Improving Customer Experiences at Nebu Café

An Oklahoma State University

School of Industrial Engineering and Management

Senior Design Project Report

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Submitted in partial fulfillment of the requirements of the course, IEM 4913, Senior Design and the Baccalaureate degree requirements of the School of Industrial Engineering and Management at Oklahoma State University

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Executive Summary

This report is an investigation into the current processes of Nebu café in order to improve the overall customer experience in the café. The purpose of the investigation was to create solutions for Devon Energy and Nebu café that reduce the total time in the café for the lunch customer, while also maintaining the current level of quality and service. It was requested that these solutions include two different approaches: ideas that involves major construction/renovation and ideas that do not involve major construction/renovation.

To develop an understanding of the current situation at Nebu, the team used data collected from their observations of the café and historical data the café already had. Data collected by observations included inter-arrival rates for customers entering the system, processing times at each station, routes that customers traveled through the café, the number of customers that chose water, and observing any problem areas for the customer. The historical data was collected from Nextep® point-of-sale technology, which is what the café currently uses to capture key information about purchases. This provided historical data dating back to November of 2015.

This raw data was then used to model the café within Simio®, a simulation software that can be used to represent the café's operations, wait times, processing times, and the total time in system for the customer. The simulation was modeled at three traffic levels (1000, 1400, and 1800 customers served during operating lunch hours) to understand the performance and behavior of the café at different levels of demand. The traffic levels were selected from historical data and observations of Nebu. The 1400 customer traffic level is the demand from team originally observed and represents an average busy day. The 1000 customer traffic level was the demand the team observed later in the café due to outside circumstances, this is close to the café demand of March and April 2016. The 1800 customer traffic level is the demand Nebu may reach in the upcoming years. Once the model of the current situation at Nebu was simulated, some of the more notable results and observations included:

- The maximum total customer time in the system was 56 minutes when 1400 customers were processed, and 72 minutes when 1800 customers were processed.
- The average queue at the Deli station was 16 and 31 people in simulation experiments with 1400 and 1800 customers, respectively.
- The Grill station had an average queue of 13 people and a maximum queue of 30 people for experiments simulated with 1800 customers.
- Average and maximum queue lengths at the Deli station were the highest of any station
- The Deli station and the Deli BYO station both exceed 90% station utilization in simulation experiments with 1400 customers.
- The Deli station, Deli BYO station, Grill station, and Sushi station all exceed 90% station utilization in simulation experiments with 1800 customers.

These queue lengths, average station utilization percentages, and total time in the café were deemed unacceptable for workers and the customers, and it was determined that improving the Deli, Deli BYO, and Grill stations should be the priority to improve the overall time in system for the most affected customer.

The team then modified the simulation model of the current system to test and analyze potential improvement strategies for Nebu café. This approach was a noninvasive and inexpensive method to test the improvement ideas, rather than physically implementing and testing the ideas at the café. The improvement ideas were generated based on interviews with experienced professionals familiar with food service improvement projects. With the assistance of the Nebu General Manager, Mark Vannasdall, each idea was investigated to determine if it was feasible and reasonable to recommend for Nebu at this time. The ideas deemed feasible and reasonable for implementation were further investigated, analyzed, and/or tested within the café simulation model.

A compiled final list of proposed recommendations is shown below, which is based on the results of the simulation experiments, further research, and cost estimates of the ideas. The recommendations are numbered, with the lower the number the larger the benefit based on the price for Nebu to implement. The expected benefit and one-year cost to implement is shown below each idea for reference.

Final List Recommendations

1. **Rearrange the number of workers at specific stations**
    - *Expected Benefit:* Reduced Average and Maximum Customer Time in System, Reduced Average and Maximum Queue Lengths for the Deli, Deli BYO, and Grill
    - *Expected Cost:* No cost
2. **Eliminate the line overlap of the Well Bistro and the Grill stations**
    - *Expected Benefit:* Reduced Congestion at the Grill, Improved Visibility of the Grill
    - *Expected Cost:* No cost
3. **Move the fresh juice option to a less busy beverage station**
    - *Expected Benefit:* Reduced Congestion at the Middle Beverage Station
    - *Expected Cost:* No cost
4. **Do not have customers empty their tray at the tray return**
    - *Expected Benefit:* Faster Tray Return Processing Time,
    - *Expected Cost:* $25
5. **Designate clear entrance and exit for tray return areas**
    - *Expected Benefit:* Reduced Congestion, Improved Customer Flow
    - *Expected Cost:* $40
6. **Create Tray Rests at the Beverage Stations with Fountain Drinks**
    - *Expected Benefit:* Faster Beverage Station Processing Time
    - *Expected Cost*: $500
7. **Include paper order forms for customers to fill out in the Deli BYO station line**
    - *Expected Benefit:* Reduced Average and Maximum Customer Time in System, Reduced Average and Maximum Queue Lengths for the Deli BYO station
    - *Expected Cost:* $500

<u>Final List Recommendations</u> (Cont.)

8. **Implement incentive system to control customer arrivals**
   (Only if at least 20% of customers that normally come during the peak hour use it)
   - *Expected Benefit:* Reduced Average and Maximum Customer Time in System, Reduced Average and Maximum Queue Lengths for all stations
   - *Expected Cost:* $720
9. **Add cold premade deli sandwiches and sides to NebuLOCAL station for easy pickup**
   - *Expected Benefit:* Reduced Average and Maximum Customer Time in System, Reduced Average and Maximum Queue Lengths for the Deli and Deli BYO stations
   - *Expected Cost:* $8,000
10. **Create a collective menu and Nebu map besides each entrance**
    - *Expected Benefit:* Reduced Congestion, Reduced Customer Time in System
    - *Expected Cost*: $2,000
11. **Redesign the trays to correctly fit the tray return conveyor and avoid conveyor jams**
    - *Expected Benefit*: Completely Eliminated Tray Return Conveyor Jams
    - *Expected Cost*: $2,000
12. **Dedicate the Entrances and Exits**
    - *Expected Benefit*: Reduced Congestion, Improved Customer Flow
    - *Expected Cost*: $1,350

The team expects that implementing these recommendations will benefit customers by reducing the amount of time spent by customers in the café and by improving navigation of the café by reducing customer congestion, improving signage, and rearranging the café's entrance/exit layout. These benefits will ultimately make eating at the Nebu café for lunch an even more satisfying experience for the customer.

1 Introduction

1.1 Devon and Nebu Café Background

Devon Energy Corporation, founded in 1971, is a leading independent company in the area of natural gas exploration and production. Over the years, Devon has focused its operations in the United States and Canada. Nebu café opened in March 2012 by Devon Energy Corporation and has become a popular eatery for Oklahoma City's downtown workforce. It is open to both Devon employees and the public from 6:30 a.m. to 9:30 a.m. for breakfast and 11:00 a.m. to 1:30 p.m. for lunch on weekdays. Nebu café is operated by Guckenheimer Services, LLC and is named after Devon Energy Corporation's first large drilling project Northeast Blanco Unit (NEBU).

Nebu café currently has 12 service stations, which offer food, beverage, and checkout service. Focusing on fresh, safe, and healthy foods, Nebu café offers a wide range of options to satisfy the desires of a variety of customers. The café was built to be aesthetically pleasing and functional for the customer, but Nebu has been experiencing more customer traffic during the lunch periods than originally planned. This has led to customer experience issues, primarily due to lengthy queues and difficulty navigating the café. Nebu café is also expected to have an increase in customers in the future due to the completion of a neighboring office building built without lunch options. This increase means that customer experience issues will continue to grow unless action is taken.

Nebu has recently begun using point of sale technology from Nextep® at the cash registers to collect point of sale data. This data includes how long the checkout process takes, the volume of sales by menu item, and sales by customer. Improvement strategies the café has implemented are to have both made-to-order items and pre-made items available at certain stations and to cross-train the majority of their food service staff to be able to work at any station. Even with these improvements, customer experience issues are still apparent and management has requested the services of a senior design team at Oklahoma State to observe the system and develop recommendations to improve the overall dining experience at Nebu.

1.2 Problem Statement

Nebu management has received customer complaints due to the time it takes customers to enter the café, navigate the food stations, obtain food, checkout, and leave. The project was to observe, model, and analyze the current system during the café lunch hours to find ways to reduce the total time in the café for the lunch customer, while maintaining the current level of quality and service. The team investigated whether reducing the average and/or the variance of the total time in system would best resolve the issue. The scope of the problem included customers entering the system, the selection of a food station, queueing in front of the station, obtaining food/beverages/tableware, checking out at the cash register, exiting the checkout line, and returning their tableware. Total time in system was defined as the duration from when the customer enters the café, until they checkout at the cash register. The tray return process was studied separately and was not included in the total time. This is because the tray return occurs outside the café itself, after the customer has sat down and eaten their food. Based on the observations and collected data, the team investigated and identified:

1. Process improvements to reduce the time to gather information to make a food purchase decision, find/locate the desired station, obtain the desired food and/or beverage, and pay at the cashier.
2. Changes to the current layout that do not require additional labor or construction costs that can potentially reduce wait-times at bottleneck stations.
3. Unrestricted changes to the current layout that can potentially reduce wait-times at bottleneck stations.

1.3 Current Situation

1.3.1 Current Layout

Nebu café is on the first floor of the Devon Energy Tower. The café has three different entrances that also serve as exits. The dining tables are located outside the café in two areas, the Main Dining area and the Concourse. Figure 1 shows the layout of Nebu café and the two dining areas. The top right region outlined in red is the Café, the top left region outlined in yellow is the Main Dining area, and the bottom region outlined in blue is the Concourse. Within the café region, the three entrances are as follows: two entrances/exits on the bottom of the region and the third entrance/exit on the left side of the region. Figure 1 also shows the open area, food counters, and the kitchen in the Café region.

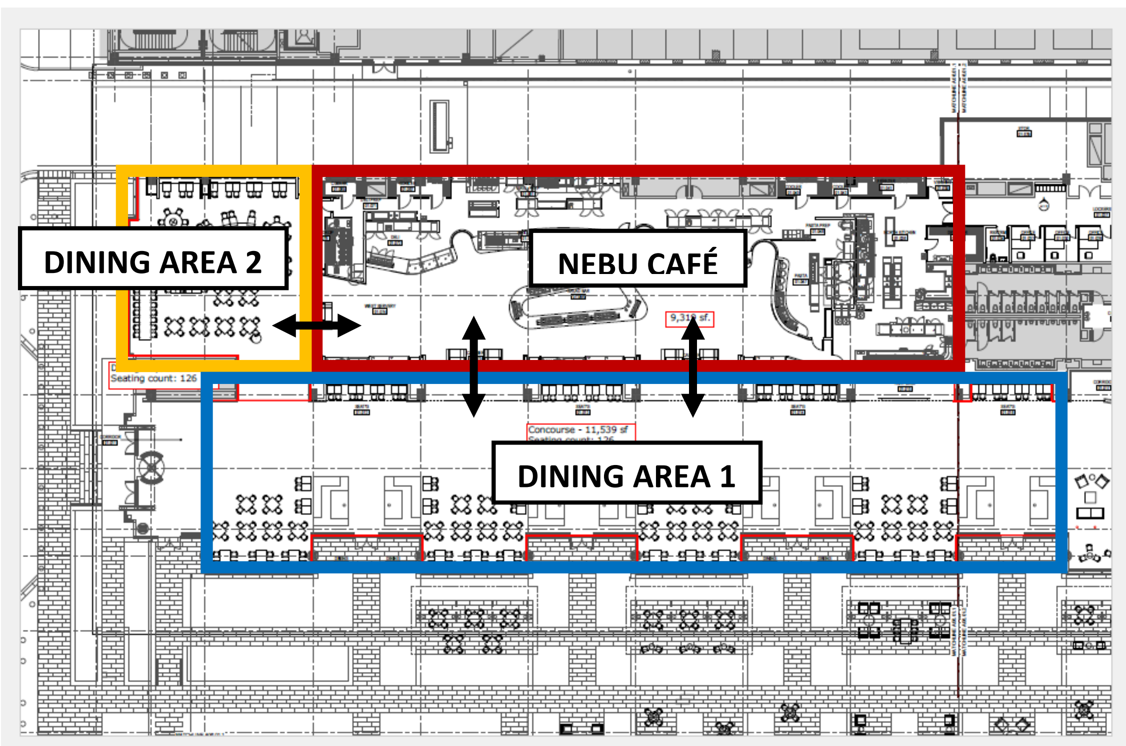


Figure 1: Nebu Café Floor Plan

Figure 2 is a simplified layout of Nebu café, which shows positions of the 12 different stations. As mentioned in Section 1, these 12 stations consist of 9 main food stations, 2 beverage stations, and 1 dessert station. During breakfast and lunch hours, customers come into Nebu café through the three entrances. One of the entrances is between station 11 and 12, one is between station 1 and 12, and the other is between the two station 11s (since one drink station is split between two locations, they are both marked 11 in the picture). Nebu café is most popular during lunch hours with an average of 1100 customers per day during lunch based on an analysis of sales from November to February.

