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Design, Simulate and Analyze Cafeteria System Using Arena

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Abstract: **An effort is made to simulate and analyze Local Cafeteria and to increase profit using software Arena (Student version). Arena logics are made to express complex conditions. New methodologies are designed towards resource management and cost analysis in a multifunctional Cafeteria system. Control and enterprise complex structure using Arena improves not only efficiency of a system but also aids towards proper understanding of organizational management.**

Keywords: **arena, simulation, cafeteria management, system management.**

1. INTRODUCTION

This paper presents ways to design a general Cafeteria system, having complex belongings, in a simple way for proper understanding and optimization of Cafeterias around the globe using software arena (student version). Managing cafeteria is a problem for many but it can be overcome by doing simulation of it and getting concrete analysis from simulation model. By using arena we can see and analyze how much baristas we need for proper management of cafeteria as well as how much sitting tables or chairs we need for proper flow of customers. We can not only improve ongoing Cafeteria but design a new properly managed cafeteria.

Study and research is made to design an optimal ongoing or new cafeteria using arena. Complex conditions are defined in arena logics for proper understanding of system.

2. DATA COLLECTION

The study is based on layout of normal Cafeterias with counters, varieties of drinks or food items, Table or chairs for customers and baristas. Simple looking cafeterias have complex systems i.e. Variation in arrival of customer per hour, Baristas on different time shifts , Tables or chair different for different variety of customers , Different queue at different locations in Cafeteria.

Below is data collected from a local cafeteria with all complex condition that normally each Cafeteria has

Cafeteria timing: 7a.m. – 8p.m.

Time and customers arrival rate:

Time	Customer arrival rate
7a.m.-10a.m.	20/hour
10 a.m.- 12p.m.	25/hour
12 p.m.- 4p.m.	30/hour
4 p.m.- 8p.m.	35/hour

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.

Tables for Sit in Customers:

There are 8 chairs for Individuals, 2 tables for pairs or couple and 1 table for group of 4.

Staff Members at Cafeteria:

Staff Members	Salary / Hour	Shift during which they are available
Staff Member # 1	$7	7a.m. – 8p.m.
Staff Member # 2	$7	7a.m. – 8p.m.
Staff Member # 3	$7	7a.m. – 8p.m
Staff Member # 4	$9	1p.m. – 8p.m
Staff Member # 5	$9	4p.m. – 6p.m

Products served at Cafeteria:

Product	Cost	% of audience orders
Salad	$3	50%
Tea or Coffee	$1	20%
Juice	$2	30%

Operations at Cafeteria and Staff member assigned to them:

Operation	Operation time in minutes			Staff-member assigned
	Min.	Mean	Max.	
Taking Oder at till	1		3	Any Staff member that is available
Preparation of Salad	2	3	4	Any Staff member that is available
Preparation of Tea or Coffee	1	2	3	Any Staff member that is available
Preparation of juice		2		Any Staff member that is available
Serving		1		Any Staff member that is available
Receiving bill at end	0.5		1	Any Staff member that is available

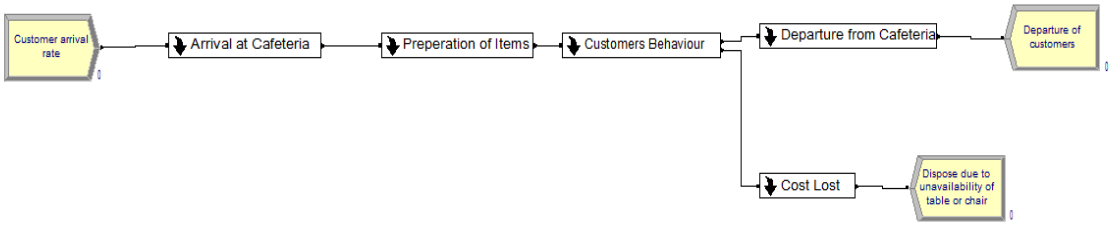
Behavior of Customers at Cafeteria:

- Customers leave cafeteria if there are more than 10 customers in queue at till
- Out of total customer ,each day, only 40% want Tables or Chairs to sit in
- If table or chair is not empty, 80% of customers left without payment even if their order is ready while 20% customer wait for table or chair to be empty, sit in customers usually take 30 minutes

