J. GUMBO'S

FROM THE BAYOU TO YOUR BOWL

PRAMIT SINGH

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PROJECT DESCRIPTION

This project simulates the functioning of food joint **J.Gumbo's .**The model was developed by observing the layout of the shop, the average footfall in a day, the number of resources available to serve the customers and the processing time required to process an order.

Also an alternative model has been suggested to reduce the waiting time in the queue for the customers and to make optimal use of the resources.

Assumptions-

The model is based on the following assumptions -:

1) The shop is open for 17 hours every day from 11am to 4am.

2) The resources work in three shifts (Two six hour shifts followed by a 5 hour shift)

Data Collection –

Data collection was done thrice and it covered the peak lunch and dinner hours.

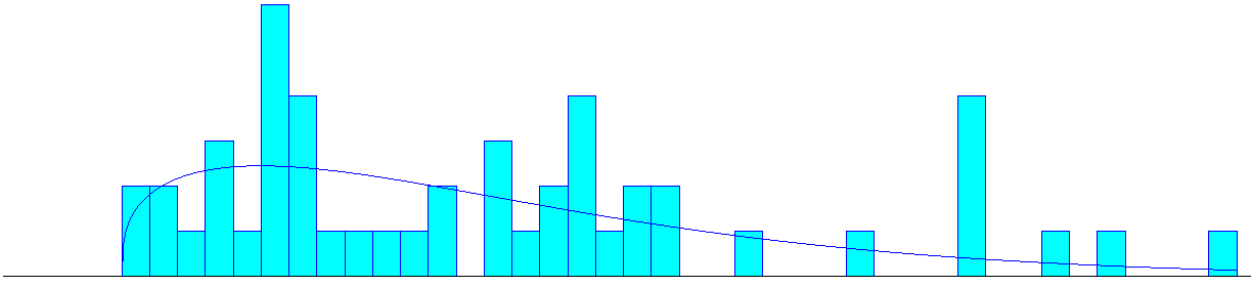
Customer arrival time, Bill payment time, and the time required for the order to be processed (i.e. for the food to arrive), were noted.

Identifying the distributions – (Best Fit)

Using Input analyzer, we found out the best fit for the data and obtained the distributions for the Interarrival time, billing time and processing time for food as explained below-:

Distribution for Interarrival time –

The data collected from J Gumbo's was saved in a text file. The file was opened using Input Analyzer (to determine the distribution of the data), hence a histogram of the data was generated.

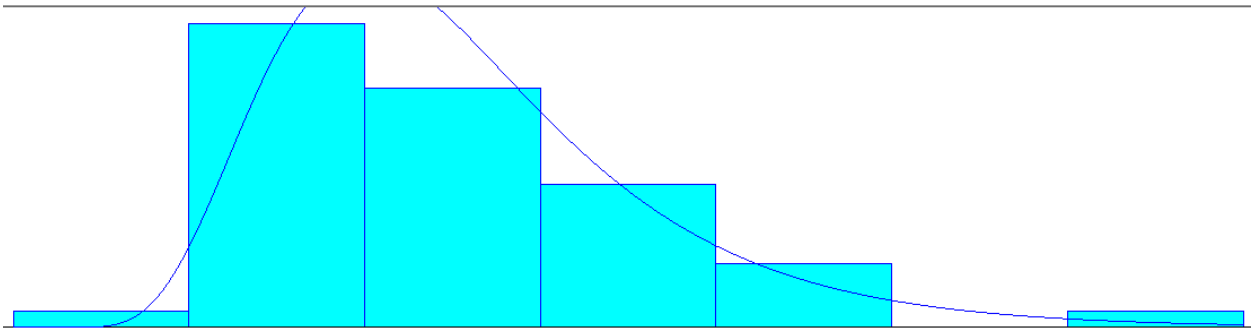


To obtain the best distribution, the fit all tab in the menu option was clicked, which provided the distribution summary of the data (displayed below).The distribution of the arrival is Weibull (14.7, 1.32)

```
       Distribution Summary

Distribution:   Weibull
Expression:     -0.5 + WEIB(14.7, 1.32)
Square Error:   0.024568

Chi Square Test
  Number of intervals   = 8
  Degrees of freedom    = 5
  Test Statistic        = 7.75
  Corresponding p-value = 0.185

       Data Summary

Number of Data Points   = 49
Min Data Value          = 0
Max Data Value          = 39
Sample Mean             = 13.1
Sample Std Dev          = 10.2
```