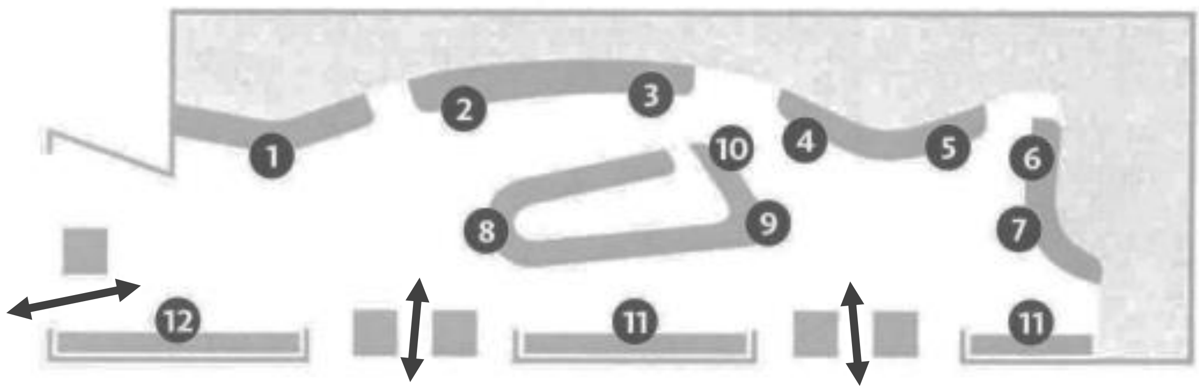


Figure 2: Simplified Layout of Nebu café Floorplan

1. Deli
2. Grill
3. Well Bistro
4. Asian Exhibition
5. Global Exhibition
6. Pizza
7. Taqueria
8. Health Bar and Soup
9. Sushi
10. Desserts
11. Beverages
12. NebuLOCAL

1.3.2 Current Constraints

Devon expressed a desire for two types of approaches to the project. One approach was to consider all options that would not involve major construction/renovation constraints while the other approach would include options considering construction/renovation. The stations that cannot be relocated without major construction are the pizza station, because of the pizza ovens nearby, and the grill station, because of the grill hood. Every other station can be relocated and is a possibility when considering arrangement options without major construction/renovation.

2 Anticipated Benefits

The project aims to create a better customer experience that will provide:

- A streamlined food buying process that reduces the amount of time spent by customers in the café selecting, obtaining, and paying for their food.
- Simpler navigation of the café by potentially reducing the distance traveled by customers, reducing customer congestion, improving signage, and/or rearranging the café layout.

3 Project Methodology

As the project commenced, both parties approved the following methodology– see Appendix A for the original proposal, and Appendix B for a detailed project schedule.

Phase I: Current Situation

- Understand the scope and constraints of Nebu's current situation by communicating with the client and observing the café during regular lunch hours.
- Collect the café layout blueprints and historical data from the Nextep® software, which includes the number of transactions, number of sales, how much of each item sold, and the checkout time.
- Create data collection plan to record data for later analysis, such as arrival rates, processing times at each station, queue lengths, customer's flow through the café, etc. through time observations.
- Perform data collection as planned.
- Distribute and collect Customer Surveys via email to Devon employees to assess current level of customer satisfaction and behavioral patterns relating to Nebu.
- Compile, organize, and analyze the collected data from historical information, observations, and customer surveys.

Phase II: Model the Current System

- Create an as-is flowchart of common customer paths through the café.
- Analyze raw data and design a representative model to develop and analyze the current system.
- Analyze the model. Analysis may include queueing analysis, simulation modeling, or other operations research techniques.

Phase III: Test and verify the analysis model of the current system

- Confirm accuracy of the analysis model using testing against observations.
- Make necessary adjustments, validate, and confirm model use with the client.
- Arrange and have a mid-project progress meeting with Devon.

Phase IV: Create process improvement ideas and test analysis model of an improved system

- Assess potential improvement ideas using quantitative metrics e.g., total distance traveled, time in system, station processes, and improving signage.
- Create alternative café layouts considering constraints.
- Create alternative café layouts without considering constraints.
- Seek to identify the best layout with facility layout software and historical data.
- Identify the most effective layout and improvement ideas based on the client's desired criteria for a more enjoyable experience for the customer.

Phase V: Finalize and implement recommendations

- Develop and submit a report including all findings and recommendations.
- Prepare and deliver a project presentation including all findings and recommendations.

3.1 Project Methodology Changes

As the project evolved, changes needed to be made to the methodology, as listed below.

Changes to Phase I: Current Situation

- Customer Surveys were not an option so the current level of customer satisfaction was assessed through communication with the Devon employees related to the project. Customer behavioral patterns information was collected through observations of the café.

Changes to Phase II: Model the Current System

- An As-Is flowchart would not be very helpful to model the café due to the variability and large variety in where customers can go. Instead, a Customer Flow Map was developed with information of what percentages of customers go to what station and in what order.
- The Analysis Method chosen was a simulation model. A simulation model allowed the team to calculate the time in system for the average customer and collect data in a highly variable environment.

Changes to Phase III: Test and verify the analysis model of the current system

- A mid-project progress meeting was not made with Devon due to the frequent communication with Nebu General Manager, Mark Vannasdall, and the IAB mentor, Cara Noltensmeyer.

Changes to Phase IV: Create process improvement ideas and test analysis model of an improved system

- Facility layout software was not used to identify the strength of alternatives due to the problem not being heavily related to facility layout. Nebu is also currently undergoing facility layout design changes that the team has not be provided the details for, so all facility layout recommendations in this report are based on the original layout observed.

Changes to Phase V: Finalize and implement recommendations

- No changes to the original methodology were made. The project did not allow for enough time to have time the team implement their recommendation ideas so a detailed design of each idea was provided in the report.

4 Data Collection and Analysis

4.1 Consultation with Field Experts

The team interviewed experienced professionals familiar with food service improvement projects. In addition to interactions with Nebu and Devon employees, the team interviewed three individuals for further insight. One of the contacts was Mr. Allen Glenn, a management consultant at Impact Management Consulting, LLC in Stillwater. Mr. Glenn has consulting experience with Barnes and Noble's cafés, along with others. The other contact was Ms. Heidi Hoart, a clinical faculty/hospitality technology professor working in the Hotel and Restaurant Administration department at Oklahoma State University who teaches courses relevant to our project like basic hotel and restaurant administration, hospitality information technology, and hospitality management. She is familiar with

Nebu café and provided her professional insight on the current operations and conditions of the restaurant. The last interview was with Ms. Terry Baker, the University Dining Services Director. Ms. Baker is in charge of the Oklahoma State Student Union Dining Services, which is similar in its operations to Nebu café, and has a very large rush during lunch hours. Her insight allowed us to learn from a larger cafeteria than Nebu to understand how they ensure customer satisfaction.

4.2 Data Collection - Current Situation

The team collected data using two different methods. The first method used was observations of customer arrival times and processing times for each station. Each station includes multiple items the customer can order, so the processing time data at each station was a collection of the processing times for the various menu items available for the respective station. To track customer paths through the café, the team observed more than 50 customers, recorded where they went and in what sequence they navigated in the system. The second data source was the historical data the café already had. The point-of-sale technology from Nextep® has been collecting data since its implementation in early November of 2015. Figure 3 shows a screenshot of Nextep®'s myReports display. The relevant information from Nextep® included the percentages of items sold by category/station, the transaction details per person, and the items sold by the hour. These three reports helped quantify the café operations. It helped identify the decisions by customers for use in simulation modeling by providing the percentage of people expected to acquire an item from a specific station. The reports also allowed an understanding of common customer behaviors and food/beverage preferences.

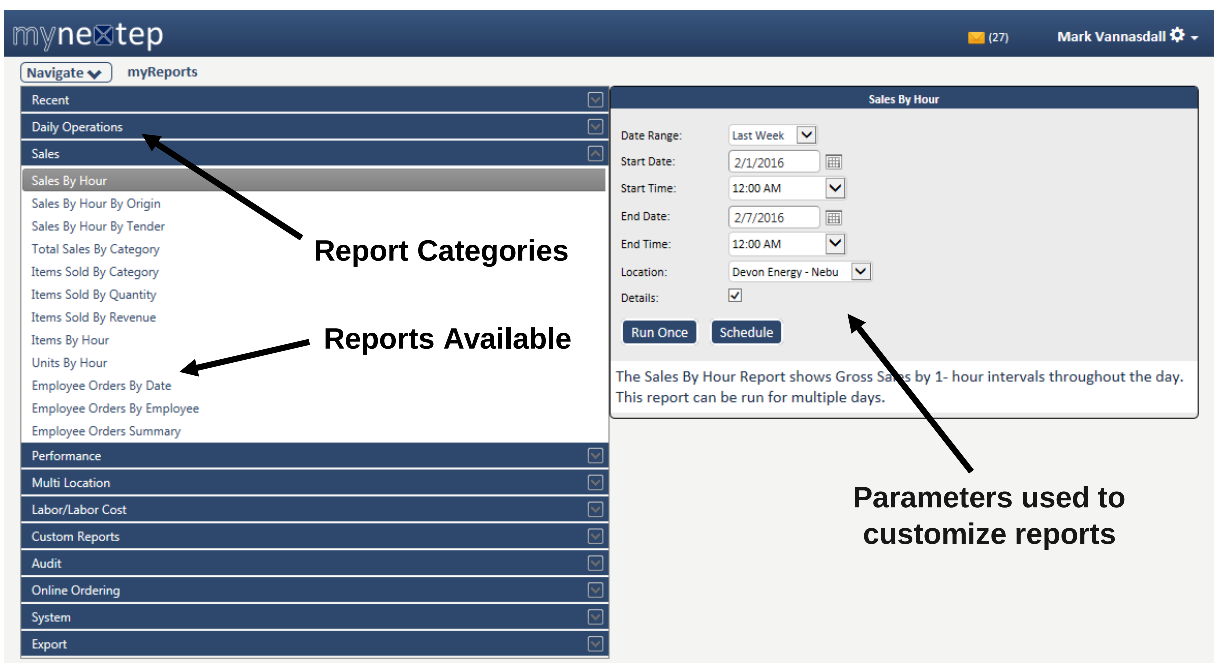


Figure 3: Screenshot of the "myReports" page of Nextep®'s interface

4.3 Raw Data Compilation and Organization

4.3.1 Observed Data

The team observed and recorded the arrival times of customers during lunch hours at each entrance of the café. The team also recorded the processing time of each station. The processing time is defined as the time it takes for a customer to get their food after they place an order. With arrival times collected at each entrance, the team was able to model inter-arrival times of customers.

The team observed and tallied the number of customers that came into the café from each of the three entrances and recorded the time at which they entered. Before the time observations, the team searched online and found a VBA code [1] that recorded the exact time information was input into a cell. During the observation, the three team members observed the arrivals of customers at the three different entrances and recorded the arrival times of customers continuously coming into the café by inputting information into a cell at the precise time the customer arrived. At the end of the observation, the team obtained three sheets of the arrival time for each customer from those three entrances. The difference between two consecutive customer arrival times was calculated to provide the inter-arrival time of customers at each entrance.

The team used a box-whisker plot to organize the inter-arrival time data. The time between each arrival was converted into seconds for consistency. The plot is shown below in Figure 4. In the figure, the variability of each data-set has been illustrated by its minimum, first quartile, median, third quartile, and maximum value. From the box-whisker plot it is clear that the smallest median customer inter-arrival time is from Entrance 1. Entrance 1 is closest to the Devon Tower main lobby. Entrance 2 is in the middle entrance of the café and has the highest median inter-arrival time. Entrance 3 connects the Dining Area 2 with Nebu café. The median inter-arrival time at this entrance is greater than Entrance 1 but less than Entrance 2. Comparing the three median inter-arrival times, the majority of customers (91% observed) arrived from Entrance 1 with very little time between arrivals.

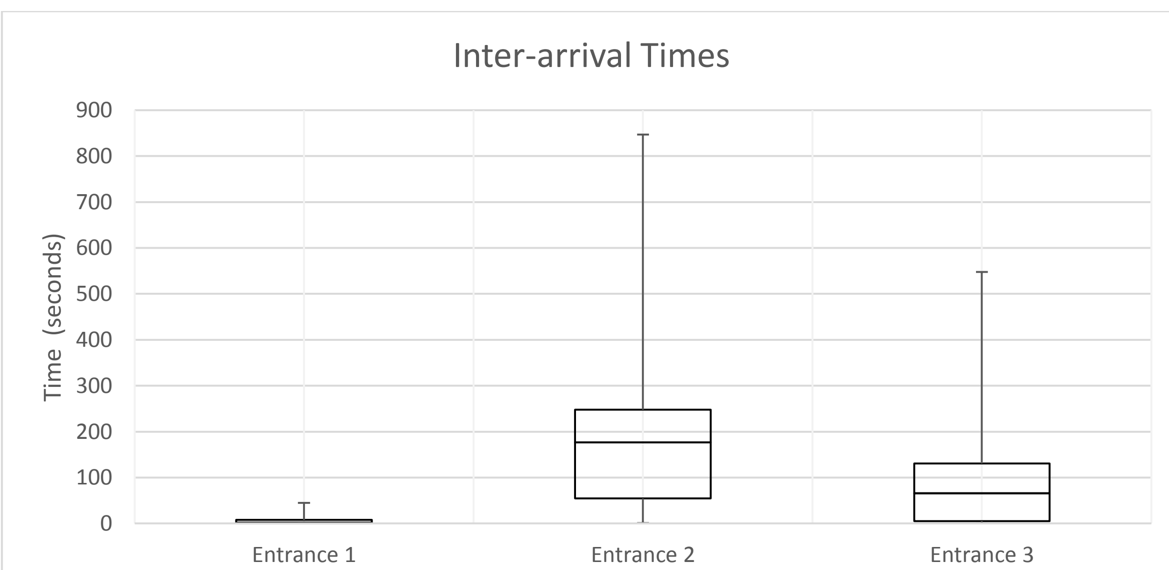


Figure 4: Entrance Inter-arrival Times, Box-Whisker Plot

The processing times at each station were collected using a similar method that was used to find the arrival times of customers. The team observed every station individually, and whenever a customer placed an order information was input into a spreadsheet to mark the start of the processing time. When a customer obtained their food and left the station, the time was entered into the same spreadsheet and used to mark the end of the processing time. After the data collection, the team had the order time and the exit time of every customer that attended the station during the observation period. To find the processing time duration, the team found the time (in seconds) between when the customer ordered to when the customer exited.

