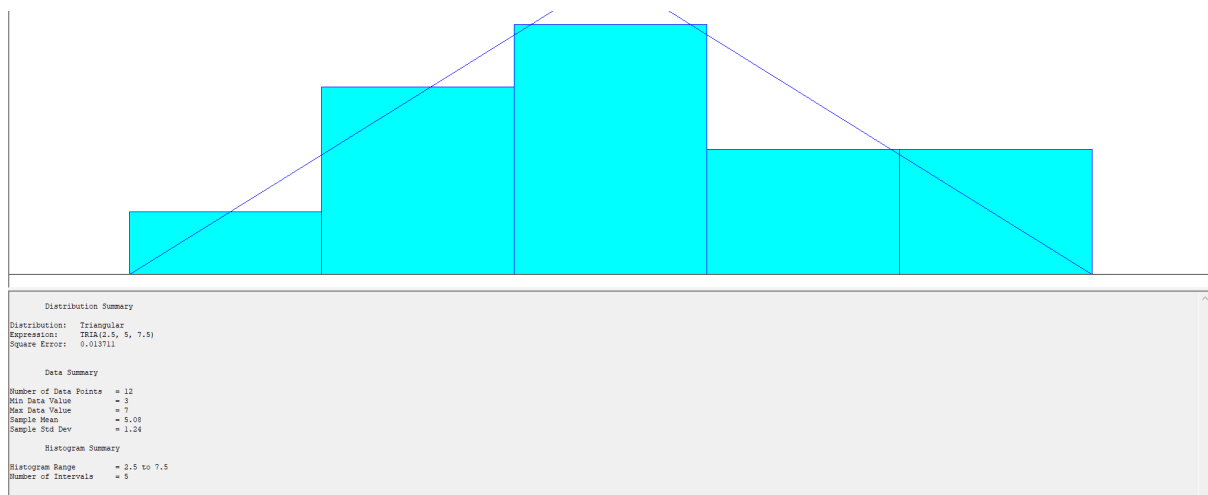


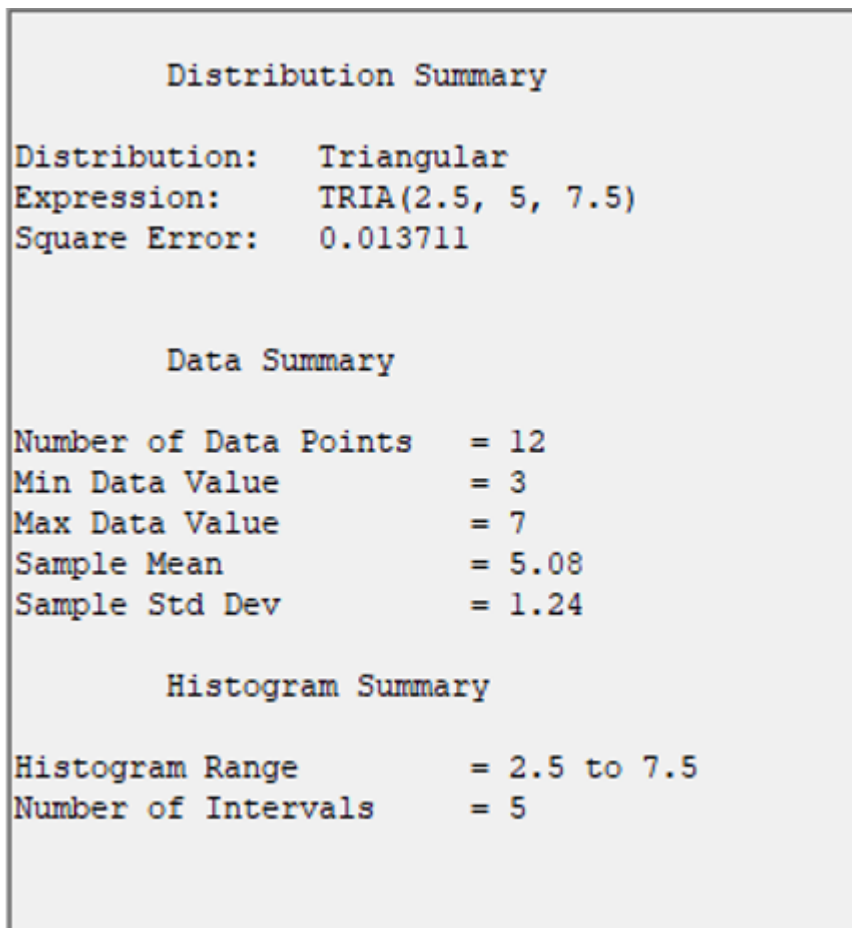




### 3.3 Order preparation time

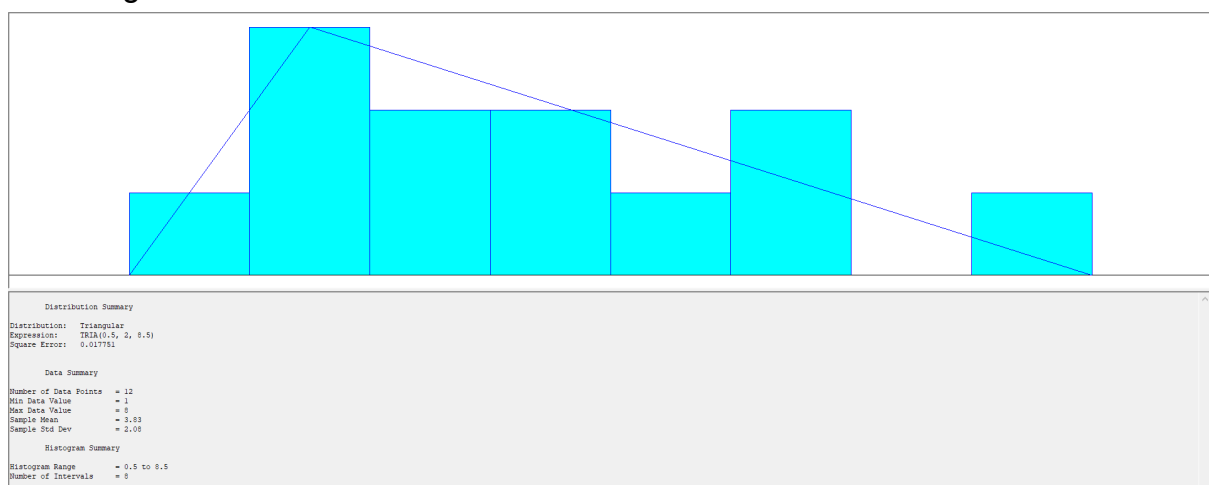
We fit the data showing the average order preparation times received from customers according to the "Triangle Distribution".