Distribution for billing time

The time required for billing of each customer was observed and the data was saved in a text file. The file was saved as a text file and was opened using input analyzer which generated the histogram below.

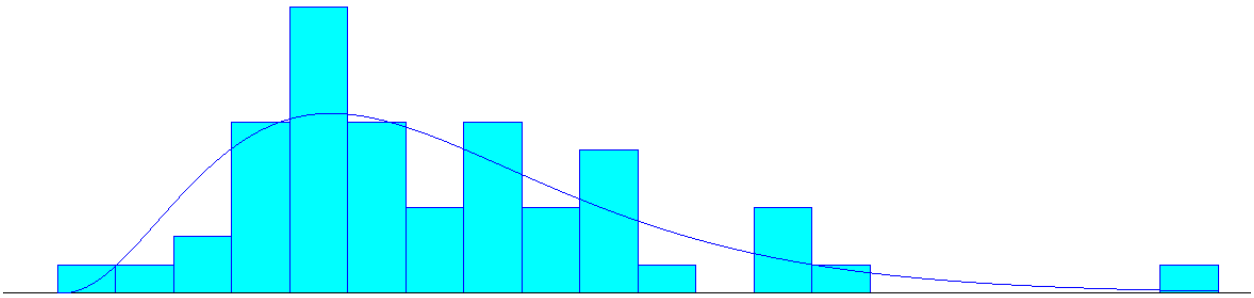


The distribution was obtained by clicking the best fit option under the menu tab.It provided a distribution summary of the data (displayed below) .The distribution was Lognormal (0.142, 0.0598).

```
        Distribution Summary

Distribution:   Lognormal
Expression:     0.01 + LOGN(0.142, 0.0598)
Square Error:   0.010721

Chi Square Test
  Number of intervals   = 3
  Degrees of freedom    = 0
  Test Statistic        = 1.41
  Corresponding p-value < 0.005

Kolmogorov-Smirnov Test
  Test Statistic        = 0.0999
  Corresponding p-value > 0.15

        Data Summary

Number of Data Points   = 49
```

Distribution for food processing time -

The time for processing each order (starting from the time the billing was completed and till the time the customer was served his order) was observed and the data was saved in a text file. The file was saved as a text file and was opened using input analyzer which generated the histogram below.



The distribution was obtained by clicking the best fit option under the menu tab.It provided a distribution summary of the data (displayed below) .The distribution was Gamma (1.91, 3.46).

```
        Distribution Summary

Distribution:   Gamma
Expression:     2.5 + GAMM(1.91, 3.46)
Square Error:   0.017597

Chi Square Test
  Number of intervals   = 8
  Degrees of freedom    = 5
  Test Statistic        = 4.87
  Corresponding p-value = 0.443

        Data Summary

Number of Data Points   = 49
Min Data Value          = 3
Max Data Value          = 22
Sample Mean             = 9.12
Sample Std Dev          = 3.53
```

J.Gumbo's Shop

Model –

The model can be defined according to the steps below -:

1) Entry Point- Customers enter the shop through this point and then proceed towards the billing counter.

2) Billing Counter – Customers order food and beverages at the billing counter and then proceed to the delivery queue.

3) Delivery Counter – The customer receives the order after it is processed.