The box-whisker plot in Figure 5 is used to visualize the processing time data. In the figure, the variability of each data set has been displayed by its minimum, first quartile, median, third quartile, and maximum value. The Health Bar and Soup, Drink, and Pizza stations were self-serve stations while the others shown were not. These three stations are unique in their processing times because the processing time solely depends on the customer while the other stations' processing times depends on a server.

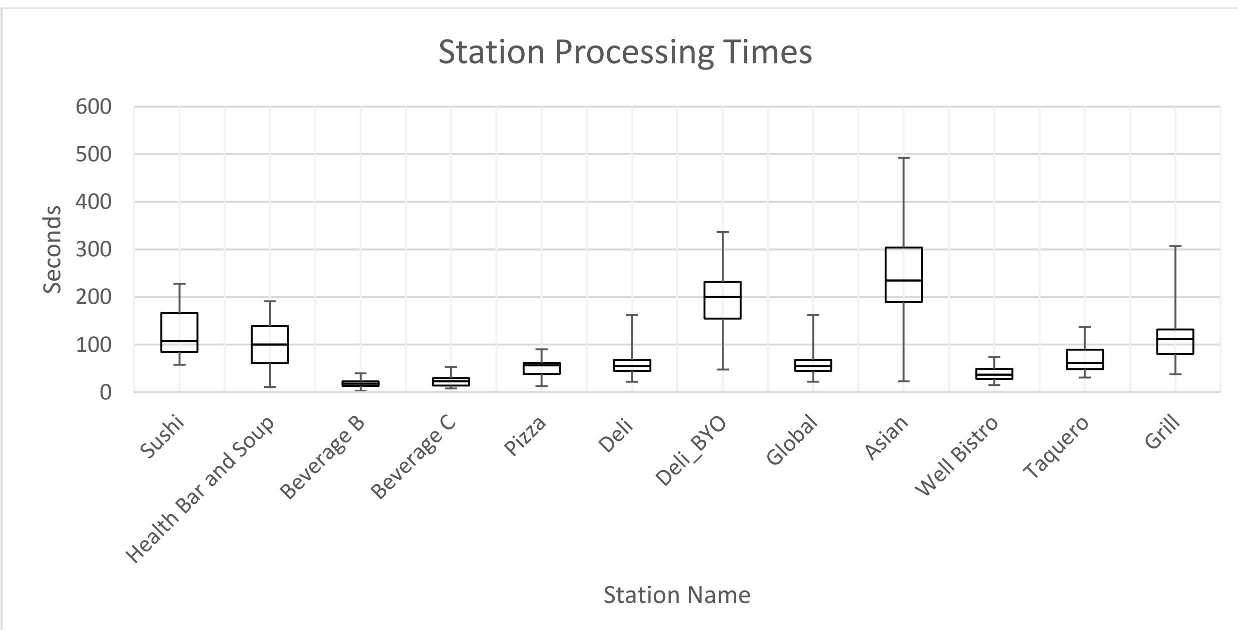


Figure 5: Station Processing Times, Box-Wisker Plot

The team also found the average customer's flow path within the café and identified customer patterns. The team observed 81 customers to create a flow path of the café. The customer flow data was collected in a matrix and is shown in Appendix C. A "1" is shown for the station the customer visited first after entering, a "2" for the station they visited second, a "3" for the station they visited third, and so forth. During analysis of the data, the team sorted the data by clustering all records with the same station visited first, second, and so on. The sorted matrix helped the team see customer flow paths in the café.

From the flow matrix, the team created the Customer Flow Map, shown in Figure 6. The flow map shows what percentage of customers went to every station at what time. The top percentage (shown in BLUE) is the percentage of customers that went to that station first upon entering the café. The middle percentage (shown in RED) is the percentage of customers that went to the following station second. The bottom percentage at each station (shown in GREEN) is the percentage of customers that went to the following station third, after already having visited two stations previously. The matrix with the collected customer flow data showed that the majority of customers visited only one station and did not get a drink before checking out. Only 2.5% of the customers observed went to two food stations and the second station was the Health Bar and Soup station. Close to 37% of customers obtained a drink after receiving their food during the observation period. Two customers observed went to one beverage station and then another beverage station.

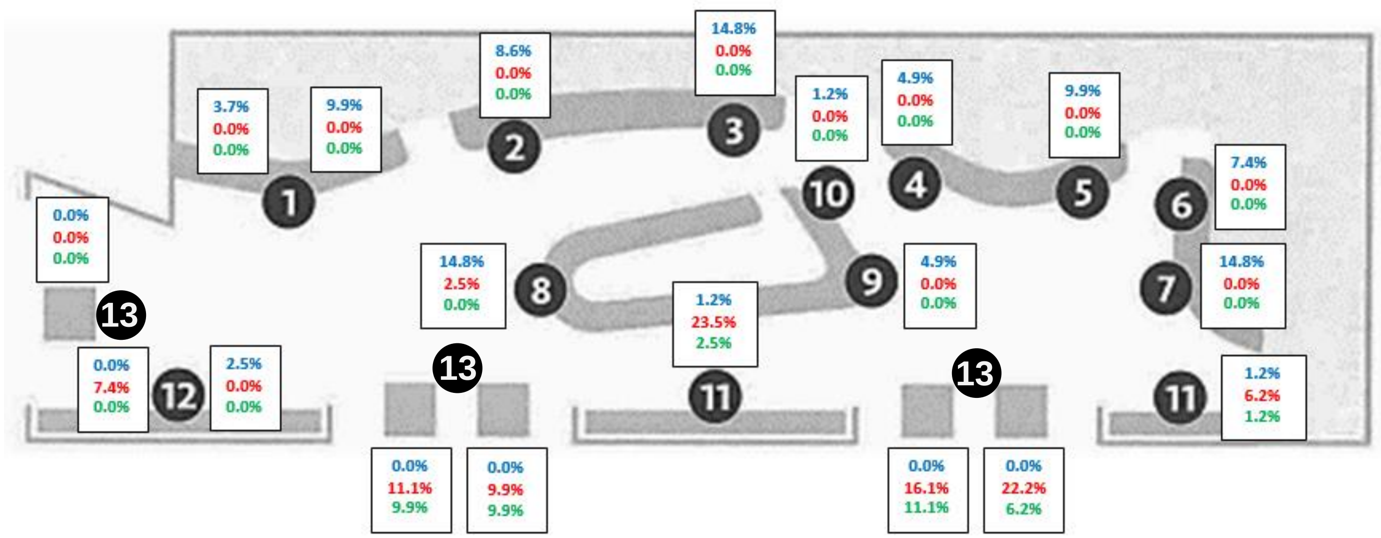


Figure 6: Customer Flow Map

1. Deli
2. Grill
3. Well Bistro
4. Asian Exhibition
5. Global Exhibition
6. Pizza
7. Taqueria
8. Health Bar and Soup
9. Sushi
10. Desserts
11. Beverages
12. NebuLOCAL
13. Cash Registers

4.3.2 Nextep® Historical Data Compilation

The percentages of items sold by category/station information was found from the Nextep® report "Items Sold by Category." This report includes the number of items and sales amount in dollars of every item, organized by the stations from which the items came. A file was exported which including all sales data from 10/1/2015 to 1/31/2016. The Nextep® system was not implemented until November so exporting a file with all the information from October to January includes everything stored in the system since its inception until the end of January. This file was then edited to only include lunch items, correct input errors, and consolidate similar food items (a list of the input errors in Nextep® and the consolidated food items is shown in Appendix D. The data was then rearranged in an appropriate table and pivot table. The pivot table separates the number of items sold and sales by station. The pivot table also provides detail within each station of how many of a specific item was sold compared to the other items sold at the same station.

During a discussion of the data with Nebu General Manager, Mark Vannasdall, the data regarding the Global station was found to be incorrect. Figure 7 shows the pivot table before revisions were made.

Row Labels	Sum of # ITEMS	% of # Items	Sum of SALES	% of Sales
⊞ **HealthBar**	**10929**	**21.22%**	**68044.26**	**18.80%**
⊞ **Bistro**	**10602**	**20.58%**	**94651.75**	**26.15%**
⊞ **Grill**	**6402**	**12.43%**	**40295.1**	**11.13%**
⊞ **Deli**	**5487**	**10.65%**	**43467.75**	**12.01%**
⊟ **Global**	**4809**	**9.34%**	**39197.15**	**10.83%**
1 Meat BBQ	350	7.28%	2712.5	6.92%
2 Meat BBQ	448	9.32%	4032	10.29%
3 Meat BBQ	85	1.77%	845.75	2.16%
BBQ Side	9	0.19%	26.55	0.07%
Egg Roll	251	5.22%	313.75	0.80%
Fried Rice	48	1.00%	141.6	0.36%
Global	343	7.13%	3259.5	8.32%
Global - Well	1368	28.45%	12996.5	33.16%
Potsticker	65	1.35%	81.25	0.21%
Stir Fry Well	663	13.79%	5469.75	13.95%
TAQ Spec Red	437	9.09%	3277.5	8.36%
TAQ Spec Well	701	14.58%	5733	14.63%
TAQ Spec Yellow	41	0.85%	307.5	0.78%
⊞ **Soup**	**3774**	**7.33%**	**12882**	**3.56%**
⊞ **Pizza**	**2869**	**5.57%**	**13883**	**3.84%**
⊞ **Taqueria**	**2602**	**5.05%**	**15860.85**	**4.38%**
⊞ **Sushi**	**2056**	**3.99%**	**21659.5**	**5.98%**
⊞ **Asian**	**1104**	**2.14%**	**10413**	**2.88%**
⊞ **Dessert**	**880**	**1.71%**	**1555.8**	**0.43%**
Grand Total	**51514**	**100.00%**	**361910.16**	**100.00%**

Figure 7: Items Sold by Category Pivot Table, before Revision

The Global station including items like “TAQ Spec Well”, “TAQ Spec Red”, and “TAQ Spec Yellow” that should be categorized in the Taqueria station. Global station items like “Stir Fry Well”, “Egg Roll”, “Fried Rice”, and “Potsticker” were also incorrectly categorized and should be included under the Asian station. Figure 8 includes the global station corrections and provides an accurate percentage of items sold for each station.

Row Labels	Sum of # ITEMS	% of # Items	Sum of SALES	% of Sales
⊞HealthBar	**10929**	**21.22%**	**68044.26**	**18.80%**
⊞Bistro	**10602**	**20.58%**	**94651.75**	**26.15%**
⊞Grill	**6402**	**12.43%**	**40295.1**	**11.13%**
⊞Deli	**5487**	**10.65%**	**43467.75**	**12.01%**
⊞Taqueria	**3781**	**7.34%**	**25178.85**	**6.96%**
⊞Soup	**3774**	**7.33%**	**12882**	**3.56%**
⊞Pizza	**2869**	**5.57%**	**13883**	**3.84%**
⊟Global	**2603**	**5.05%**	**23872.8**	**6.60%**
1 Meat BBQ	350	13.45%	2712.5	11.36%
2 Meat BBQ	448	17.21%	4032	16.89%
3 Meat BBQ	85	3.27%	845.75	3.54%
BBQ Side	9	0.35%	26.55	0.11%
Global	343	13.18%	3259.5	13.65%
Global - Well	1368	52.55%	12996.5	54.44%
⊞Asian	**2131**	**4.14%**	**16419.35**	**4.54%**
⊞Sushi	**2056**	**3.99%**	**21659.5**	**5.98%**
⊞Dessert	**880**	**1.71%**	**1555.8**	**0.43%**
Grand Total	**51514**	**100.00%**	**361910.16**	**100.00%**

Figure 8: Items Sold by Category Pivot Table after Revision

To find the percentage of customers that obtain a beverage the team used the same “Items Sold by Category” report from Nextep®. Using all the sales data from 10/1/2015 to 1/31/2016 the team was able to know how many drinks were sold. Assuming that a negligible percentage of customers obtain a beverage and not food, the team divided the total number of beverages sold in the time period by the total number of food items sold. There were 16,820 Beverages sold with 51,514 food items sold. This meant that almost 33% of customers bought a drink. After further evaluation of the Nextep® report, the team discovered that water cups were not included in this total. Customers who get water cups still arrive at the drink station, fill up a cup and then head to the register. The beverage information is needed to understand the traffic at the drink station so the water cup data that was missing was crucial. The team observed 85 customers exiting Nebu café and took a tally of how many had a cup of water. Out of the 85 customers observed, 38 customers or 44.71% had a cup of water. This water percentage was added to how many customers bought a drink to find the total number of customers that stopped at the drink station. This total came out to 77.36% of people obtained a paid or free beverage from the drink stations.

The percent utilization of each of the cash register stations was found in the Nextep® "Transaction Detail" report. This report broke down each purchase made, including information such as the date and time of the purchase, the total transaction time, the register where the transaction occurred, and the method of payment.

4.4 Analysis of Raw Time Data

4.4.1 Observed Data

The team compared the processing times of the different food stations. From the comparison, the team found that customers were processed quickly at several stations, such as the Well Bistro, but at other stations' processing times were relatively slow. For self-serving stations, variability of processing time might be large because of customers' preferences and the ability to choose any combination from a large number of options. For stations with servers, variability in the processing times could be large because of special circumstances such as dietary restrictions, substitutions, or other customized orders. Standard cooking practices are used for nearly every station, which helped keep the overall variability of each station low.

