Cairo University

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Report for problem 1 - The Market

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Course Name: Systems Modeling and Simulation

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Contents

Problem formulation & Objectives:

System: Market system.

Objects: Cashier, Customers.

Purpose:

1. The average service time of the express customers and the regular customers.

2. The average waiting time in the express cashier queue and the regular cashier queue.

3. The maximum express cashier queue length and regular cashier queue length.

4. The probability that a customer waits in the express cashier queue.

5. The portion of idle time of the express cashier and regular cashier.

6. Does the theoretical average service time of the service time distribution match with the experimental one?

7. Does the theoretical average service time of the service time distribution match with the experimental one for both types of customers?

8. How does using a different percentage of both types of customers (for example, 40% express customers and 60% regular customers) affect the system?

System Components:

- **Entity**: Customers.
- **Attributes**: Items.
- **Activity**: Shopping
- **State variables**:

a. The number of busy Cashier.

b. The number of customers in the market.

- Events:

a. Exogenous event: Arrival of customer.

b. Endogenous event: Service completion of a client.

System analysis including cumulative distribution tables, calendar table (for 10 customers).

Distribution for customer type and the cumulative probability

customer type	prob	Com	Interval
E	0.6	0.6	00-60
R	0.4	1	60-100

Random digit for generate customer type.

customer	random digit	type
1	72	R
2	90	R
3	83	R
4	12	E
5	27	E
6	33	E
7	15	E
8	49	E
9	51	E
10	65	R

Distribution for Inter arrival time and the cumulative probability.

IAT	Prob	Com	Interval
0	0.16	0.16	0-16
1	0.23	0.39	16-39
2	0.3	0.69	39-69
3	0.21	0.9	69-90
4	0.1	1	90-100

Random digit for generating inter arrival time.

customer	random digit	Inter arrival time
1	3	0
2	14	0
3	55	2
4	82	3
5	73	3
6	1	0
7	43	2
8	28	1
9	10	0
10	34	1

Distribution for service time for express customers and the cumulative probability.

ST for express	prob	Com	Interval
1	0.3	0.3	0-30
2	0.4	0.7	30-70
3	0.3	1	70-100

Random digit for generating service time for express customer.

customer	random digit	service time for express
1	-	-
2	-	-
3	-	-
4	82	3
5	14	1
6	29	1
7	9	1
8	38	2
9	10	1
10	-	-

Distribution for service time for regular customers and the cumulative probability.

ST for regular	Prob	Com	Interval
3	0.2	0.2	0-20
5	0.5	0.7	20-70
7	0.3	1	70-100

Random digit for generating service time for regular customers.

customer	random digit	service time for express
1	39	5
2	58	5
3	11	3
4	-	-
5	-	-
6	-	-
7	-	-
8	-	-
9	-	-
10	53	5

customer	customer type	Inter arrival time	arrival time	service time	time service begin	waiting time in express	waiting time in regular	Time service ends	time in system	ava for ex	ava for reg
1	R	0	0	5	0	0	0	5	5	0	5
2	R	0	0	5	5	0	5	10	10	0	10
3	R	2	2	3	10	0	8	13	11	0	13
4	E	3	5	3	5	0	0	8	3	8	13
5	E	3	8	1	8	0	0	9	1	9	13
6	E	0	8	1	9	1	0	10	2	10	13
7	E	2	10	1	10	0	0	11	1	11	13
8	E	1	11	2	11	0	0	13	2	13	13
9	E	0	11	1	13	2	0	14	3	14	13
10	R	1	12	5	13	0	1	18	6	14	18

Customer	Customer Type	IAT	Arrival Time	Service Time	TimeService Start	Waiting Time EX	Waiting Time RG	Time Service End	Time in System	Avb for ex	Avb for
1	R	0	0	5	0	0	0	5	5	0	5
2	R	0	0	5	5	0	5	10	10	0	10
3	R	2	2	3	10	0	8	13	11	0	13
4	E	3	5	3	5	0	0	8	3	8	13
5	E	3	8	1	8	0	0	9	1	9	13
6	E	0	8	1	9	1	0	10	2	10	13
7	E	2	10	1	10	0	0	11	1	11	13
8	E	1	11	2	11	0	0	13	2	13	13
9	E	0	11	1	13	2	0	14	3	14	13
10	R	1	12	5	13	0	1	18	6	14	18

1. Average service time for Express =0.9
2. Average service time for Regular =1.8
3. The average waiting time in the express cashier queue = 0.3
4. The average waiting time in the regular cashier queue =1.4
5. The maximum express cashier queue length =1
6. The maximum regular cashier queue length =2
7. The probability that a customer waits in the express cashier queue =0.2%
8. The portion of idle time of the express cashier =5
9. The portion of idle time of the express cashier =0

Experimental Design Parameters:

- Type of customer is r randomly generated following the cumulative distribution (probabilistic parameter).

• Inter arrival is randomly generated following the cumulative distribution (probabilistic parameter).

• Service time is randomly generated following the cumulative distribution (probabilistic parameter).