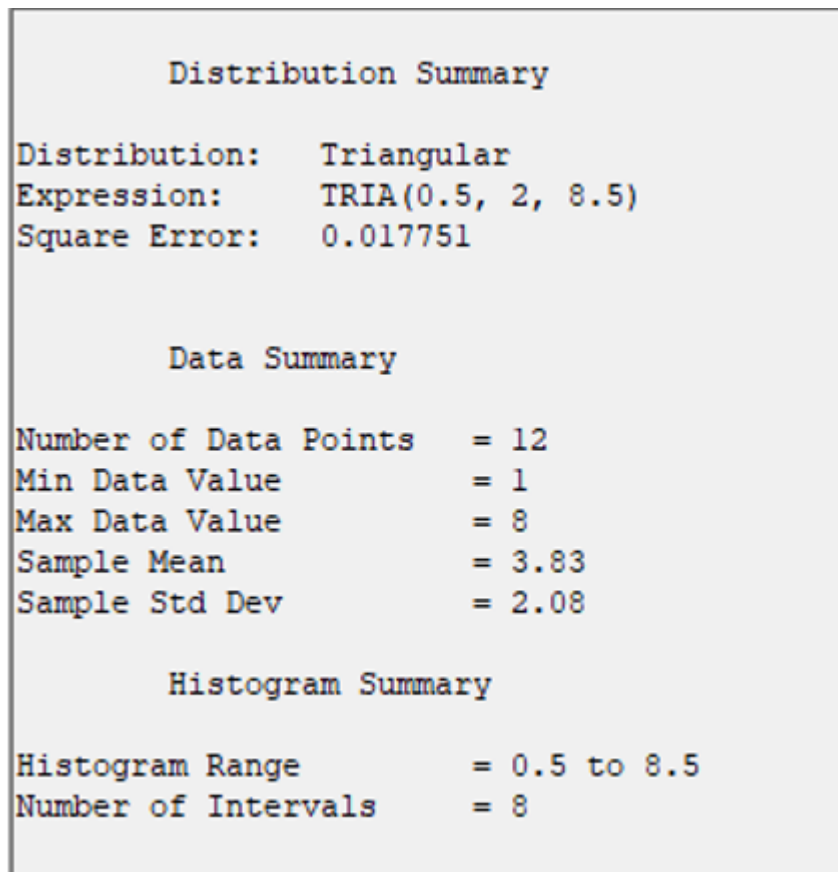




### 3.4 Queue Waiting Time

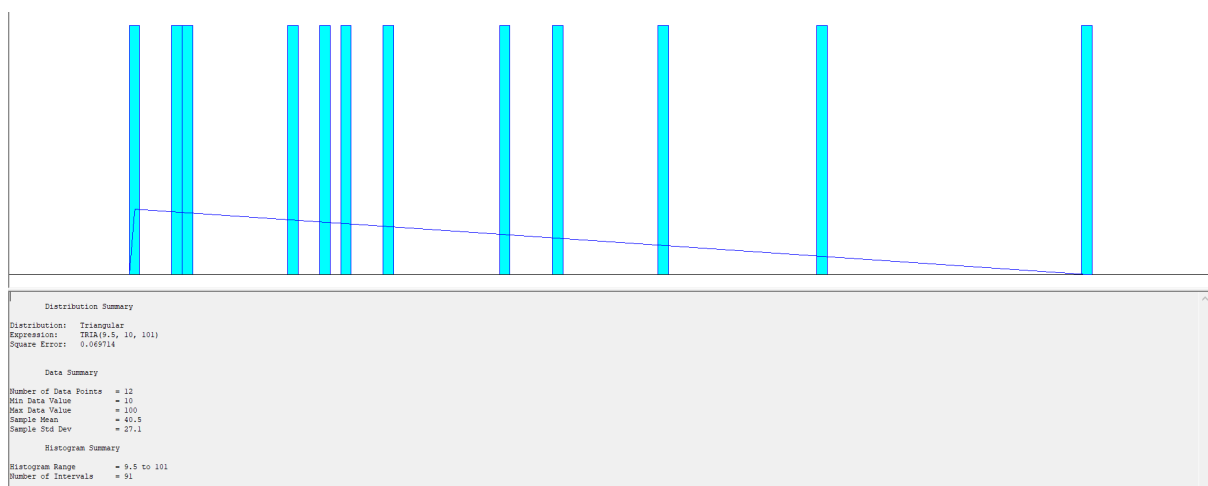
Considering the average order preparation times and waiting times received from customers, we fit the data showing the time customers spend in the queue according to "Triangle Distribution".





### 3.5 Sitting Time

We have fitted the data showing the length of time customers order in the coffee shop in this area.



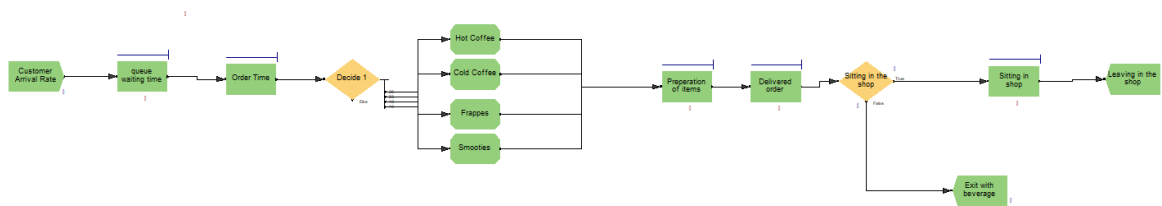
Distribution Summary	
Distribution:	Triangular
Expression:	TRIA(9.5, 10, 101)
Square Error:	0.069714
Data Summary	
Number of Data Points	= 12
Min Data Value	= 10
Max Data Value	= 100
Sample Mean	= 40.5
Sample Std Dev	= 27.1
Histogram Summary	
Histogram Range	= 9.5 to 101
Number of Intervals	= 91

## Model Of Self-Service Coffee Shop System:

The analysis and optimization of the cafeteria system depends entirely on how the model in the Arena is designed. This varies according to your data and the distributions you apply to your data. We used "ARENA student version" in this field.