The team analyzed the raw data collected in ExpertFit® to find the inter-arrival and processing time distributions to be used in a simulation model to represent the Nebu café's operations. ExpertFit® is a probability distribution fitting software that provides a detailed analysis of the data which is further discussed in Section 5.1.1.

4.4.2 Nextep® Historical Data Analysis

The team used the data from the "Items Sold by Category" report and the "Items Sold by Category Pivot Table after Revision" to understand the current operations of the café. The report provided the team with the percentages of food that was sold from a particular station. Figure 9 organizes this information into a pie chart of every station's item sales percentage excluding the beverage station. This information was used to understand how much traffic each station received and what percentage of customers go to what station when they enter the café. The beverage station percentage was not included in this figure because the team made the assumption that customers get their food first and then their beverage, so only the stations that the customer would first visit were included.

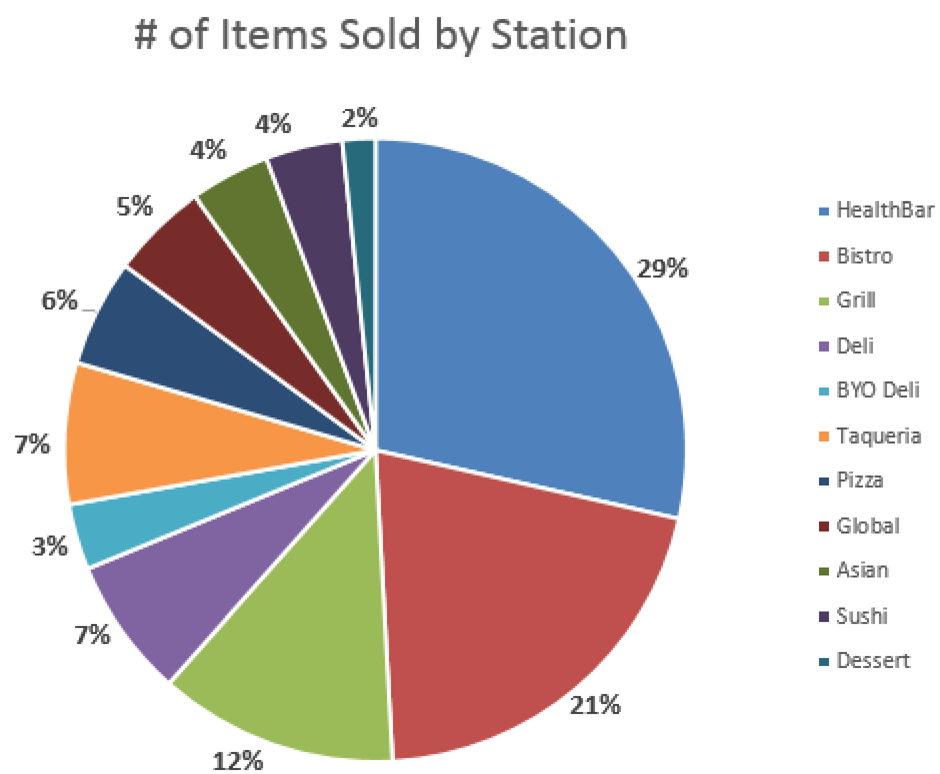


Figure 9: Percentage of Items Sold by Station

The team used data from the "Transaction Detail" report to develop a better understanding of how customers use the exits within the café. The report provided transaction time, processing time of each transaction, and identified which register each transaction occurred at. The total transaction time was used to create empirical distributions for the customer processing times at each cash register within the model. The transaction location was used to find the percentage of customers that use each register, and organized into a pie chart shown in Figure 10. Purchases can occur at five different locations named Register 1 through Register 5. This information helped the team develop an understanding of the traffic at each register. The reason the percentage at Register 5 is so low is because it is an overflow register that is only open on an "as needed" basis when traffic in the café is very high. Register 1 and 2 are at Exit 2, Register 3 and 4 are at Exit 2, and Register 5 is at Exit 3. Because of the registers positioning at the three exits, it is reasonable to assume that these percentages can also be used to explain the percentage of customers that use each exit. Combining the registers percentages shows that approximately 62% of customers use Exit 1, 34% use Exit 2, and 1% use Exit 3.

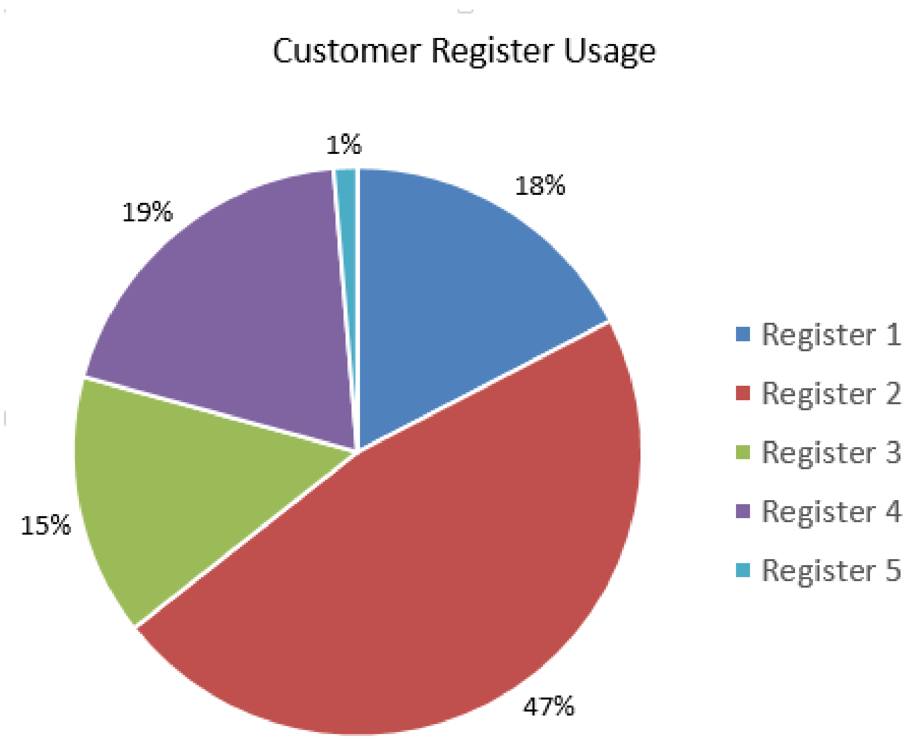


Figure 10: Percentage of the Customer Register Usage

5 Modeling the Current System

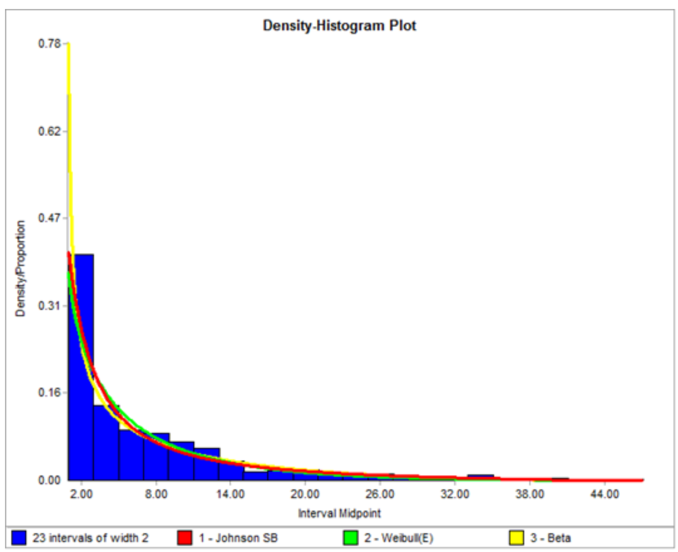
In order to better understand the current situation at the café, the team chose to develop a computer simulation model using Simio® software. A simulation model can be used to faithfully represent the café's operations, wait times, processing times, and the total time in system for the customer. The model uses the data collected by the team to virtually show how the café performs and behaves over a period of time. Possible changes can then be applied to this model to determine their impact. The team used a simulation model instead of an analytical model because of the complexity of the system under consideration. Moreover, a simulation model can use either a parametric or an empirical distribution of the data, which can provide an accurate model of the current system. The simulation model also allows the analysis of potential solutions in a way that is noninvasive and inexpensive. Because this percentage is so low, the team will assume that the majority of customers only obtain food from one station before obtaining a drink or checking out.

5.1 Input Data Analysis

The first step in the creation of the simulation model was to prepare the data the team collected for use in the simulation model. The team utilized ExpertFit® to analyze the collected data and determine the best distribution, whether empirical or theoretical, for the inter-arrival time of customers and every station's processing times.

In ExpertFit®, the team input all the collected data and observed the Data Summary. Then, the team used the Automated Fitting Models option, along with adding in the normal distribution, to compare the top distributions fits found by the software. The ExpertFit® distribution methodology and analysis for each inter-arrival time and each station's processing time is described in Appendix E. For each station and entrance, the top three distributions were compared graphically in a Density-Histogram Plot. All three distributions were assessed for how well they represented the actual situation at the café. After selecting the top distribution based on fit and industry use, it was tested using two Goodness-of-Fit Tests. The Kolmogorov-Smirnov Test and the Chi-Square Test were applied to the distribution to see if it was accepted to the alpha = 0.25 level of significance.   All the plots and tables are shown in Appendix F.

After careful analysis of all the distributions, the team decided to use empirical distributions to model the entrance inter-arrival times and the stations' processing times in the simulation model instead of using the parametric distributions. The empirical distribution was the best choice to use for various reasons. The inter-arrival data for Entrance A was compared to various parametric distributions and did not pass the Chi-square or Kolmogorov-Smirnov (K-S) test, which is shown in Figure 11. The inter-arrival time for Entrance A could not be accurately fitted to a parametric distribution and all the entrances needed to be modeled consistently so using an empirical distribution was the best choice for the inter-arrival times.



Kolmogorov-Smirnov Test with Model 1 - Johnson SB

Sample size 537
Normal test statistic 0.17735
Modified test statistic 4.10979

Note: No critical values exist for this special case. The following critical values are for the case where all parameters are known, and are conservative.

	Critical Values for Level of Significance (alpha)				
Sample Size	0.150	0.100	0.050	0.025	0.010
537	1.132	1.217	1.351	1.472	1.619
Reject?	Yes				

Figure 11: Density-Histogram Plot and K-S Test for Entrance A

Another reason the team used the empirical distributions comes from how the team collected processing times. The team observed the processing times of each station instead of each menu item specifically which varies from customer to customer. Because each station offers various items with varying processing times, a parametric distribution to model the entire stations' processing time is not always appropriate because of irregular patterns. For example, there are different types of rolls made in the Sushi station. The processing time of making sushi rolls is different depending on the roll being made. From Figure 12, it can be seen that the processing times collected are in three distinct clusters, 58-113, 135-201, and 212-223. A possible explanation of these three groups is that each cluster shows the processing times of different ranges of sushi rolls. If this is the case, it is not as accurate to use one parametric distribution to represent the three different distributions, even if the selected distribution passes the Chi-square test and K-S test.

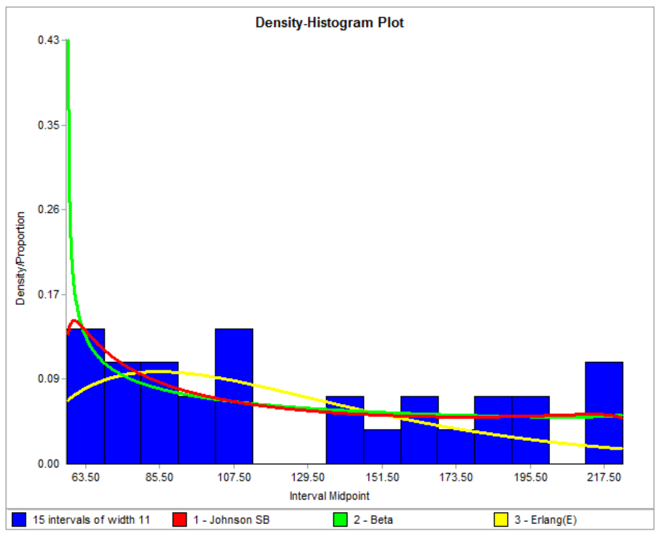


Figure 12: Density-Histogram Plot of Sushi Station

5.2 Design of the Current System

To make the simulation model operate in a manner that is relatable to the real system, the team obtained the floor plans of Nebu café and used it as the background of the Simio® model. Cash registers, food stations, and drink stations were modeled in their relative locations, and everything was scaled according to the floor plan. To determine the order in which customers visit each station, the team applied the individual customer flow data to a sorted customer flow matrix discussed in Section 4.3.1 and used this sample to make assumptions. The team utilized the data collected from "Items Sold by Category" and "Transaction Detail" reports within Nextep® to determine the percentages of customers that chose a particular station. Empirical distributions of station processing and inter-arrival times obtained from the raw data analysis were used in the simulation.