• Arrival time = arrival[i-1] + IAT (controllable parameter).

• Start Service = maximum(arrival[i] , end service[i-1] (controllable parameter).

• Waiting time = start service – arrival time (controllable parameter).

• End service = start service + service time (controllable parameter).

• Time in system = end service – arrival time (controllable parameter).

Justification of experiment parameters values

Customers = 500 to test every case in the problem (service in express cashier

– waiting in express cashier queue – service in regular queue – waiting in the regular cashier queue).

Time between arrivals is a random value because there is no specific arrival time for the customers.

Service time is random because people take different time to complete them activity.

- Inter arrival time: the time between each customer and the customer after him.

• Arrival time: the time at which the customer will arrive.

• Start service time: the time at which the customer will start the service.

• Waiting time: the time that the customer will wait to start the service.

• Service time: the time that the customer will spend during the service.

• End service time: the time at which the customer will complete the service.

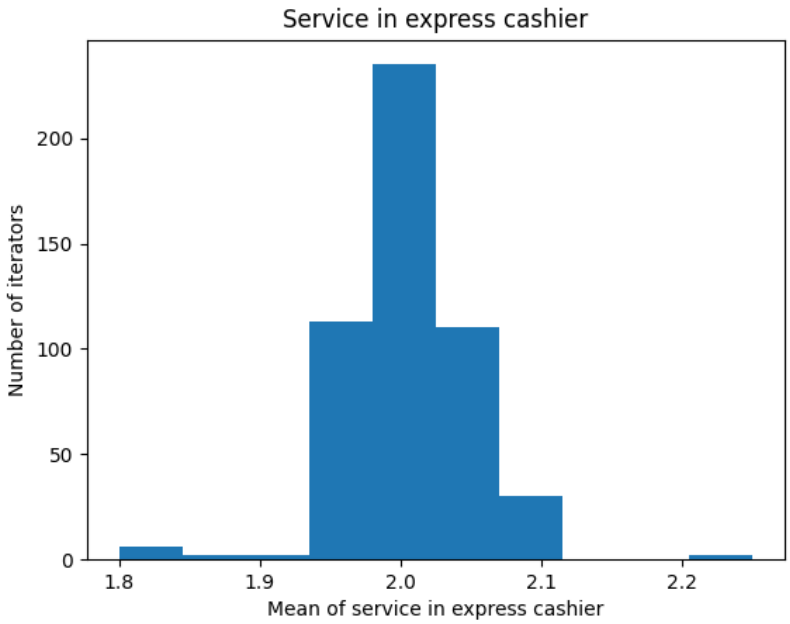
• Time in system: the total time for the customer to complete the service since his arrival time.

• Teller idle time: the time at which the teller will be free.

Results Analysis

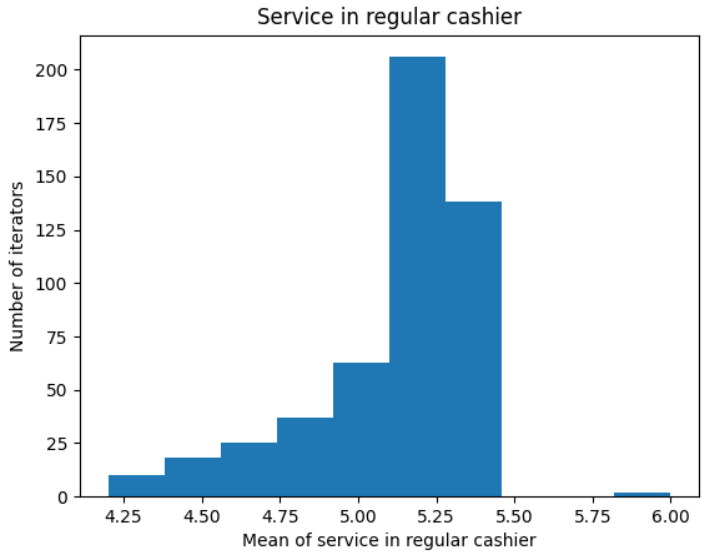
1. The theoretical average service time for express = 2