The results from the Arena model help to understand the system and also allow to improve it by making changes to the model and comparing the results. Together with the prepared models, it provides an understanding of the system. It is not a good idea to apply different kinds of suggestions in real situations before performing the output, so there is always a need to simulate systems and check facts and figures before implementing any idea or suggestion.

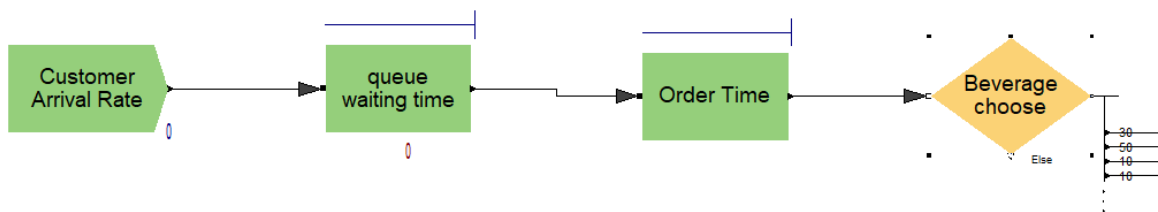
## Model Of Self-Service Coffee Shop



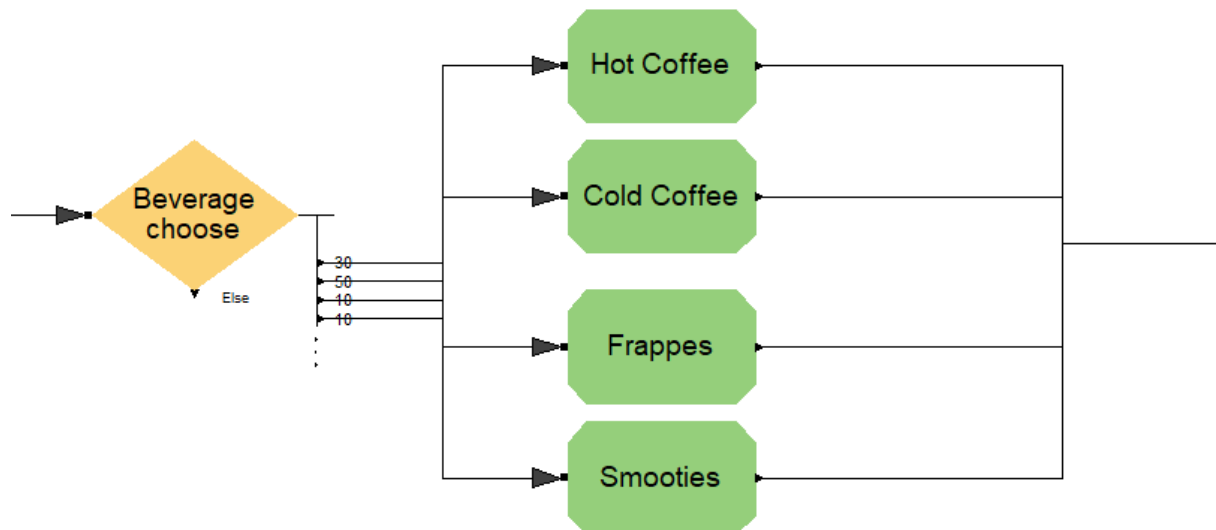
What you see above is the general screenshot of our model. The picture quality is greatly reduced due to the data in the model. For this reason, you can see the general picture in detail from the link below. In addition, we divided each area into parts to make the overall picture more understandable, and we found it appropriate to add it to the report in this way.

image [link](#).

Detailed examination of the prepared the model.