5.3 Simulating the Current System

5.3.1 Overview

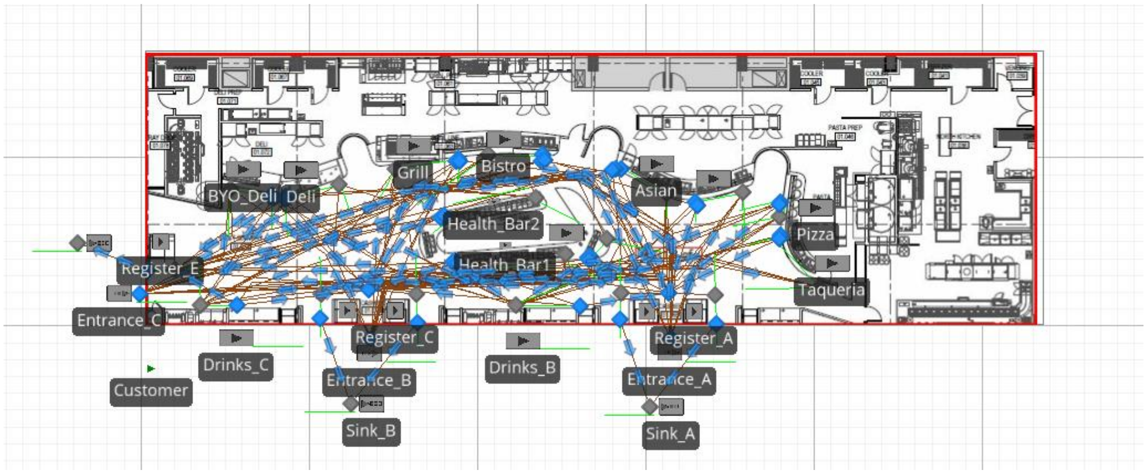


Figure 13: Screen Shot of the Nebu café within Simio®

Figure 13 is a picture showing the Simio® model laid out in accordance to the original floor plan of Nebu café. This picture displays the layout of different food stations, entrances/exits, and registers. The customers' flow paths (the red lines with blue arrows showing the direction of traffic flow) can easily be seen. All paths are drawn based on the Customer Flow Map in Figure 6, which determines that the average customer moves through the system in the following order: enter the café, order a food item, acquire a beverage, pay at a register, and exit the café.

While observing customer flow, it was noted that the Dessert station and NebuLOCAL station had no customers waiting in line and that the processing time for each was only a few seconds. Both of these are self-serve, grab-and-go style stations that only account for a very small percentage of the café's overall sales. Because of these reasons, the option of going to the Dessert station or the NebuLOCAL station to pick up food was not included in the simulation.

5.3.2 Entities (Customer)

In the simulation, the customer is modeled as an entity, which is any distinct and independent object that needs to be represented in a model. Within Simio®, this entity moves through the designed system interacting with different objects such as servers, resources, paths, and more. The characteristics of an entity can be modified, such as its name and description, as well as the speed at which it moves through the system. For the simulation model of Nebu, the initial desired speed of the entities is set at 1 mile per hour. The average human walks at a speed of 3 or 4 miles per hour, and this was lowered to 1 mile per hour for the simulation to effectively model the observed slower pace customers are walking at while navigating the café. This speed is also more reflective of the speed customers travel when they are comparing menu options and deciding on what station to go to after they enter the system.

5.3.3 Servers (Stations)

This simulation model involves 13 food stations: Deli, BYO_Deli, Grill, Bistro, Asian Exhibition, Global Exhibition, Pizza, Taqueria, Health Bar_1, Health Bar_2, Sushi, Drink_B, Drink_C. There are 5 cash registers involved in the model, Register_A through Register_E. All of these stations are modeled within Simio® as objects called servers. Servers can model the time delay for any function where a customer must go through a process, such as acquiring food or paying for a meal. A server also has input and output nodes that can each have queues, providing entities that enter the server with the option to wait in a line to be processed. Within the model, servers were placed at each food station based on the café floor plan, and assigned a random server delay described by empirical processing time distributions based on the timed observations from Nebu. When an entity enters a server, the time it takes it to be processed is sampled from this empirical distribution.

5.3.4 Sources and Sinks (Entrances and Exits)

There are 3 sources and 3 sinks in this model, referred to as Entrance 1 through 3 and Exit 1 through 3, respectively. A source is an object within Simio® that generates entities that arrive to the system. A sink is an object that records the entities statistics and then destroys the entities as they leave the system. Customers have the option to enter Nebu from three locations, as well as the option to exit through three locations, so it was necessary to include objects within the model for each of these six locations. The inter-arrival distribution used in each source is shown in Appendix G.

5.3.5 Simulation Flow Logic

Using the historical data pulled from the Nextep®, including the number of items sold by station, the path logic was established. The arrival rate from Appendix G was used to start entities in the simulation and determine what entrances customers used. Figures in Appendix F shows the original inter-arrival times fitted within Expertfit®. From the entrances, each path leading to a food station is weighted with the percentage of purchases that station is responsible for, stated in Figure 9. The logic is that if, on average, one food station accounts for 25% of the purchases, then 25% of the people that enter the café will proceed to that particular station.

Because only 2.5% of customers were observed going to more than one food station, the team assumed that the large majority of customers only obtain food from one station. Therefore, from the food station, the customer has the option of going to one of the drink stations, or going to one of the cash registers. Based on the Nextep® data and observations, it was determined that 32.65% of customers purchase a drink and 44.71% obtain a cup of water. Therefore, 77.36% of customers from each station proceed to the drink stations while the other 22.64% go directly to the cash registers, then exit. From either the food station or the drink station, the customers can go to one of five cash registers, as shown in Figure 10. Register 1 and Register 2 are at Exit 1, Register 3 and Register 4 are at Exit 2, and Register 5 is at Exit 3. The model is constructed so that when a customer proceeds to an exit, they will choose the cash register with the shortest line at that particular exit.

5.4 Validation of the Current System

The team validated the As-Is simulation of Nebu café to ensure that any simulation based experiments would provide reliable results. The team did not have the time or data available to perform extensive statistical studies to validate the simulation, so critical system features and outputs were studied instead. These critical simulation outputs include average customer time in system, maximum customer time in system, average queue length at each station, maximum queue length at each station, and station utilization. The critical outputs were compared with observations made by the team, and compared with

Mark Vannasdall's years of experience, to validate the model. The following areas were calibrated to create an realistic simulation: the number of deli workers, the number of servers, the inter-arrival time at Entrance_A, and the number of daily customers at the cafe. The processes used for adjusting these areas are discussed below.

The deli area was split up into two stations, the BYO (Build Your Own) Deli station and the Deli station. These two stations are unique because they share the same counter and food supplies. The simulation originally modeled each station as a server with a capacity of 1. This setup did not accurately reflect the system because it did not allow the BYO Deli station worker to assist the Deli station worker when they had nobody in line at their station. Two Worker Objects were implemented in the simulation to model the current system of how the server at the BYO Deli station takes orders at the Deli station if they are available. The Worker Object at the BYO Deli station will move to the Deli station and increase the capacity of the server from 1 to 2 as long as no one is in queue or being processed at the BYO Deli station. This modification to the simulation is necessary in order to obtain a utilization of the BYO Deli server and a throughput rate at the Deli that were as similar as possible to the real café.

Each station in the simulation was modeled with the number of servers that the team observed while performing time observations at the café. After the creation of the initial simulation the team returned to the café to validate that the number of servers at each station was correctly modeled. Mark Vannasdall was also consulted to ensure that the number of servers for each station was consistent with past seasons, not just the periods the team observed. A few stations server values were adjusted and the final server values for each station are shown in Table 1.

Station Name	# of Servers
Deli Station	1
Deli BYO Station	1
Grill Station	3
Bistro Station	2
Asian Station	3
Global Station	2
Pizza Station	3
Taqueria Station	2
Sushi Station	1

Table 1: Number or Servers at a Station

The original simulation model used an empirical inter-arrival distribution that used the data the team observed. The data was collected for the hour period of 11:20 am to 12:20 pm. This hour is considered part of the peak time for Nebu café, so it is when the most arrivals are expected. Using a distribution solely based on this peak hour data inaccurately represented the system because the model did not have a fluctuating inter-arrival rate. To correct this issue, model calibration was applied to the empirical inter-arrival distribution for the peak hour. This model calibration adjustment was based on the historical transaction data from the same day that the inter-arrival data was collected. Nextep®'s transaction data provided the exact time each customer checked-out at the cash register. This data was used because customers who enter the system have to exit, so when the exit rate increases the arrival rate also has to increase (this is with the assumption that there is little to no balking in the system based on the team's observations). The number of customers that checked-out in 20 minute intervals from 11:00 AM to 1:30 PM was found. The elapsed time between customers was found and then compared with the other 20-minute periods, and for any similar rates the period was consolidated. The values organized from the transaction data are shown below in Table 2.

11:01 AM - 11:20 AM		11:21 AM - 11:40 AM		11:41 AM - 12:00 PM		12:01 PM - 12:20 PM		12:21 PM - 12:40 PM		12:41 PM - 1:00 PM		1:01 PM - 1:20 PM	
107	Customers	187	Customers	245	Customers	201	Customers	154	Customers	89	Customers	50	Customers
5.35	Customers / Minute	9.35	Cust / Min	12.25	Cust / Min	10.05	Cust / Min	7.70	Cust / Min	4.45	Cust / Min	2.50	Cust / Min
11.21	Seconds / Customer	6.42	Sec / Cust	4.90	Sec / Cust	5.97	Sec / Cust	7.79	Sec / Cust	13.48	Sec / Cust	24.00	Sec / Cust

Table 2: Adjusted Arrival Rates

The average time between customers from 11:21 AM to 12:20 PM was very similar so this time period was consolidated into one period. The seconds/customer rate for the 11:21 AM – 12:20 PM period was used as the base for the adjustment factor because this time period was when the inter-arrival data was observed. Every other interval's second/customer rate was divided by this time period to find how much the new mean would be. The mean for the observed hour time period was then calculated and every other interval's average time was scaled by multiplying its adjustment factor with the average time for the hour time period observed. The difference of the average time for each period subtracted by the observed period's average time was then calculated. This value gave the number that needed to be added to the observed empirical distribution to appropriately shift the mean to reflect the variation in inter-arrival times. The distribution and variation was assumed to be similar so only the mean was adjusted based on the time period. The results for each time interval are shown in Table 3.

11:01 AM - 11:20 AM		11:21 AM - 12:20 PM		12:21 PM - 12:40 PM		12:41 PM - 1:00 PM		1:01 PM - 1:20 PM	
107	Customers	633	Customers	154	Customers	89	Customers	50	Customers
5.35	Customers / Minute	10.55	Cust / Min	7.70	Cust / Min	4.45	Cust / Min	2.50	Cust / Min
11.21	Seconds / Customer	5.69	Sec / Cust	7.79	Sec / Cust	13.48	Sec / Cust	24.00	Sec / Cust
1.97	Adjustment Factor	1.00	Adjust Fact	1.37	Adjust Fact	2.37	Adjust Fact	4.22	Adjust Fact
11.39	Avg Time (seconds)	5.78	Avg Time	7.91	Avg Time	13.69	Avg Time	24.37	Avg Time
5.61	Difference (seconds)	0.00	Difference	2.14	Difference	7.92	Difference	18.60	Difference

Table 3: Adjusted and Consolidated Arrival Rates

During the validation stage, the team noticed the observation data were collected on a busy day. Modeling the simulation based on this data provided an outlook of the cafeteria when approximately 1400 customers enter the café. This value was confirmed by referring to historical records of that day to make sure the number of customers that entered and exited the cafe in that two-and-a-half-hour lunchtime window matched. The number of customers was acceptably close, within 100 customers, so the inter-arrival rate was validated. Mark Vannasdall mentioned to the team that a new building would be completed in the next two years across the street from Nebu, and that a large increase in customers is expected. With this in mind, the team created three inter-arrival adjusted values based on the created distribution to test the simulation when 1000, 1400, and 1800 customers were processed in the café. The inter-arrival values were adjusted by scaling the original inter-arrival distribution. The use of three inter-arrival distributions was very beneficial for the team because each experiment could then be simulated for an average slow day (1000), average busy day (1400), and extremely busy day (1800). The team was then able to base each of their recommendations for improvements based on how busy the café is during these three situations.

5.5 Difference between the Simio® Model and the Real Situation

The team ran the Simio® model several times and observed customers' flow in the café and also made adjustments (adjusting the positions of queues and processing lines and changing the capacity of stations). The team tried to adjust the model according to the metrics, such as number of servers and queue length. However, there was still a differences between the Simio® model and the real situation in the café. One reason was that the team only tracked customers' paths based on stations they ordered food, and did not include stations they just visited, stood by, and left during our observation. A second reason was that all customers were modeled either in queues or in stations instead of walking randomly through the café. The simulation also models what the system looks like when a customer only orders one entrée and possibly a drink. Occasionally in the real system, a customer will buy food from multiple stations but the flows observations showed that this was rare. Balking could not be accurately modeled in the simulation because of the complexity and variation of when and why people balk from a line so balking was not considered in the model.

5.6 Results of the Current System

Appendix H displays the outputs of the Simio® model of the Current System for 1000 lunch customers, 1400 lunch customers, and 1800 lunch customers. The simulation ran 100 times each for the three ranges of lunch customers. The results include the averages and standard deviations of the ten simulations. The key metrics shown in the table are divided into two parts. The first part includes average customer time in system, maximum customer time in system, and the standard deviation for both. The second section includes the average queue length at each station, maximum queue length at each station, and the standard deviation from both. Each station's average utilization percentage after one hundred simulation runs is shown in Appendix I.

Important things to note from Appendix H include the following:

- The average customer time in system is low with a small standard deviation, which is favorable. The maximum customer time in system value of about 28 minutes is acceptable with 1000 customers. However, this becomes unacceptable with a value of 56 and 73 minutes when 1400 and 1800 customers are simulated during the lunch period, respectively.
- The Deli station's queue length is acceptable with 1000 customers but increases dramatically with an increase in customers. The average line for the Deli station is about 16 people with 1400 customers and almost 31 people with 1800 customers. These average queue lengths are excessively large, so improvement ideas should be a focus for the Deli station. The Deli average and maximum queue lengths are the highest of any station.