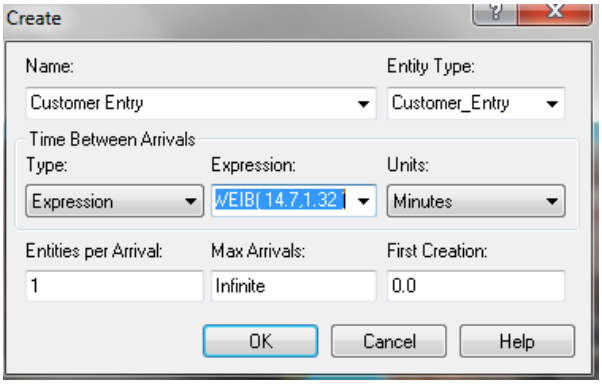
   A snapshot of the model has been shown below -:

Customer Arrival –

The customer arrival time follows a Weibull distribution with alpha (the Shape parameter to the distribution) = 14.7, and beta= 1.32 (The Scale parameter to the distribution).

This has been achieved by using a create module in Arena .It simulates the process of customers entering the system following Weibull (14.7, 1.32)

The snapshot of Customer Entry process is displayed below -:

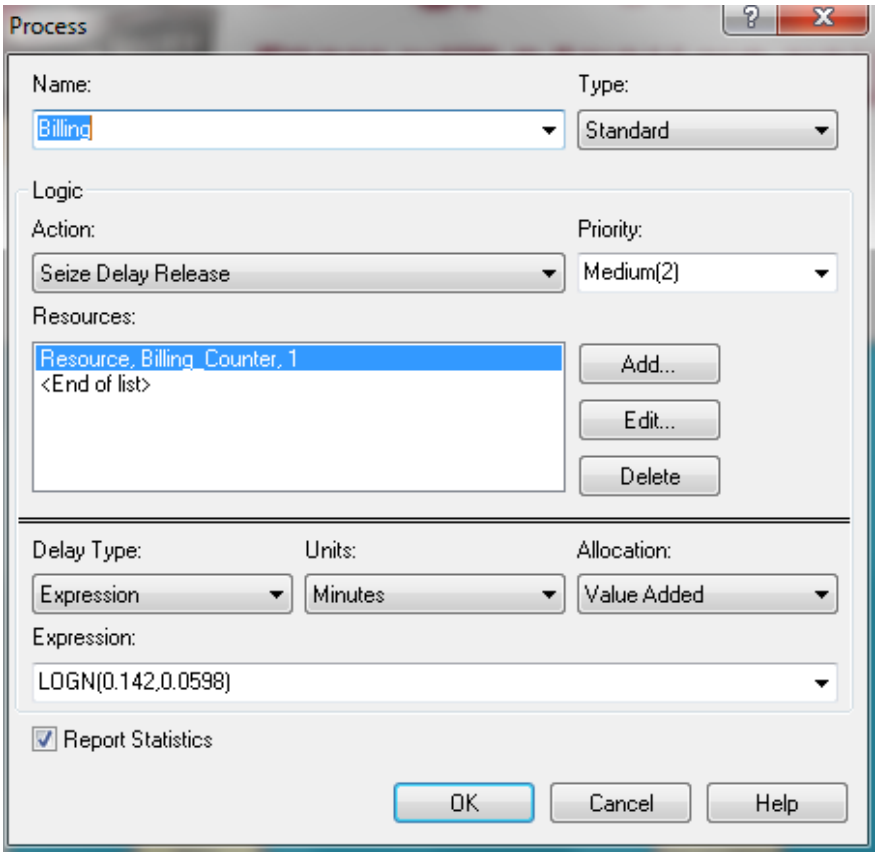


Billing Time-

The billing time (time required to receive the order and complete the payment process) follows a lognormal distribution with mean 0.142 and standard deviation 0.2.

This has been simulated using a process module in Arena .It simulates the process of customers ordering food and making payment.