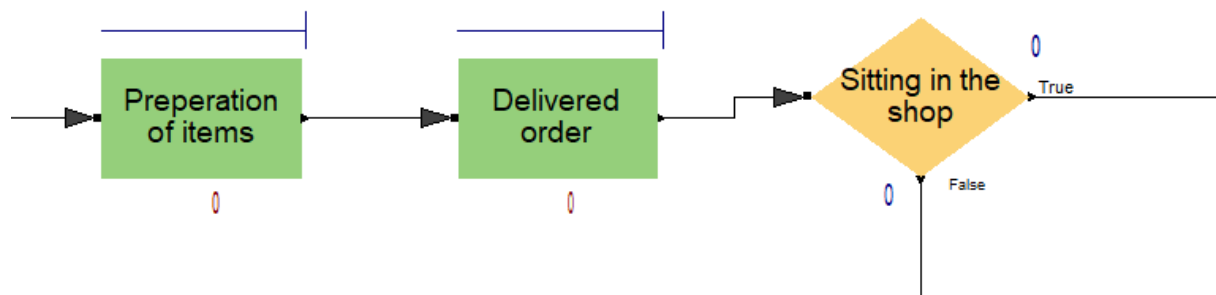


We started our model with the "Customer Arrival Rate" field in the field shown below. Then the process continues with successive processes. The model progresses in line with the data prepared with the "Queue Waiting Time" and "Order Time" processes. Then, with the "Beverage choose" field, customers are offered options from the menus. According to this result, the model continues to progress.

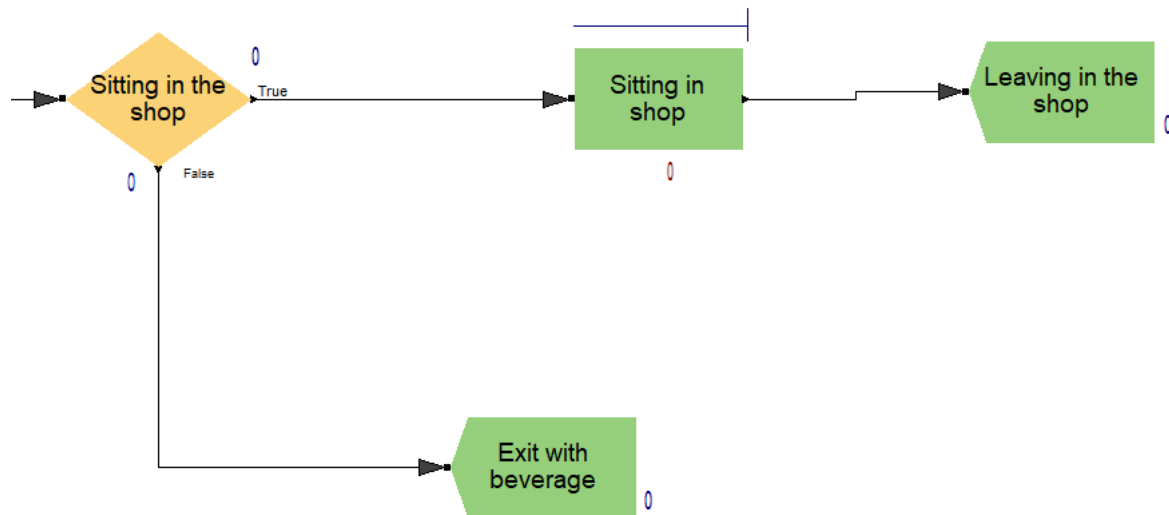


Customers are offered 4 main categories. (These categories are also available in our menu data.) As a result of these categories, it is possible for the customer to make a clearer choice and to choose the products in the category more easily. As you can see from the model picture, each menu category has different percentage values. This shows which category and products customers tend to choose.

The values are respectively; Hot Coffee 50% Cold Coffee 30%, Frappes 10% and Smoothies 10%.



In the next stage, customers are met with "preparation of items" and "delivered order" processes. These stages are modeled using the prepared data and the fit data. Then the "Sitting in the Shop" area appears before the customer. In this area, which is offered to the customer himself, he can take the product he ordered and leave the shop, or sit in the shop.



Data rate of customers in this option is 75% sitting in the shop, 25% leaving the shop.

## Conclusion

This project aimed for new methodologies not only for designing, analyzing and optimizing self-service coffee shop systems, but also easily applicable to various other service industries where customer behavior is of fundamental importance. Throughout the project, we learned to use the "ARENA" application and to model a coffee shop from scratch with this application. The coffee shop we want to model in our project is the "Soulmate" coffee shop in our close vicinity. During the modeling, we did not work on detailed issues such as cost and personnel activities in the shop. Rather, we wanted to investigate which products the customers tend to choose at what rate. We wanted to seek answers to these questions by simulating a system. Simulated systems allow to understand and analyze the system as a whole, not just any part. The results of the simulation provide insight into the various possible outcomes and how to manage them. Optimizing the entire system with complex belonging has always been an obstacle, but Arena helped us to overcome this problem efficiently and effectively.