- The Deli BYO station results show an acceptable line length average of 2 people with 1000 customers. The station shows an unacceptable queue average of 7 people with 1400 customers and nearly 13 people when 1800 customers are modeled in the system.
- The Grill station's average queue length is acceptable until 1800 customers are simulated. When 1800 customers are modeled, the average queue becomes close to 13 people. A line this size is large enough to affect customer satisfaction negatively.
- The Global and Taqueria stations utilize two workers at each station but have very little average and maximum queue lengths.
- All the stations' average and maximum queue lengths values are not large other than the Deli, Deli BYO, and Grill stations. Improving these three stations should be the priority to improve the overall time in system for the customer.

Important things to note from the "Utilization Results of the Current System" table located in Appendix I include the following:

- The highest average utilization of any station when 1000 customers enter during the lunch period is 79%, occurring at the Deli BYO station. This percentage is large but a value of 79% or lower is acceptable.
- With 1400 customers, the following two stations have an average station utilization of 90% or higher: Deli (90.3%) and Deli BYO (92.9%). These station utilization times are too high, especially for an average, which results in overworked staff and large queues.
- With 1800 customers, the following four stations have an average station utilization of 90% or higher: Deli (93.7%), Deli BYO (94.6%), Grill (90.1%), and Sushi (91.7%). These average utilization percentages are unacceptable for the worker and the customers.
- The largest standard deviation value of the average station utilization with 1000 customers is at the Deli station (10.7). Standard deviation is important to note because it tells us how much fluctuation there is in the station utilization percentages over 100 runs.
- The largest standard deviation value of the average station utilization with 1400 customers is at the Sushi station (10.0).
- The largest standard deviation value of the average station utilization with 1800 customers is at the Asian station (9.2).

6 Process Improvement Ideas

6.1 Ideas Generated

The following list contains the initial ideas generated by the team to lead to an improved customer experience at Nebu café. Ideas were gathered through conversations with subject matter experts, Mark Vannasdall, and the team's own knowledge. The separated list has two sections: with major construction/renovation, without major construction/renovation.

6.1.1 Ideas Generated Involving Major Construction/Renovation:

Idea	Issue to Address	Objective
Dedicate the entrances and exits of the café	During times of high traffic the café experiences unpleasant congestion especially at Entrance/Exit 1.	Dedicated entrances and exits may reduce congestion, encourage customer flow, and reduce pilferage.
Relocate the drink stations	The drink stations keep customers in the system longer and increase congestion around them.	Relocating the drink stations to outside the café and having the customer purchase an empty cup may reduce congestion in the café.
Create tray rests	Customers have complained that there is no place to rest your tray when filling a beverage.	Tray rests for the soup and drink stations would allow customers to rest their tray to make it easier to pour their soup or beverage.
Reconstruct the Salad Bar	Congestion occurs around the salad bar due to limited walkway space around it. There is space in the middle of the salad bar, which workers rarely use.	Eliminating the current design of the Salad Bar and rebuilding a single line bar that can be approached from both sides will add more open space in the middle of the café for movement, and reduce customers having to circle the large salad bar island.

6.1.2 Ideas Generated Not Involving Major Construction/Renovation:

Subcategory	Idea	Issues to Address	Objective
Congestion	Implement Mobile and Online Ordering	Lines at certain stations can block customer pathways if they get too long.	Mobile/online ordering may reduce congestion in the café and is more convenient for the customer.
	Alternate popular food stations with not as popular food stations	The busiest stations are adjacent to each other creating high customer congestion in these areas.	Alternating food stations may allow better spacing in the café, and reduce congestion due to lines nearby each other.
	Eliminate the line overlap at the Well Bistro station and the Grill station	The Well Bistro line overlaps the Grill line, so customers must walk through the Bistro line to exit the Grill station.	Switching the flow direction of the Well Bistro may allow Grill customers to not have to go through the Well Bistro line when they exit with their food.

Subcategory	Idea	Issues to Address	Objective
Congestion	Relocate the fresh juice option to a less busy beverage station	The majority of customers obtain a beverage at the middle drink station, which has the juice option, creating congestion and underutilizing the other beverage stations.	Relocating the juices may create a more even distribution of people at each of the drink stations.
	Implement an incentive system to rebalance customer arrivals	The majority of customer arrivals occur during a peak lunch hour creating a buildup of lines and congestion.	Incentives for customers who come during non-peak time can reduce server idle time, congestion in the café, and the total time in system for the customer.
Signage	Create a combined menu and Nebu map in front of each entrance	Small menus are at every station, making it difficult for customers to quickly select a station to order at.	The combined menu may reduce the time a customer spends deciding what to order, and as a result, reduce the total time spent in the café.
Tray Return	Redesign the trays to avoid tray return conveyor jams	Occasionally, when customers put their trays partially in the conveyor, the conveyor becomes stuck.	Shortening the trays may eliminate the inconvenience of jams in the conveyor system.
	Do not have customers empty their tray at the tray return	Congestion occurs when customers have to wait for others to clear their trays. Silverware is occasionally thrown away when customers clear their trays.	Not having customers empty their own trays may greatly reduce missing silverware, speed up the tray return process, and make it simpler for the customer.
	Designate a clear entrance and exit for tray return areas	Customers are currently confused what side they should enter the tray return from.	Designated entrances might eliminate flow issues in the tray return area.
Wait Time Reduction	Replicate the most attended food station	A large number of customers attend a few stations while some stations receive a very small number of customers.	Adding another one of the most popular station might reduce the line and increase throughput.
	Add cold premade deli sandwiches and sides to the NebuLOCAL station for pick-up	Customers who want a cold, pre-made sandwich/wrap have to wait in the deli line even though their sandwiches are already made.	Adding pick-up sandwiches might allow a fast and convenient option for the customer and reduce the Deli station line.

Subcategory	Idea	Issues to Address	Objective
Wait Time Reduction	Include paper order forms to fill out in line at the Deli BYO station	Customers spend time making decisions for their order while they are being served, which slows down processing time of the station.	Paper order forms eliminate customer and server interaction, which may increase the speed of service.
	Reduce the menu choices and only include items with quick processing times	Some menu items take a long time to be prepared and cook while others are quick.	Having quick item options might significantly reduce the time in system for the customer, and including rotating menus would still allow for diversity.
	Rearrange the number of workers at specific stations	Certain stations have multiple workers but small lines while other stations have one worker with large lines.	Rearranging the number of workers may balance the throughput to avoid some stations having long lines and other stations having no lines.

6.2 Discussion of Ideas and Results

The team discussed all the ideas with the Nebu General Manager, Mark Vannasdall. Changes to the café affect Mark the most and he is the most qualified individual estimated impact of any potential changes. The discussion categorizes each idea into one of three categories: Feasible, Feasible– Not Recommended, Not Feasible, and Already Implementing. The category of "Already Implementing" does not mean the team should not look into the idea further, it only means that the idea needs to be coordinated with the existing plans. Section 6.2.1 through Section 6.2.3 list the proposed ideas, the conclusion drawn from the ideas, and Mark Vannasdall's comments.

6.2.1 Discussion of Ideas Involving Major Construction/Renovation:

Idea	Conclusion	Mark Vannasdall's Comments
Dedicate the entrances and exits of the café	Feasible	The cash registers would need rewiring and minor construction to move
Move the drink stations outside	Not Feasible	Cannot close drink stations if outside the cafe
Create tray rests	Feasible	No concerns
Reconstruct the Salad Bar	Feasible Not Recommended	Costly construction would be required

6.2.2 Discussion of Ideas Not Involving Major Construction/Renovation:

Idea	Conclusion	Mark Vannasdall's Comments
Implement Mobile and Online Ordering	Feasible	The biggest challenges would be to create clear pick-up locations for customers and to keep the food hot.
Alternate popular food stations with not as popular food stations	Feasible Not Recommended	The only stations that would be able to move would be the Grill with the Global, but the grill hood is not an option to be relocated.
Eliminate the line overlap of the Well Bistro and the Grill	Feasible	Changing the line direction of the Bistro is possible, if there is room on the other side.
Move the fresh juice option to a less busy beverage station	Feasible	It is only feasible to move it to the one other soda fountain beverage station.
Implement incentive system to distribute customer arrivals	Already Implementing	They are currently implementing "Pirq" app software already, but would like incentive ideas for the app.
Create a collective menu and Nebu map besides each entrance	Feasible	No concerns
Redesign the trays to avoid tray return conveyor jams	Feasible	No concerns
Do not have customers empty their tray at the tray return	Feasible	Nebu replaces 12 dozen forks a quarter so this would save money and time.
Designate clear entrance and exit for tray return areas	Feasible	This would mainly improve the tray return area closest to the elevators.
Replicate the most attended food station	Feasible Not Recommended	Nebu wants diversity in their stations, and replicating a station would reduce that diversity.

Idea	Conclusion	Mark Vannasdall's Comments
Add cold premade deli sandwiches and sides to NebuLOCAL station for pickup	Feasible	During slow periods, the café reduces the number of operating stations. This means less traffic nearby the NebuLOCAL station. However, during busy periods the recommendation should be effective.
Include paper order forms to fill out while in line at the Deli BYO station	Feasible	Was not able to obtain feedback.
Reduce the menu choices and only include items with quick processing times	Feasible Not Recommended	Nebu wants to keep their menu options because of their current success. Changing the menu is not needed at this time.
Rearrange the number of workers at specific stations	Feasible	Avoid adding additional staff to not increase labor costs.

6.3 Final List of Ideas

The table below is the list of final ideas that the team has determined feasible, recommended, and worthy of further investigation and experimentation. The table shows the idea and the team's methodology to analyze the idea to have a thorough list of recommendations. An "**X**" means the respective investigation methodology technique has been used to analyze the idea.

6.3.1 Final Ideas Involving Construction/Renovation:

	Evaluation Methodology			
Final Idea	**Manager Experience**	**Simulation**	**Cost Estimates**	**Proposed Design**
Dedicate the entrances and exits of the café	**X**		**X**	**X**
Create tray rests	**X**		**X**	**X**

6.3.2 Final Ideas Not Involving Construction/Renovation:

	Evaluation Methodology			
Final Idea	**Manager Experience**	**Simulation**	**Cost Estimates**	**Proposed Design**
Implement Mobile and Online Ordering		X	X	X
Eliminate the line overlap of the Well Bistro and the Grill			X	X
Relocate the fresh juice option to a less busy beverage station	X		X	X
Implement incentive system to distribute customer arrivals		X	X	X
Create a cobined menu and Nebu map besides each entrance			X	X
Redesign the trays to avoid tray return conveyor jams			X	X
Do not have customers empty their tray at the tray return	X		X	X
Designate clear entrance and exit for tray return areas			X	X
Add cold premade deli sandwiches and sides to NebuLOCAL station for pickup		X	X	X
Include paper order forms for customers to fill out in the Deli BYO station line		X	X	X
Rearrange the number of workers at specific stations	X	X	X	X

7 Evaluation of Improvement Strategies

7.1 Evaluation by Simulation Studies

Each simulation experiment used the simulation model of the current system with specific adjustments to reflect the idea. The objective, cost estimate (if applicable), simulation design, and results are developed in each simulation experiment.

7.1.1 Mobile and Online Ordering Strategy

7.1.1.1 Objective

The purpose of implementing a mobile and online-ordering option is to improve the customer experience by reducing congestion and the customers' average time spent in the café. A Mobile and Online Ordering option is convenient for customers who do not want to physically wait in line. Instead of waiting in the café, they can place an order and continue to work at their desk or spend time socializing until their food is ready to be picked up. Less people waiting in the café means less congestion in the café, especially during the peak lunch hour. Not waiting in the café also significantly reduces the time in system for the customer who uses online-ordering because they will only need to enter the café to pick up their food and leave. The team investigated what it would look like if Nebu used Nextep® Systems' Mobile and Online Ordering software. Nebu already uses Nextep® for their point of sales data, so the staff is familiar with the interface of Nextep®. A simulation experiment of the café will show the expected results and benefits an online ordering system can have. Utilizing a simulation is much cheaper to test and helps to justify the expenses of implementation.

7.1.1.2 Simulation Design

The team designed two different simulation experiments to simulate using the Nextep® Systems' Mobile and Online Ordering service in two possible ways. The descriptions of the common elements in both designs is below, with the differences in the two experiment designs highlighted.

The team's idea is to implement a system where customers can look at a menu on their phone or computer, select an item, pay, and then become notified when their food is ready.

1. **Guaranteed Time:** The online software will guarantee that the customer's food will start being made by a certain time. The worker at each station, where an online option is available, will serve all regular customers first and make the online orders second. Due to the guarantee that their food will be made no later than a specific time, the worker will make the online order immediately when the time guarantee limit is reached. The team designed a guaranteed time of 15 minutes, but this value can be easily adjusted in the simulation. The Nextep Online-ordering system will notify the customer when their food is starting to be made and it will also notify the customer when their food is ready to be picked up.

2. **No Guaranteed Time:** The online software will not guarantee that the customer's food will be made by a certain time but the software will give an estimated time of completion based on the current queue for the stations that have the online ordering option. All online orders will be sent to the end of the line of customers at the time when the online order is placed. The worker will

make the online order when that spot in line is up next and the app will notify the customer that their food is being made and notify the customer when their food is ready to be picked up.

Once notified, the customer enters the café and walks to the station that made the food they ordered. The food will be waiting for the customer at a designated pickup location beside the end of the station's line where they can pick-up the food and exit the café.

The team tested the model with the assumption that 15% of customers will use the online ordering option. This percentage is easily adjustable in the model at any time. The simulation designed accounts for the following stations offering the online order option: Deli BYO, Deli, Grill, Bistro, Asian, Global, Taqueria, and Sushi. The Pizza station, Health Bar station, and Beverage stations were not designed to offer an online ordering option because they are self-serve stations with no servers.