The snapshot of the Billing process module used in Arena is displayed below -:

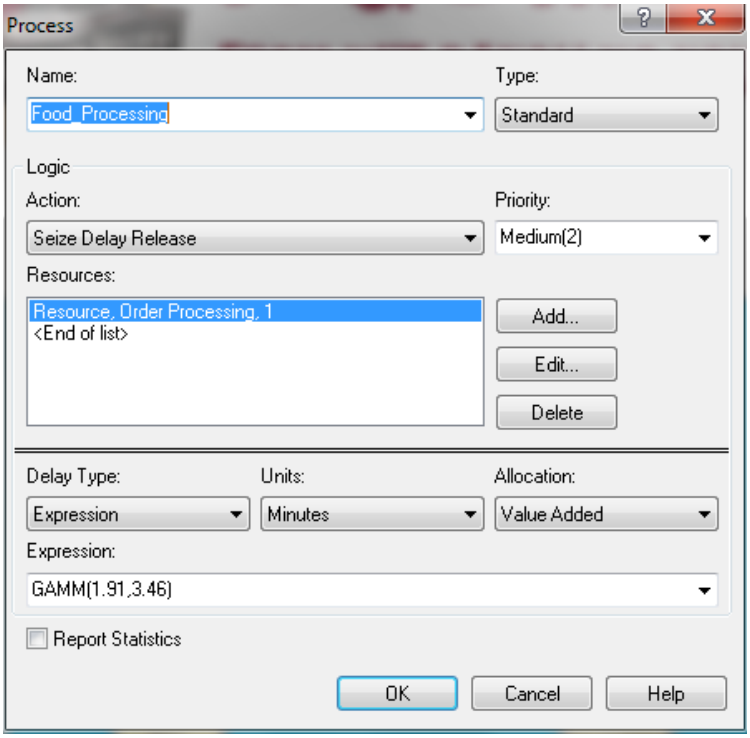


Order Processing Time-

The Order Processing time follows a gamma distribution with alpha (the Shape parameter to the distribution) = 14.7, and beta= 1.32 (The Scale parameter to the distribution).

In this step we simulated the process of customers waiting in the delivery queue for orders to be processed (time required for the food and beverages to be served).

This was achieved in Arena using a process module, which has been displayed below -:



Simulating the model - :

The model was run considering the following -:

Time per day – The shop is open for 17 hours a day .Hence the model was run for 1020 minutes.

Days per week – The shop is opened 7 days a week.

The number of replications was set as 100.

Results

The model was executed for 100 replications and the result was noted.

Total Time in System

The average total time in the system is observed as 9.3307 minutes, while the maximum waiting time (during peak hour) was observed as 60.04 minutes.

Total Time	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
Customer_Entry	9.3307	0.32	6.9454	18.8633	1.0751	60.043

Waiting Time in Queue

The maximum waiting time in queue is 0.15 minutes for the billing queue and 51.44 minutes for the food processing queue.

The maximum number of people waiting in the food queue (order delivery queue) is 7.

Queue

Time

Waiting Time	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
Billing.Queue	0.00018419	0.00	0.00	0.00217491	0.00	0.150
Food_Processing.Queue	2.5141	0.26	0.7046	11.0822	0.00	51.445

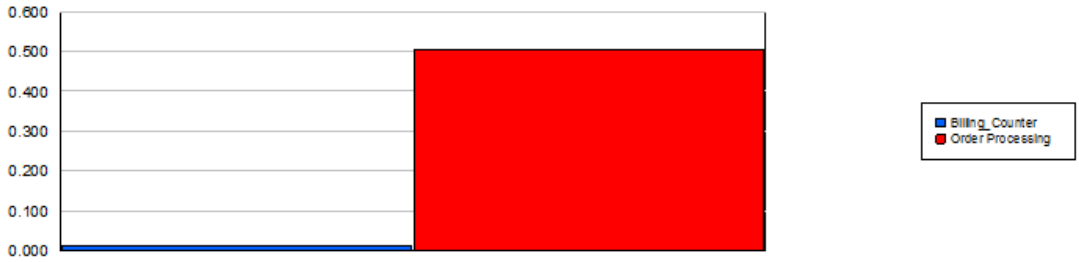
Other

Number Waiting	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
Billing.Queue	0.00001398	0.00	0.00	0.00014713	0.00	1.000
Food_Processing.Queue	0.1936	0.02	0.04904620	0.8366	0.00	7.000

Resource Utilization

The average resource utilization is 10% for the billing counter resource and 50% for the order processing (food delivery) resource. .