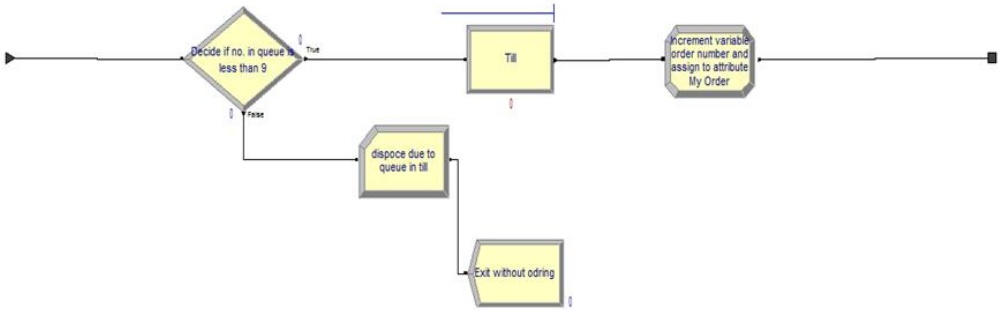
3. APPROACH TO ARENA

Analysis and optimization of Cafeteria system purely depends on how designing the model in Arena**.** Results from arena model helps in understanding the system as well as allows to improve it by putting changes in model and comparing results. Practicing different kind of suggestions in real situations before realizing output is not a good idea therefore there is always a need to simulate systems and check facts and figures before implementing any idea or suggestions.

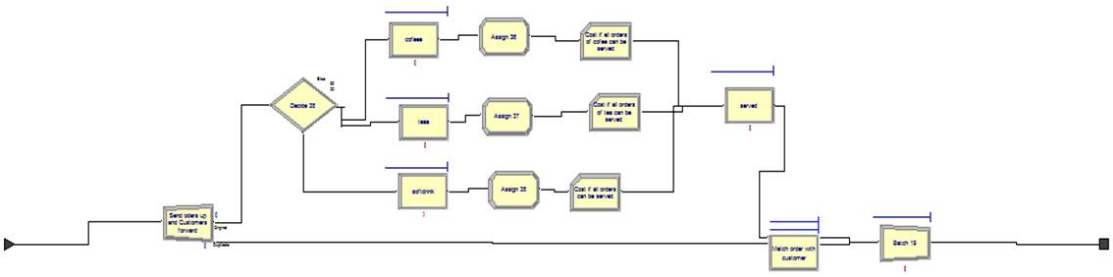
Model for Cafeteria system:



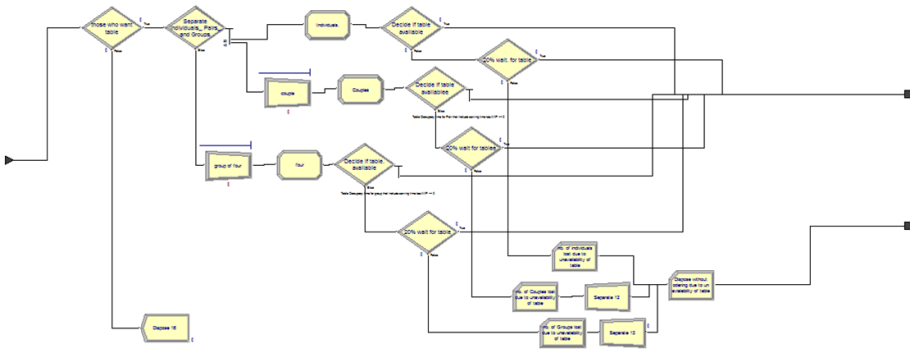
Logic in Submodule Arrival at Cafeteria is as bellow



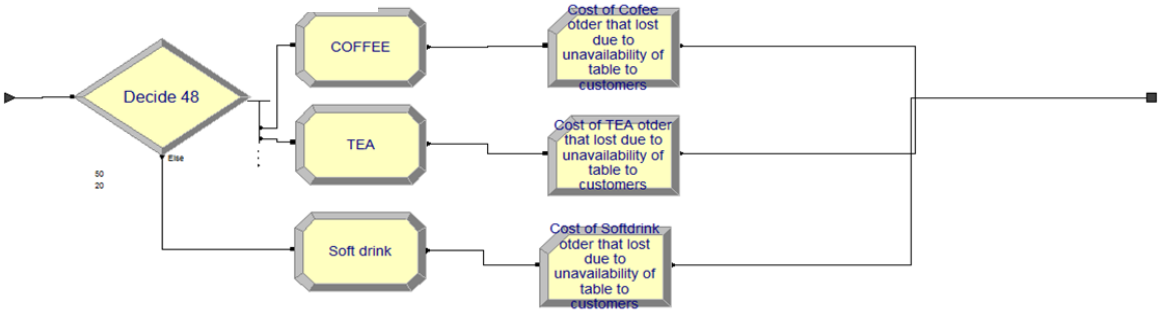
Logic in Submodule Preperation of Items is as bellow