The simulation experiment creates an online customer entity 15% of the time. When the entity leaves the source, it follows the same weighted path logic as a normal customer entity with the exception of the three types of station that were not designed to offer online ordering. When the online customer reaches the input node of the station they are sent to an online waiting queue and a food entity is created in the station's queue. The online customer entity waiting in the online waiting queue resembles the customer placing the online order and waiting to be notified when it is ready.

1. **Guaranteed Time:** The food entity is sent to the back of the station's current queue and has a lower priority than a regular customer entity. This means that the online order will only be made if there are no regular customers in line. If the food entity sits in the station's queue for too long (15 minutes) then the food entity's priority value changes to be larger than regular customers so it is immediately sent to the front of the line. The simulation was designed this way to allow a guarantee that the online customer's food would start being made by 15 minutes or less.

2. **No Guaranteed Time:** The food entity is sent to the back of the station's current queue with the same priority as the regular customer entity. The online orders are made when it reaches the server after waiting in line.

The food entity is destroyed after it is processed and enters the output node of the station. The online customer that was waiting for that food to be processed in the online waiting queue immediately appears at the output node of the station. The customer then leaves the café and goes straight to the sink, avoiding the register stations because the customers paid when placing the order.

7.1.1.3 Cost Estimate

Because Nebu café already takes advantage of Nextep® for point-of-sale data, the team investigated the online-ordering program offered by Nextep® that could easily be incorporated into the café's current system. Based on the quote received from Guckenheimer's Nextep® Solutions Consultant, the online-ordering service would cost $2,400 per year, and includes unlimited orders and service during this time. There is also the cost of implementing online-order screens at each station, which would cost $2,500 per screen. The simulation models the online-order option at all food stations within the café except for the Pizza station and the Health Bar, which would create the need for seven screens total. However, it is up to the discretion of Nebu café to determine the number and timing of stations they would like to convert to online ordering. By starting with fewer station options for the online-orders, the café could have a warm-up period to observe customer reaction to online ordering as well as adjust to and improve the way Nebu employees work with the Nextep® system. Lastly, the Solutions Consultant said there would be the setup cost of installing the computers and the software that could range anywhere between $3,600 and $7,200. This cost would cover the installation costs, as well as the design and implementation of pick-up areas for the online-orders. The total expected cost to implement online ordering at seven stations would be roughly $25,000 for the first year and an additional $2,400 per year after that.

Cost Item	Cost
Seven Screens	$2,500 x 7 = $17,500
Setup and Installation of Computers	$3,600-$7,200 (Take the middle, which is $5,400)
Online-ordering Service per Year	$2,400
Total	**$25,300**

Table 4: Cost Estimate for the First Year Installing Nextep

7.1.1.4 Results

The results for the key metrics from the simulation experiment are shown in Appendix J and Appendix L. One hundred simulation runs were taken and each of the key metrics took the average from the one hundred runs when 1000 customers eat lunch, 1400 customers eat lunch, and 1800 customers eat lunch.

Table 5, shown below, highlights the important information drawn from the comparison of the results from the tables located in Appendix H and Appendix J. Table 6 highlights the important information drawn from the comparison of the results from the tables located in Appendix J and Appendix L.

Values in black mean the experiment produced a smaller value than the current system model. Smaller values are preferred and show favorable results. Values in red means the experiment produced a larger value than the current system mode, which is not favorable.

Key Metric Compared – Guaranteed Time	Number of Customers	Difference in specified units	Percentage difference
Average Customer Time in System (minutes)	1000	0.000	0.01%
	1400	0.122	1.99%
	1800	0.435	5.13%
Maximum Customer Time in System (minutes)	1000	6.556	23.67%
	1400	10.617	18.87%
	1800	15.940	21.97%

Table 5: Experiment Results for Mobile and Online Ordering – Guaranteed Time

Key Metric Compared – Guaranteed Time	Number of Customers	Difference in specified units	Percentage difference
Average Customer Time in System (minutes)	1000	0.139	3.17%
	1400	0.373	6.09%
	1800	0.028	0.33%
Maximum Customer Time in System (minutes)	1000	2.673	9.65%
	1400	3.037	5.40%
	1800	5.533	7.63%

Table 6: Experiment Results for Mobile and Online Ordering – No Guaranteed Time

The mobile and online ordering experiment produced undesirable results. There was a slight improvement with the average customer time in system value for both the guaranteed time design and the no guaranteed time design except for the 1800 customer demand levels. This would be desirable except for the fact that both mobile and online ordering experiment designs provided results that had significantly worse maximum customer time in system values. The team wants to reduce the average customer time in system while also reducing the maximum customer time in system to an acceptable level to reduce customer complaints. Based on the simulation, implementing a mobile and online ordering system in the café would be convenient for the customers that use it, but for the regular customers, it would make the café lines issues worse.

7.1.2 Incentives to Balance Customer Arrivals

7.1.2.1 Objective

The purpose of implementing an incentive system for Nebu café is to reduce the queue lengths for the food station and to better distribute the servers' utilization, which ultimately leads to a reduction of the average time a customer spends in the café. The peak lunch hour for Nebu is 11:20 AM to 12:20 PM. More than half of the lunch customers arrive in this time range, which leads to large station lines and high wait times for the customer. The incentive system will utilize the services of "Pirq", a mobile application that enables businesses to track customers and offer customized rewards and offers. The application is recommended to be used primarily to offer discounts and special deals to incentivize customers to obtain food at the café outside the peak hour for lunch. Incentivizing customers to come to the café during the slower lunch times can also reduce the idle time of workers and potentially increase purchases made at the café. If the café ever does not want to use the offers at specific times, they can limit the number of customers that can use it or offer it to customers depending on the day. The use of a simulation experiment will provide details that can assess implementing the incentive system.

7.1.2.2 Simulation Design

The team modeled the effect of incentives in the simulation by focusing on adjusting the inter-arrival values at Entrance 1. Over 80% of customers arrive from Entrance 1 so adjusting the Entrance 1 arrival rate was good enough to see the effect an incentive system could have on the café. The team tested the idea that 10% and 20% of customers would switch the time they eat lunch to a non-peak time rather than during the peak lunch hour because of an incentive system. In the simulation model of the current system, the team found the number of customers that eat lunch within the peak one hour lunch period. The inter-arrival distribution for each period was shifted to adjust the arrivals. The peak period inter-arrival distribution mean was shifted by adding time to it to reduce the number of customers that arrived in that time period by 10%, and then 20%. The non-peak period's inter-arrival distribution means were shifted by subtracting time equally between them to increase the number of customers that arrived in the non-peak period time that is equal to the decrease in the number of customers that arrived during the peak period. Therefore, the number of customers that entered the café during the entire lunch period does not change.

The simulation experiment is only testing the balancing of customer arrivals. The simulation is not testing whether the incentive system would *"increase customer demand"* for that day or not. If customer demand increased, it would be an additional benefit for the café until the café becomes too crowded. If the café did become too crowded during the traditional non-peak periods, a limit on the number of people that can use the incentive deal could be implemented.

7.1.2.3 Cost Estimate

The Pirq mobile application costs businesses $30 per month for the standard program, and $60 per month for the premier program. However, it is free for customers to download and use the application on their mobile devices. Table 7 shows the differences between the Standard and the Premier programs offered to businesses by the application.

Loyalty Pricing and Features	**Standard $30/month**	**Premier $60/month**
Digital Punch Card	X	X
Mini website in-app	X	X
Customer demographics	X	X
Analytics dashboard	X	X
Business profile in-app	X	X
Social media integration	X	X
No contract	X	X
No setup fees	X	X
Private VIP offers		X
Public offers		X
Complete marketing kit		X
Customer Feedback forms		X
Weekly push notifications		X
Weekly email campaigns		X

Table 7: Standard Pirq versus Premier Pirq Programs

The recommended program for Nebu café, based on the team's research of the application, would be the premier program. This is because premier program would allow Nebu to use not only the customer punch card, but also the public and private offer option for customers to come outside the peak traffic times of the café. Premier is also recommended because of the marketing kit that is included in the package. The kit includes pop-up stands with signage, Pirq cards with download and start-up instructions for the mobile application, and tags for customers to scan for their punch card. These materials will facilitate quicker promotion and customer awareness of the program. The total estimated cost of one year's use of the incentive app would be $720 considering that the discount incentives would be canceled out by an increased demand.

7.1.2.4 Results

The results for key metrics from simulation experiment are shown in Appendix N. One hundred simulation runs were taken and each of the key metrics was averaged over one hundred runs, when 1000 customers eat lunch, 1400 customers eat lunch, and 1800 customers eat lunch.

Table 8 highlights the important information drawn from the comparison of the results from tables located in Appendix H and Appendix N. Values in black mean the experiment produced a smaller value than the current system model. Smaller values are preferred and show favorable results. Values in red mean the experiment produced a larger value than the current system mode, which is not favorable.

Key Metric Compared – 10%	Number of Customers	Difference in specified units	Percentage difference
Average Customer Time in System (minutes)	1000	0.003	0.08%
	1400	0.072	1.18%
	1800	0.043	0.50%
Maximum Customer Time in System (minutes)	1000	1.507	5.44%
	1400	1.753	3.12%
	1800	0.456	0.63%
Average Queue Length of the Deli Station (customers)	1000	0.291	10.07%
	1400	0.921	5.78%
	1800	0.646	2.11%
Maximum Queue Length of the Deli Station (customers)	1000	0.36	3.65%
	1400	1.38	4.37%
	1800	1.13	1.98%
Average Queue Length of the Deli BYO Station (customers)	1000	0.402	18.93%
	1400	1.113	15.23%
	1800	0.793	6.28%
Maximum Queue Length of the Deli BYO Station (customers)	1000	0.99	14.93%
	1400	1.80	12.23%
	1800	1.50	6.35%
Average Queue Length of the Grill Station (customers)	1000	0.002	0.68%
	1400	0.094	3.51%
	1800	0.409	3.14%
Maximum Queue Length of the Grill Station (customers)	1000	0.20	4.35%
	1400	0.35	2.78%
	1800	0.71	2.31%

Table 8: Experiment Results for the Incentive System at 10%

Table 9 highlights the important information drawn from the comparison of the results from the tables located in Appendix H and Appendix P. Values in black mean the experiment produced a smaller value than the current system model. Smaller values are preferred and show favorable results. Values in red mean the experiment produced a larger value than the current system mode, which is not favorable.

Key Metric Compared – 20%	Number of Customers	Difference in specified units	Percentage difference
Average Customer Time in System (minutes)	1000	0.067	1.52%
	1400	0.195	3.19%
	1800	0.426	5.02%
Maximum Customer Time in System (minutes)	1000	2.644	9.55%
	1400	2.744	4.88%
	1800	1.712	2.36%
Average Queue Length of the Deli Station (customers)	1000	0.171	5.91%
	1400	0.189	1.18%
	1800	1.325	4.34%
Maximum Queue Length of the Deli Station (customers)	1000	0.49	4.97%
	1400	0.77	2.44%
	1800	2.48	4.33%
Average Queue Length of the Deli BYO Station (customers)	1000	0.344	16.18%
	1400	0.754	10.32%
	1800	0.012	0.09%
Maximum Queue Length of the Deli BYO Station (customers)	1000	0.88	13.27%
	1400	1.27	8.63%
	1800	0.12	0.51%
Average Queue Length of the Grill Station (customers)	1000	0.032	11.12%
	1400	0.832	31.02%
	1800	2.396	18.36%
Maximum Queue Length of the Grill Station (customers)	1000	0.09	1.96%
	1400	2.52	19.98%
	1800	4.17	13.59%

Table 9: Experiment Results for the Incentive System at 20%

The incentives to Balance Customer Arrivals experiment produced varying results. The average customer time in system did not show strong improvement for the 10% incentive experiment for all three customer demand levels. The average customer time in system results for the 20% incentive experiment were positive. The comparison of the 10% and 20% use of the incentive system has shown that the incentive system should only be applied if about 20% of customers that normally come during the peak hour will eat during a different time because of the incentives.

7.1.3 Premade Sandwich Pick-up Experiment

7.1.3.1 Objective

The purpose of implementing a premade sandwich pick-up option in the café is to reduce the Deli station's line, which will lead to a reduction of the average time in system for Deli customers. The current café's Deli station offers premade sandwiches that the customer can have heated or pressed, along with two sides. Offering a quick pick up option for cold sandwiches/wraps and sides at the NebuLOCAL station will allow customers in a hurry or who just want a cold sandwich to avoid waiting in the Deli line. The team's idea includes cold sandwiches/wraps and sides to be offered à la cart that are prepackaged. The simulation experiment is to test out the effect it can have on the Deli station.

7.1.3.2 Simulation Design

The premade sandwich pick-up experiment was simulated by creating a NebuLOCAL station server and then transferring the customers who normally went to the Deli station server to the NebuLOCAL station server. The first thing the team had to do was to find the percentage of people that would go to the NebuLOCAL station to grab a sandwich/wrap instead of grabbing a sandwich/wrap at the deli. This percentage was obtained by using the percentage of cold sandwiches and wraps people buy at the Deli station. In the Nextep® data, the deli items are labeled as either a Panini or a Wrap. Not every sandwich that is ordered at the station is heated on a Panini press but all sandwiches are labeled as Panini in the system, so to ensure accuracy, no Panini items were used to calculate the percentage of customers that obtained a non-heated food item at the station. The percentage was found by finding the percentage of wraps sold at the Deli station, since wraps are not heated. This wrap percentage was found to be 15% of total items sold at the station. The team expects 15% to be a low estimate for the actual system because cold sandwiches were not considered so there likely will be even more benefits than modeled in the experiment.