Scheduled Utilization	Average	Half Width	Minimum Average	Maximum Average
Billing_Counter	0.01083981	0.00	0.00851158	0.01382815
Order Processing	0.5059	0.01	0.4005	0.6299



Improved Model

An alternate model has been suggested -:

The purpose of this model is to do the following -:

1) Reduce the maximum waiting time in the queue
2) Reduce the total time spent by a customer in the system.
3) Increase the utilization of resource at the billing counter.
4) Reduce customer waiting time during peak hours.

The Model –

In this model, we have proposed the following changes-:

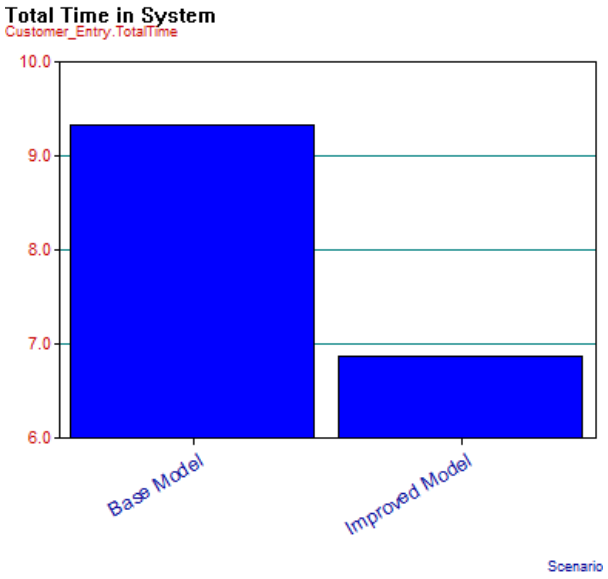
1) Instead of having dedicated resources for billing counter and food delivery counter ,the two resources will share the job load and will be able to process billing requests as well as food requests depending upon there availability, which means if a resource is available he can take up both the billing as well as the food processing request.
2) Also considering that resources work for two 6 hours shift followed by a 5 hour shift, In this model two resources work for first 6 hours shift,3 resources for next 6 hours to handle the peak time customers and 1 resource work for the last 5 hours to handle the relatively lean period.

A snapshot of the model has been represented below -:

Comparison

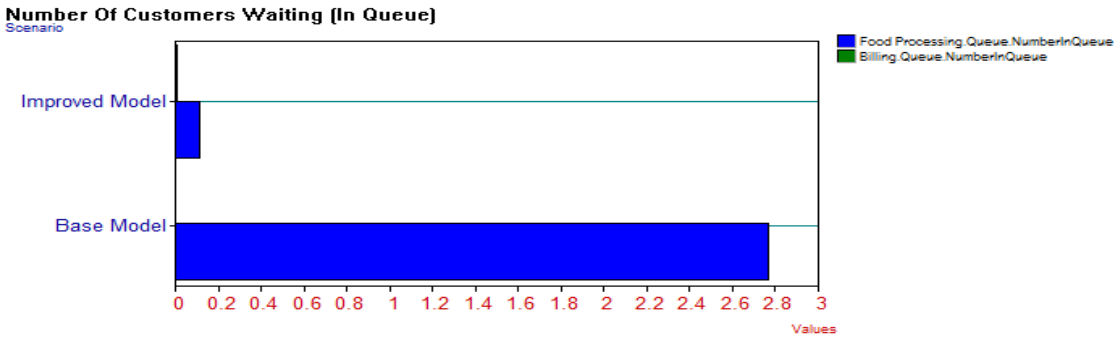
Average total time spent by a customer in the system-

We observe that the average total time spent by a customer in the system is reduced from 9.3 minutes to 6.8 minutes in the improved model.