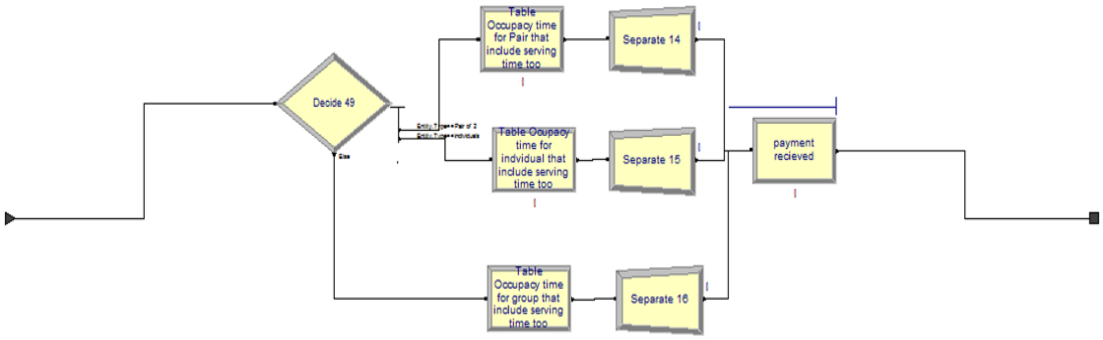
Logic in Submodule Customers Behaviour is as bellow



Logic in Submodule Cost Lost is as bellow



Logic in Submodule Departure from Cafeteria is as bellow



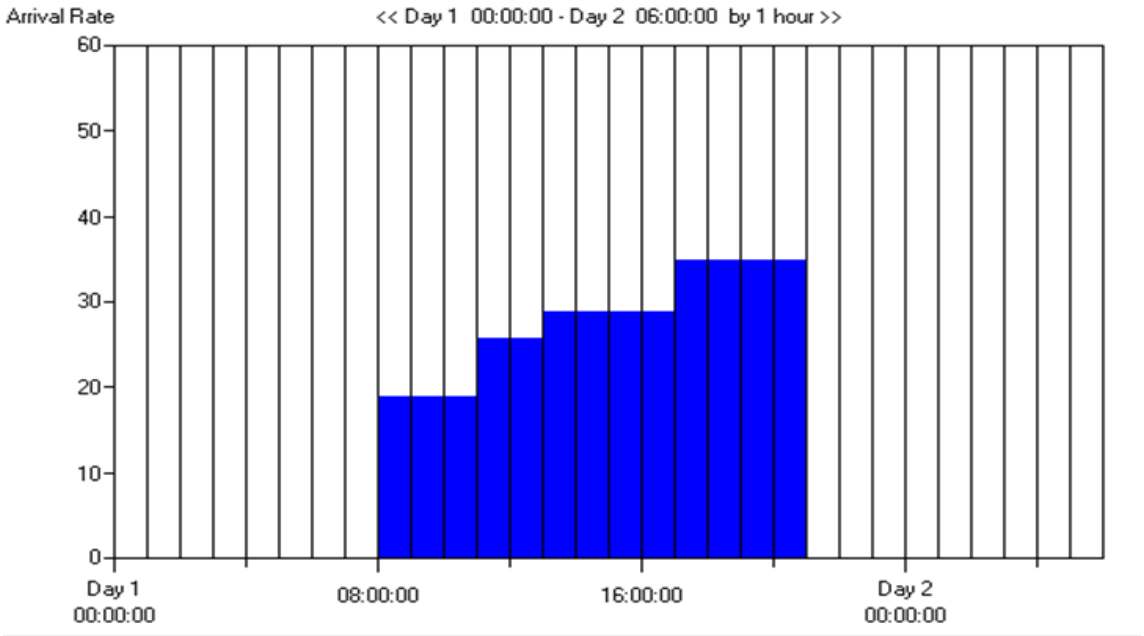
4. DESIGN OF MODEL

More precise and accurate the model, more precise and accurate will be the results. Design of Arena simulation model for cafeteria or Restaurant based on data above involves

- Arrival rate
- Design of Queue at till
- Allocation of resources according to shift and availability
- Preparation of all types of products and assigning cost
- Serving same order to same customer
- Allocation of tables and chairs to customer
- Cost Analysis
- Showing results in user defined

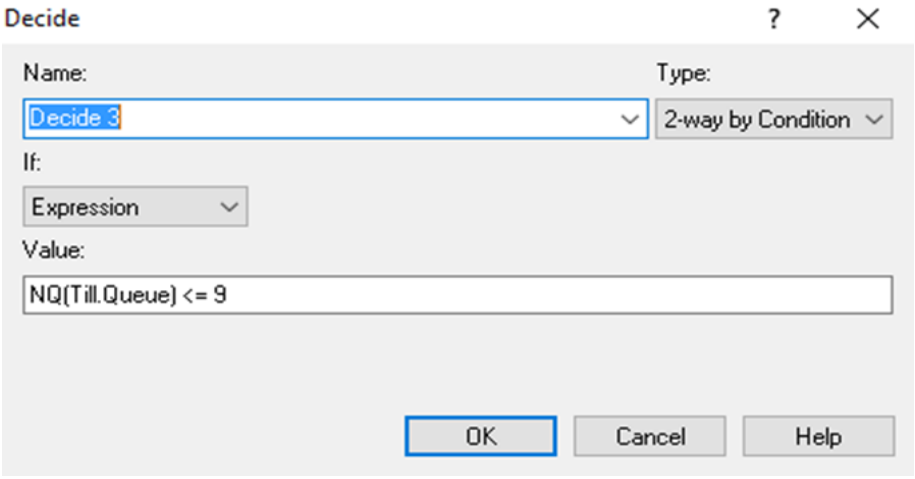
Arrival rate:

Customers Arrival rate is described by schedule in Create module as follows



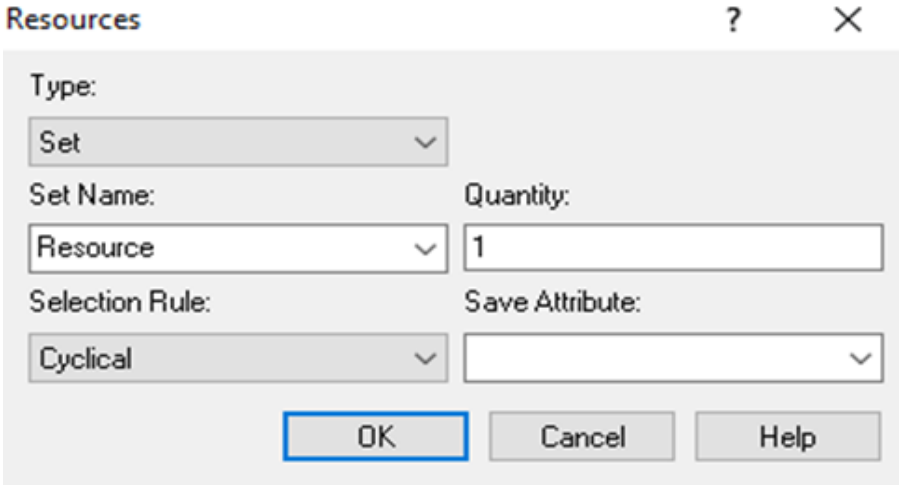
Design of queue at till:

According to condition that Customers leave cafeteria if there are more than 10 customers in queue at till. Use Decide module to put condition on till process



Allocation of resources according to shift and availability:

To allocate resources according to data we have to use Type Set in defining the resource Shifts are described separately for every resource in Schedule.



Resource shifts and costs are further described as

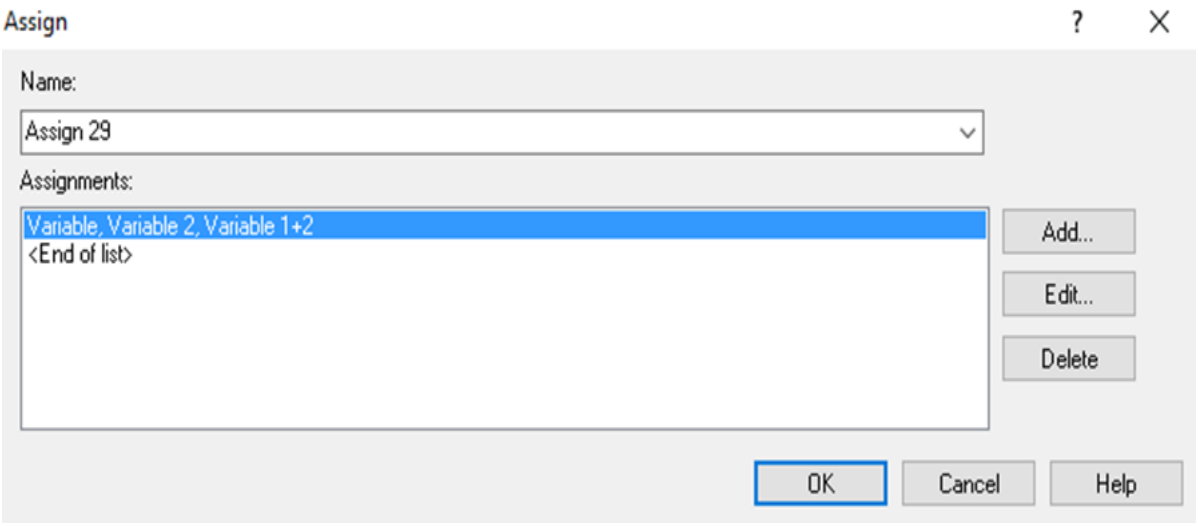
Resource - Basic Process

	Name	Type	Schedule Name	Schedule Rule	Busy / Hour	Idle / Hour	Per Use	StateSet Name	Failures	Report Statistics
1	resource 1	Based on Schedule	Schedule 8	Wait	7	0.0	0.0		0 rows	☑
2	resource 2	Based on Schedule	Schedule 8	Wait	7	0.0	0.0		0 rows	☑
3	resource 3	Based on Schedule	Schedule 8	Wait	7	0.0	0.0		0 rows	☑
4	part time staff 1	Based on Schedule	Schedule 5	Wait	9	0.0	0.0		0 rows	☑
5	part time staff 2	Based on Schedule	Schedule 6	Wait	9	0.0	0.0		0 rows	☑