and the experimental = 2 There are right

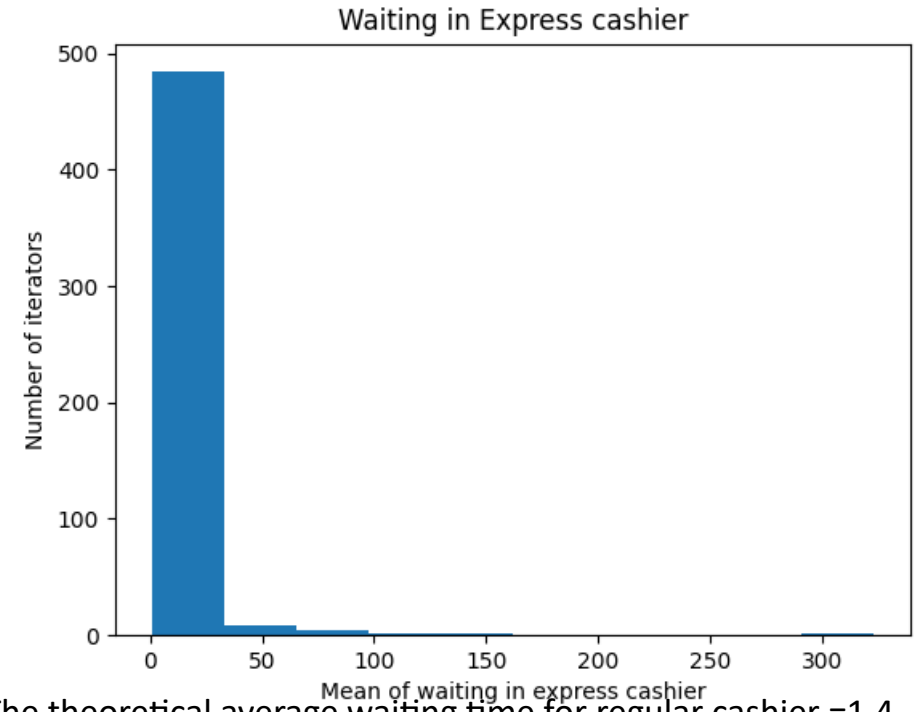


2. The theoretical average service time for regular = 5.2

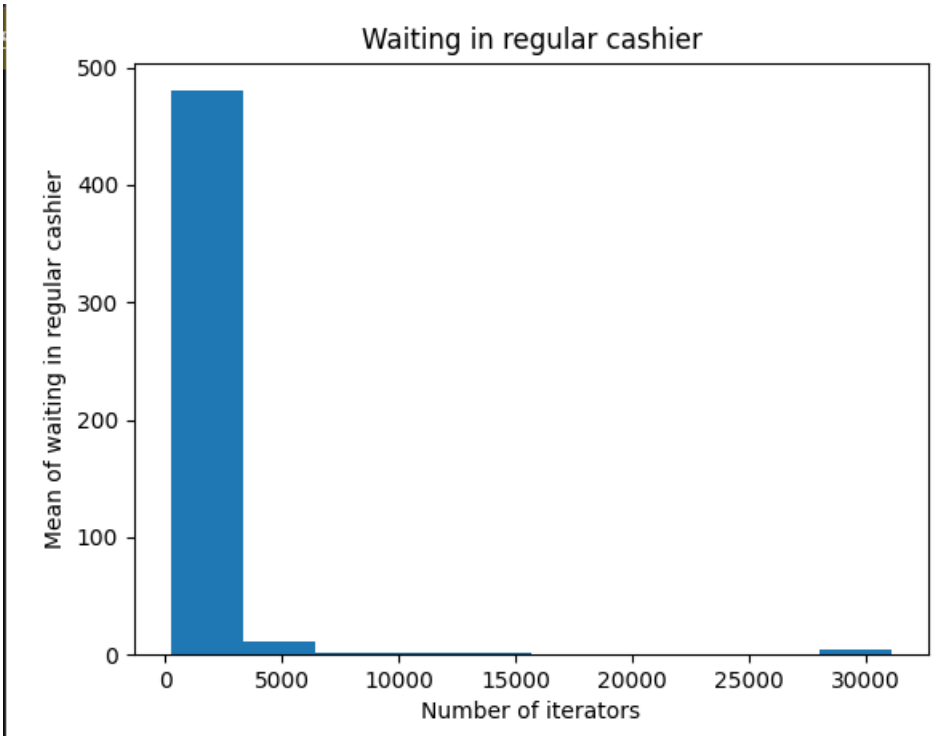
and the experimental = 5.11 The two approximately same.



3. The theoretical average waiting time for express cashier =0.3 and the experimental = 0.8 There are almost close



4. The theoretical average waiting time for regular cashier =1.4 and the experimental = 11.34 are not close



• The theoretical maximum express cashier length = 1 and the

experimental one = 14

• The theoretical maximum regular cashier length = 2 and the

experimental one = 93

• The theoretical probability that a customer waits in express cashier = 0.2

and the experimental one = 0.26

• The theoretical portion of idle time of the express cashier = 9 and

the experimental one = 395.65

• The theoretical portion of idle time of the regular cashier = 0 and

the experimental one = 14.85

1. Average service time for Express =2
2. Average service time for Regular =5.2

• The Average service time for Express in theoretical =2 the experimental = 2 so it's match

- Average service time for Regular in theoretical =5.2 the experimental = 5.11 so there are approximately match

• The average inter-arrival time of the inter-arrival time distribution in theoretical =1.86 match with the experimental = 1.85 so there are approximately match

• How does using a different percentage of both types of customers (for example,

40% express customers and 60% regular customers) affect the system?

It affects the system in average service time and average waiting time So if the percentage of regular customers decreased the average waiting time will be decreased in regular cashier.

Conclusion

In the simulation model we will find the experimental is with more

accuracy than the theoretical because we trace with large number but in theoretical, we trace with small number so the result of

experimental is the best one.