Number of customers waiting in Queue – The number of customers waiting in queue has decreased from 2.7 to 0.11 for the second billing/food processing counter queue (Food delivery Queue in Base model)

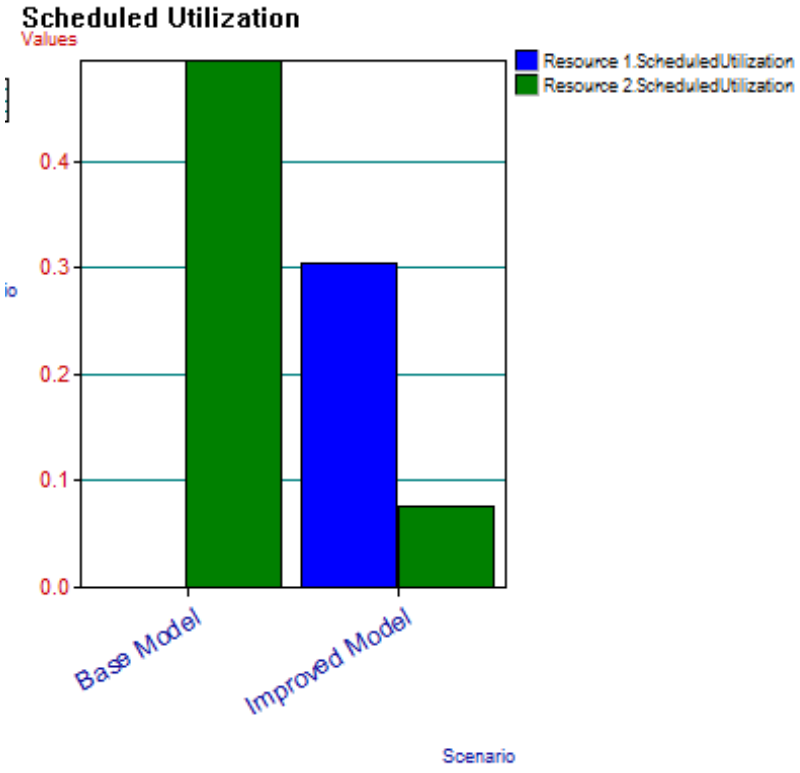
In case of the first billing/ food processing counter of the improved model (billing counter in base model), the number of customers almost remains the same.



Scheduled utilization –

The improved model increases the resource utilization of resource 1 from 0.1 % to 31.5 %.

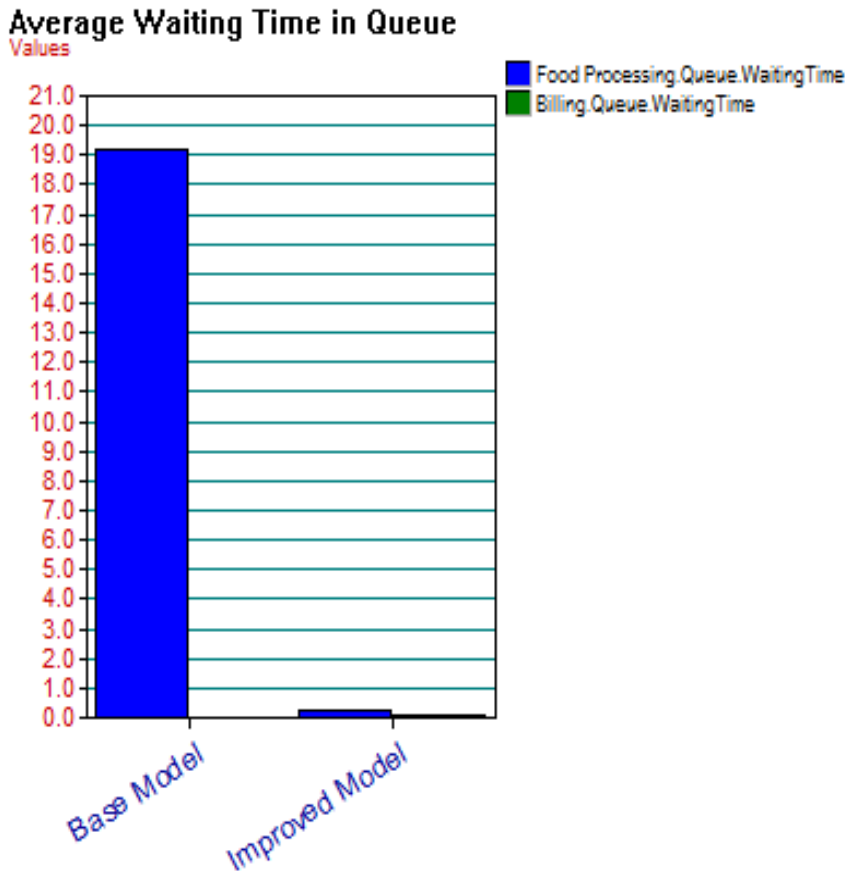
And although the utilization of resource 2 declines still the improved model shows a better balance in distribution of work.