Preparation of all types of products:

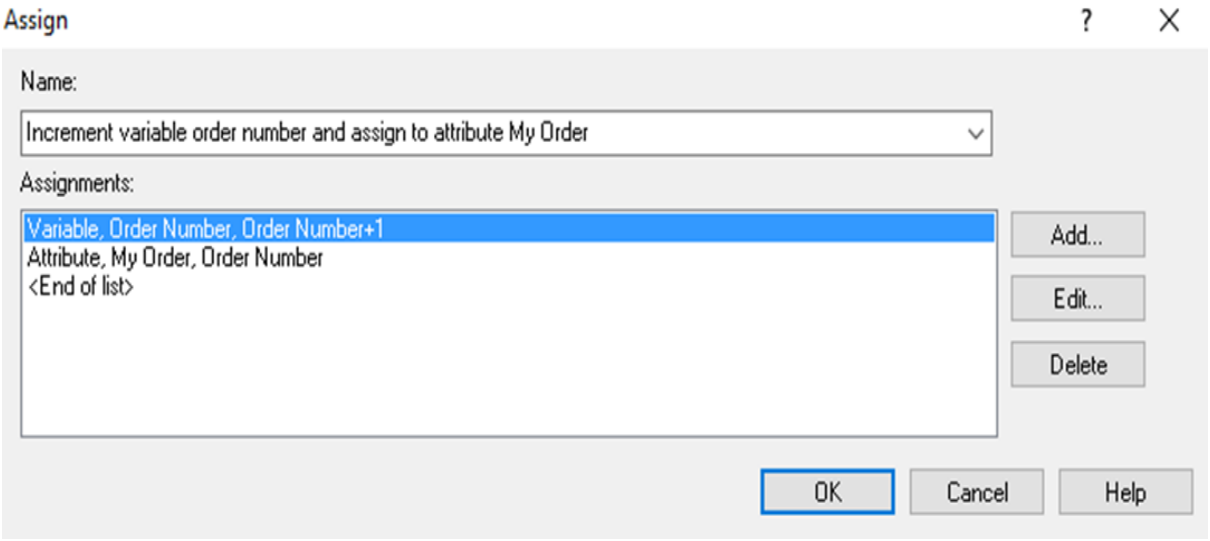
Use Separate module and generate orders to process then assign cost and record it

Assigning Cost by Variable in Assign module i.e. Variable1+2 for coffee means $2 per coffee

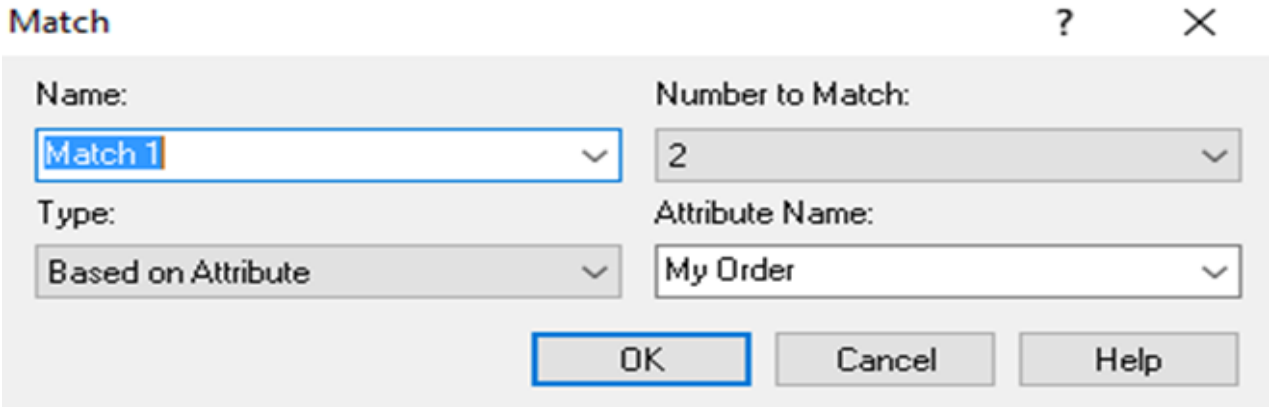


Serving same order to same customer:

To make system capable of understanding to serve same order to same customer unique no. is assigned to every order and customer and use Match module to match order to a customer



In order to detect this Match module is based on attribute specified in variable



Allocation of tables and chairs to customer:

Allocation of tables and chairs to three different variety of customers is designed by use of Decide module and Process module

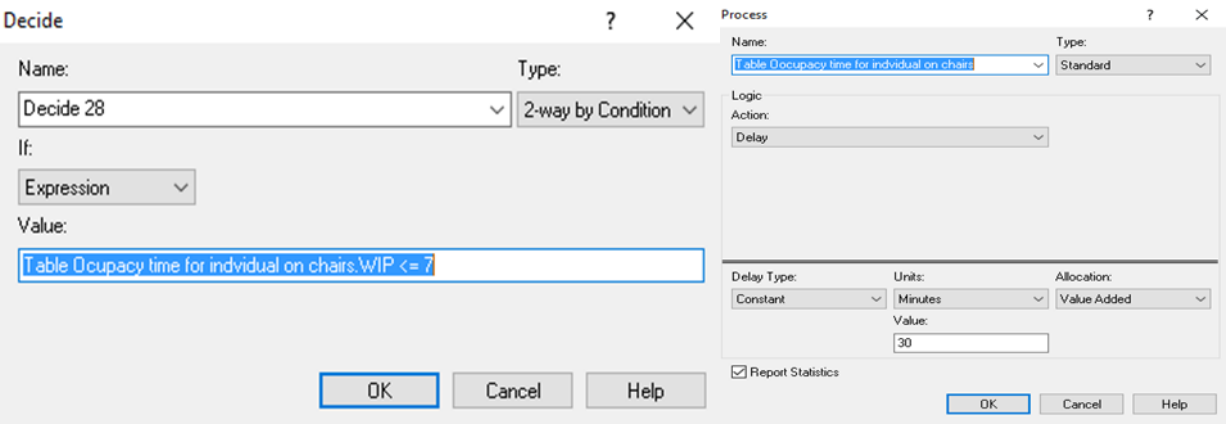
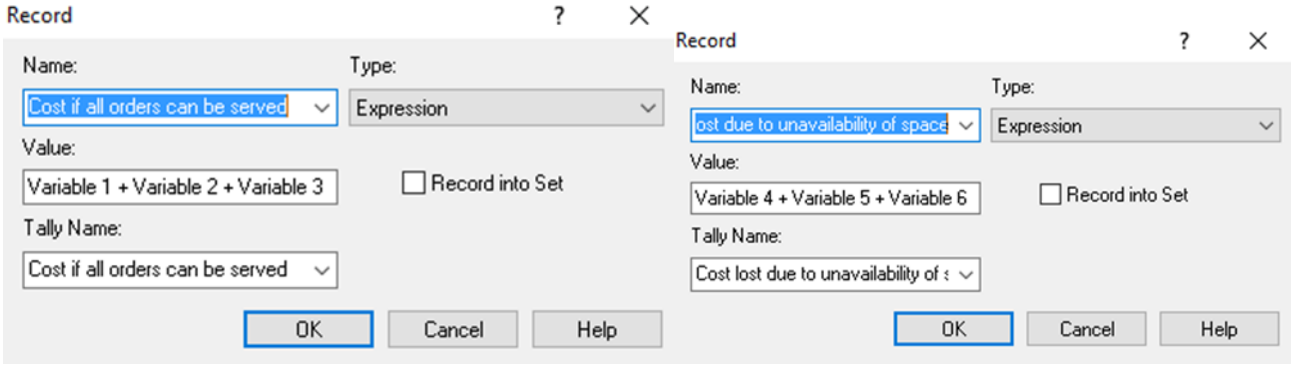


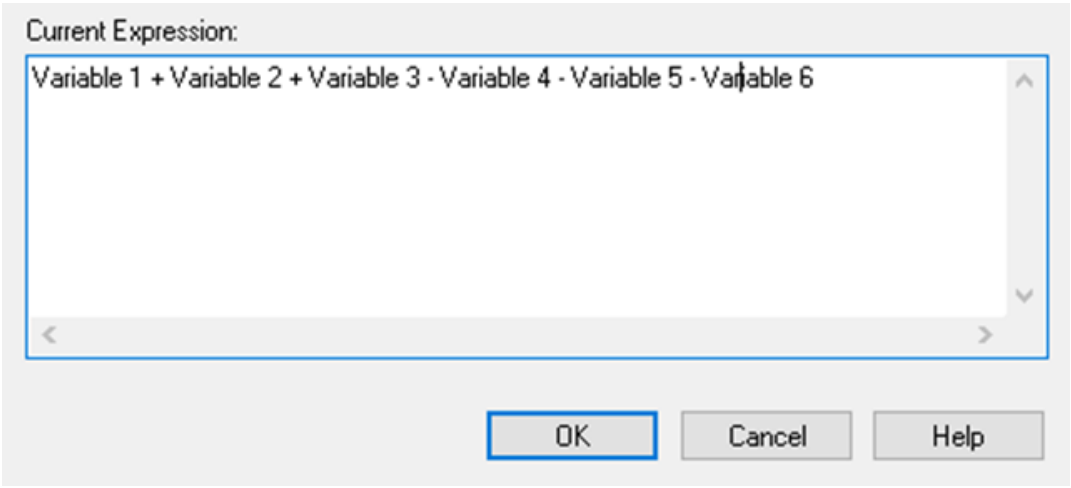
Table occupancy time for individuals on chairs.WIP <=7 means seven places are available for individuals to sit on chairs and whenever the eighth individual came it should have to wait according to conditions described.