Waiting Time in Queue

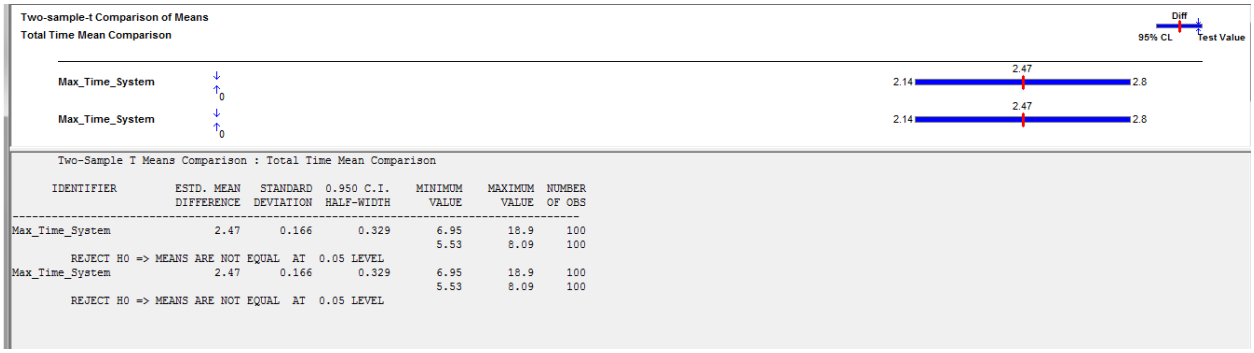
The average waiting in queue has decreased from 19.17 to 0.21 for the second billing/food processing counter queue (Food delivery Queue in Base model)

In case of the first billing/ food processing counter of the improved model (billing counter in base model), the average waiting time almost remains the same.



Statistical Testing

We can also show that the total time spent by an entity in system is reduced by using the two-sample T-test in Output Analyzer.



Two-Sample T Means Comparison : Total Time Mean Comparison

IDENTIFIER	ESTD. MEAN DIFFERENCE	STANDARD DEVIATION	0.950 C.I. HALF-WIDTH	MINIMUM VALUE	MAXIMUM VALUE	NUMBER OF OBS
Max_Time_System	2.47	0.166	0.329	6.95	18.9	100
				5.53	8.09	100
REJECT H0 => MEANS ARE NOT EQUAL AT 0.05 LEVEL						
Max_Time_System	2.47	0.166	0.329	6.95	18.9	100
				5.53	8.09	100
REJECT H0 => MEANS ARE NOT EQUAL AT 0.05 LEVEL						

Conclusion

The current operating model at J Gumbo's was analyzed and an alternative model, which suggested the following improvements were proposed -:

1) It reduces the Average time a customer spends in a system.
2) It increases the resource utilization and also has better load balancing ability.(Workload is distributed more efficiently between resources)
3) Resource planning is done to handle peak phase and lean phase.

REFERENCES

1) Simulation with Arena 5th Edition by W. David Kelton (Author), Randall Sadowski (Author), Nancy Zupick (Author)
2) Images – Flickr.com
3) Report format – Scribd.com