Cost Analysis:

To perform Cost Analysis place Record module to record costs at different levels and assign them names



To determine Revenue use another Record module at the end with math logic in expression. Every variable represent Cost value assigned to orders



Showing results in user defined:

Use Record module at different position in model to count no. of customers lost and no. of customers served. By this way results are easy to understand and analyze. Reports are detailed but in order to get what our desire is we use Record module so that all desired results shows at one place.

Arena can built different graphs on data seen on *User defined* to express rational between different variables which are important for analysis and improvement.

5. ANALYSIS

By running this Cafeteria system for 10 days we can analyze the system, by analyzing different component we can also put suggestions in model and we can optimize this system.

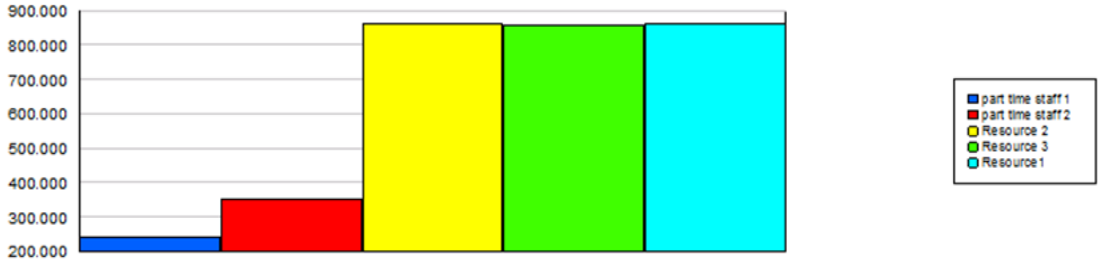
RESOURCES OR STAFF-MEMBERS:

Utilization:

Scheduled Utilization	Average	Half Width	Minimum Average	Maximum Average
part time staff 1	0.3057	0.01	0.3051	0.3064
part time staff 2	0.8201	0.02	0.8186	0.8216
Resource 2	0.7327	0.10	0.7247	0.7407
Resource 3	0.7312	0.08	0.7250	0.7374
Resource1	0.7323	0.07	0.7269	0.7376

Cost:

Busy Cost	Average	Half Width	Minimum Average	Maximum Average
part time staff 1	242.14	6.80	241.61	242.68
part time staff 2	353.19	9.31	352.46	353.92
Resource 2	860.99	122.13	851.38	870.61
Resource 3	859.36	93.75	851.98	866.74
Resource1	860.54	77.55	854.44	866.65



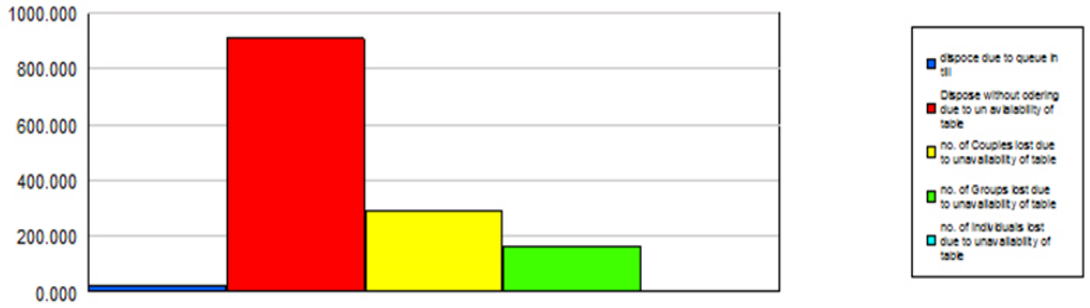
USER DEFINED:

Only highlighted costs should be considerable because these are based on variables described i.e. Total Cost means total earned cost is 6293 and lost cost is 1035 for 10 days

Expression	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
Cost if all orders can be served	3639.96	306.41	3615.84	3664.07	1.5000	7344.50
Cost lost due to unavailability of space	509.77	116.11	500.63	518.91	1.0000	1035.00
Total cost	3132.91	351.47	3105.25	3160.57	17.5000	6293.00

No. of customers lost due to queue at till, no. of customers lost due to unavailability of table in contrast with variety of customers

Count	Average	Half Width	Minimum Average	Maximum Average
dispoce due to queue in till	21.5000	184.24	7.0000	36.0000
Dispose without odering due to un avialability of table	908.50	222.36	891.00	926.00
no. of Couples lost due to unavailability of table	292.50	69.88	287.00	298.00
no. of Groups lost due to unavailability of table	161.00	50.82	157.00	165.00



For analyzing the queue at different positions in the model

Waiting Time	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
Batch 18.Queue	0.00	0.00	0.00	0.00	0.00	0.00
couple.Queue	0.1140	0.03	0.1118	0.1163	0.00	7.4072
group of four.Queue	0.1437	0.11	0.1352	0.1522	0.00	7.9061
juice.Queue	0.05046987	0.00	0.05044188	0.05049786	0.00	2.2240
Match 1.Queue1	0.00	0.00	0.00	0.00	0.00	0.00
Match 1.Queue2	0.1594	0.14	0.1488	0.1700	0.03335456	2.9802
payment recieved.Queue	0.08428940	0.11	0.07568327	0.0929	0.00	4.9373
prep of salad.Queue	0.04686782	0.07	0.04157356	0.05216207	0.00	2.4427
served.Queue	0.04954078	0.08	0.04351494	0.05556662	0.00	2.8971
teaa.Queue	0.04734917	0.12	0.03821585	0.05648248	0.00	2.3758
Till.Queue	0.04297128	0.06	0.03799981	0.04794275	0.00	2.1290

6. OPTIMIZATION

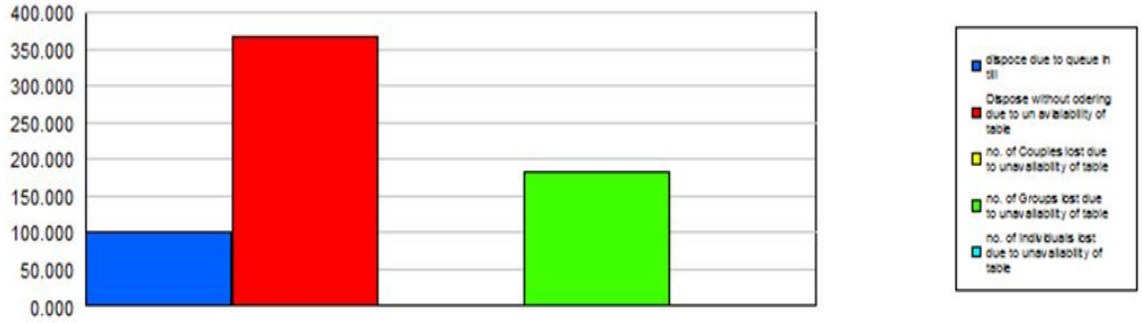
On the basis of arena model it is easy to detect where there is a need of improvement. Any kind of suggestions for improvement can be tested on arena and analyze the results again and again until system is properly optimized. On the basis of above results, by adding two more tables for Pair/Couples and reducing one Resource (one with 2 hour shift) we move towards optimized results.

7. RESULTS

Expression	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
Cost if all orders can be served	3649.96	676.12	3596.75	3703.17	1.5000	7426.00
Cost lost due to unavailability of space	301.00	142.32	289.80	312.20	1.0000	624.50
Total cost	3350.03	594.76	3303.22	3396.84	19.5000	6839.50

Total Cost means total earned cost is 6839 and lost cost is 624 for 10 days.

Count	Average	Half Width	Minimum Average	Maximum Average
dispoce due to queue in till	100.50	235.06	82.0000	119.00
Dispose without odering due to un avialability of table	367.00	216.00	350.00	384.00
no. of Couples lost due to unavailability of table	0.5000	6.35	0.00	1.0000
no. of Groups lost due to unavailability of table	183.00	101.65	175.00	191.00



OPTIMAL SOLUTION:

This model shows increase in cost by adding two more table for couples or pairs at the loss of a resource. Although we have earned profit but dispose due to queue at till become 100. So again it's not an optimal solution. In order to get optimal solution one has to put all suggestions and see what arena analyzes in the case of Local Café. The best optimal solution from all the suggestions was to fully utilize all five resources and add two tables for couples and one for group and the results are as below

Expression	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
Cost if all orders can be served	3572.02	470.79	3534.97	3609.08	1.5000	7210.50
Cost lost due to unavailability of space	39.2907	19.43	37.7614	40.8200	1.0000	83.0000
Total cost	3524.77	861.64	3456.95	3592.58	19.5000	7126.00

Total Cost means total earned cost is 7126 and lost cost is 83 for 10 days. Café can easily recover the cost of tables with in a month.

8. CONCLUSION

The paper intended new methodologies to design, analyze and optimize not only restaurant and cafeteria systems but it can easily be applied to various other service industries where customer behavior is of core importance. Cost is the most important factor in any business, by simulating a system, one can not only reduce cost but can also allocate resources. It allows not only to understand and analyze any single portion but system as a whole. The results of simulation gives perception into variety of possible outcomes and how to manage them. Optimization of whole system with complex belonging was always a hurdle but Arena overcome this issue efficiently and effectively.

ACKNOWLEDGEMENT

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