From every entrance source, a new path was created that went to the NebuLOCAL station server. This path was given the weight of 15% of the previous Deli station weight while the path to the Deli station's weight was reduced by 85%. The NebuLOCAL station processing time was designed for 15 seconds per customer. The 15-second duration was decided on by the team to be a slight overestimate for the customer to grab the sandwich or wrap they want. The team used an overestimate for the processing time to ensure the results from implementing the idea in real life would provide at least the same level of results as the simulation. This value can be easily changed in the simulation model. When the customer leaves the NebuLOCAL server, they either obtain a drink and then checkout or go straight to check-out based on the beverage data the team found and used in the current system simulation.

7.1.3.3 Cost Estimate

The cost to implement the premade sandwich pick-up idea is estimated to be $8,000 a year. This cost comes from the assumption that clamshell plastic clear food boxes (8"x8") would be used to hold the sandwiches and sides. An order of 160 boxes is $71.96 according to an online source [2]. Assuming 320 boxes would be used per week, the total cost per year is $8,000. There is no additional cost to prepare the premade sandwiches/wraps because the sandwiches are already being premade in the current system and it is assumed in the experiment that the same total number of cold sandwiches/wraps are sold.

7.1.3.4 Results

The results for key metrics from simulation experiment are shown in Appendix R. One Hundred simulation runs were taken and each of the key metrics took the average from the one hundred runs when 1000 customers eat lunch, 1400 customers eat lunch, and 1800 customers eat lunch.

Table 10 highlights the important information drawn from the comparison of the results from the tables located in Appendix H and Appendix R. Values in black mean the experiment produced a smaller value than the current system model. Smaller values are preferred and show favorable results. Values in red mean the experiment produced a larger value than the current system mode, which is not favorable.

Key Metric Compared	Number of Customers	Difference in specified units	Percentage difference
Average Customer Time in System (minutes)	1000	0.182	4.14%
	1400	0.353	5.78%
	1800	0.160	1.88%
Maximum Customer Time in System (minutes)	1000	3.572	12.90%
	1400	6.080	10.81%
	1800	6.576	9.07%
Average Queue Length of the Deli Station (customers)	1000	1.049	36.26%
	1400	6.377	40.04%
	1800	9.320	30.51%
Maximum Queue Length of the Deli Station (customers)	1000	2.57	26.06%
	1400	10.98	34.80%
	1800	16.48	28.81%
Average Queue Length of the Deli BYO Station (customers)	1000	0.309	14.52%
	1400	0.338	4.63%
	1800	0.008	0.06%
Maximum Queue Length of the Deli BYO Station (customers)	1000	0.87	13.12%
	1400	0.45	3.06%
	1800	0.11	0.47%

Table 10: Experiment Results for Premade Sandwich Pick-ups

The premade sandwich pick-up experiment produced favorable results in many areas. The average customer time in system showed a slight improvement but all the other key metrics percentages shown in Table 9 reveal significant improvement for the maximum customer time in system, the Deli Station average queues, and the Deli Station maximum queues for all three customer values. The Deli BYO station showed strong favorable results for both the average and maximum queue lengths for the 1000 customer demand levels, but not for the 1400 and 1800 customer demand levels. This is most likely due to the Deli BYO worker having more demand at their station so they cannot assist the Deli station.

7.1.4 Deli Order Form Experiment

7.1.4.1 Objective

The purpose of implementing order forms at the Deli station and Deli BYO station is to reduce the processing time for food items by removing the time the customer exchanges info to the worker. Reducing the time it takes to make a sandwich or wrap will reduce the queue of the station and ultimately decrease the average time in system for customers ordering at the Deli BYO station. While customers wait in line, they will select items they want by marking a laminated form that has the menu printed on it. When it is their turn to order, they will hand the form to the server so the server can make the sandwich without waiting on the customer to make decisions. The customer can also go to the drink station or leave the line while the sandwich is being made. A simulation experiment that models the use of order forms can evaluate potential benefits without spending the time and money to test the idea in the real system.

7.1.4.2 Simulation Design

The deli order forms simulation experiment involved adjusting the processing time of the Deli BYO station. The implementation of deli order forms for the Deli BYO stations would eliminate the time spent on customers making decisions on what sandwich they want to make because those decisions can be made while they are waiting in line. The station's processing times were reduced by 15%. The team was not able to get an estimated time an order forms system would save from Mark Vannasdall's experience in the café. The team used the 15% reduction value based on their observations of the system and believes this 15% is a very conservative estimate, with the potential time saving being even higher. This percent reduction was applied to the entire processing time distribution that the team found from their data collection.

The envisioned implementation plan is to use 400 forms that can be reused each day in the café. The sandwich/wrap options will be printed on the cards and laminated. Using an international paper size of A6, which is 4.1" × 5.8", with 110 lb. paper thickness should allow the customer to have plenty of space on the paper to read the options printed on it and should be thick enough to allow the customer to write on the paper while standing. The customers will be able to pick-up a form and an erasable marker to fill out their order. After the customer completes their order, they can either hand the forms to the worker or drop it in an order queue and put the pen back from the pick-up location. The team is leaving the implementation design ultimately up to Nebu but this is the implementation plan the team used to provide an estimated cost.

7.1.4.3 Cost Estimate

According to Envelopes.com, an order of 100 A6 sized paper with custom printing and 110lb paper weight costs $85.95 [3]. The estimated cost to laminate every sheet is $1.29/sheet according to staples.com. An order of 48 black Expo markers costs $70 according to information from Staples [4] online. This leaves the total projected cost estimate to implement reusable deli order forms to be around $500.

7.1.4.4 Results

The results for key metrics from simulation experiment are shown in Appendix T. One hundred simulation runs were taken and each of the key metrics took the average from the one hundred runs when 1000 customers eat lunch, 1400 customers eat lunch, and 1800 customers eat lunch.

Table 11 highlights the important information drawn from the comparison of the results from the tables located in Appendix H and Appendix T. Values in black mean the experiment produced a smaller value than the current system model. Smaller values are preferred and show favorable results. Values in red mean the experiment produced a larger value than the current system mode, which is not favorable.

Key Metric Compared	Number of Customers	Difference in specified units	Percentage difference
Average Customer Time in System (minutes)	1000	0.095	2.16%
	1400	0.200	3.27%
	1800	0.072	0.84%
Maximum Customer Time in System (minutes)	1000	5.524	19.94%
	1400	5.232	9.30%
	1800	3.648	5.03%
Average Queue Length of the Deli Station (customers)	1000	0.024	0.83%
	1400	0.284	1.79%
	1800	1.500	4.91%
Maximum Queue Length of the Deli Station (customers)	1000	0.15	1.52%
	1400	0.18	0.57%
	1800	1.81	3.16%
Average Queue Length of the Deli BYO Station (customers)	1000	0.735	34.59%
	1400	2.869	39.26%
	1800	2.972	23.54%
Maximum Queue Length of the Deli BYO Station (customers)	1000	1.43	21.57%
	1400	4.22	28.67%
	1800	4.67	19.75%

Table 11: Experiment Results for the Deli Order Forms

The deli order forms experiment produced overall improvement, which is shown in Table 11. The average customer time in system showed a slight improvement but the maximum customer time in system showed a large improvement, especially for the 1000 and 1400 customer demand levels. While the Deli station showed very little change, the Deli BYO station showed a large percentage of improvement in both the average and maximum queue lengths.

7.1.5 Rearranging the Workers/Servers

7.1.5.1 Objective

The purpose of rearranging the number of servers in the café is to improve the throughput of stations that currently have long queues. Certain stations in the café have multiple workers serving customers but do not experience long lines. Other stations have long lines but still have room to fit one more worker. Workers are cross-trained so moving workers to another station should not be an issue. A simulation experiment that moves servers from one station to another can provide an idea of what rearrangements of servers would provide the best results.

7.1.5.2 Simulation Design

The simulation experiment of rearranging the capacity of the server at specific stations was designed to find the best possible implementation. Initially, the team used the results from the simulation model of the current system to see what stations could benefit from an additional worker, as well as, what stations would not be greatly affected with the reduction of a worker. The Deli, Deli BYO, and Grill stations had the worst queues in the current system simulation. The Global and Taqueria stations both used two workers but had very small queues in the current system simulation. The team used this information to move a worker from the Global station to the Grill station. The team moved one of the workers from the Taqueria station to the Deli BYO station. The Deli BYO worker is originally designed in the simulation of the current system to assist the Deli station whenever there is no line at the Deli BYO station. A second worker at the Deli BYO station follows the same logic and can serve customers from the Deli station line when there is no line in the Deli BYO station line. With this change, the Global and Taqueria station can now serve one customer at a time. The Grill station can serve up to four customers at one time and the Deli station can serve up to three customers at one time.

The Sushi and Asian capacity values for the simulation servers were not changed because only one physical worker is at each station. The Bistro has two workers at the station but the reduction of a worker created very large queues in the simulation. The pizza station is self-serve with one worker making sure the inventory of pizza does not reach zero. Because of these conditions, the only workers that could be moved were the second workers at the Taqueria and the Global station.

7.1.5.3 Cost Estimate

Employees are already cross-trained to work at multiple stations and since employees would be moved to other stations instead of new employees being hired, so no additional cost is expected.

7.1.5.4 Results

The results for key metrics from simulation experiment are shown in Appendix V. One hundred simulation runs were taken and each of the key metrics took the average from the one hundred runs when 1000 customers eat lunch, 1400 customers eat lunch, and 1800 customers eat lunch.

Table 12, shown below, highlights the important information drawn from the comparison of the results from the tables located in Appendix H and Appendix V. Values in black mean the experiment produced a smaller value than the current system model. Smaller values are preferred and show favorable results. Values in red mean the experiment produced a larger value than the current system mode, which is not favorable.

Key Metric Compared	Number of Customers	Difference in specified units	Percentage difference
Average Customer Time in System (minutes)	1000	0.514	11.69%
	1400	1.030	16.85%
	1800	0.297	3.49%
Maximum Customer Time in System (minutes)	1000	13.032	47.06%
	1400	29.693	52.78%
	1800	22.188	30.59%
Average Queue Length of the Deli Station (customers)	1000	2.474	85.52%
	1400	11.707	73.51%
	1800	11.621	38.04%
Maximum Queue Length of the Deli Station (customers)	1000	5.07	51.42%
	1400	16.89	53.53%
	1800	16.98	29.68%
Average Queue Length of the Deli BYO Station (customers)	1000	1.876	88.21%
	1400	6.628	90.72%
	1800	10.766	85.27%
Maximum Queue Length of the Deli BYO Station (customers)	1000	3.54	53.39%
	1400	10.31	70.04%
	1800	16.48	69.71%
Average Queue Length of the Grill Station (customers)	1000	0.212	73.30%
	1400	2.264	84.41%
	1800	10.830	83.01%
Maximum Queue Length of the Grill Station (customers)	1000	1.35	29.35%
	1400	6.50	51.55%
	1800	18.84	61.41%

Table 12: Experiment Results for Rearranging the Amount of Workers

The rearranging the number of workers/servers among stations produced favorable results in the key categories. The average customer time in system showed a strong improvement for the 1000 and 1400 customer demand levels, and a slight improvement for the 1800 customer demand levels. The other key metric percentages shown in Table 12 reveal significant improvement for the Deli, Deli BYO, and Grill queues as well as the maximum customer time in system for all three customer values. The results for the average and maximum queue for Global station showed that the values were still acceptable. The results for the average and maximum queue for the Taqueria station showed that the values were still acceptable for the 1000 and 1400 customer demand levels but the values fell into the unacceptable range for the 1800 customer demand levels with 14.9 average customers in queue and 29.4 average maximum queue length.

7.2 Evaluation of Ideas Not Requiring Simulation

The team's analysis of ideas without simulation experimentation included the expected cost estimates of each idea and the proposed design plan that the team would recommend.

Idea	Cost Estimate	Proposed Design	Benefit Estimates
Dedicate the Entrances and Exits	• Estimated total cost of **$1,350** • Estimated cost of $600 for rewiring the cash registers and a cost of $750 to repair the flooring assuming 100 square feet of flooring would need to be replaced or repaired • Cost based on estimates from electricians and flooring companies in the Oklahoma City Area, assuming the flooring is replaced with the same laminate wood	Move all registers to two of the current entrances (entrance 2 and 3) and make entrance 1 a dedicated entrance. Create signage on the exterior of the café to indicate to customers where the proper entrance and exit areas are, and include signage in the interior of the café to direct customers to the exits.	Dedicating the entrances and exits can reduce congestion near all three entrances, especially at entrance 1. It can also ensure that customers travel in a similar direction in the café.
Create tray rests for the Beverage station with Soda Fountains	• Estimated cost of **$500** • Estimation based on online research of tray slides for buffets and cafeterias	Install tray supports onto the existing drink counter spaces to allow customers to rest their food or food trays while acquiring a drink.	Customers will no longer have trouble obtaining a drink when a full tray of food is in their hands improving beverage station processing times.

Idea	Cost Estimate	Proposed Design	Benefit Estimates
Eliminate the line overlap of the Well Bistro and the Grill	• Estimated **no cost**	Reverse the assembly process behind the counter at the Well Bistro station to encourage customers to place their order where they currently complete/pick-up their order, causing the customer line to build away from the Grill station.	Eliminating the current line overlap will make it easier to avoid congestion for customers exiting the Grill station. It will also improve the Grill station's visibility to customers, improving navigation.
Move the fresh juice option	• Estimated **no cost**	Move the fresh juice containers and cups to Beverage C. This puts the juice drink option closer to Exit 3, where less beverage traffic and less walkway congestion occurs.	Relocating the fresh juice option to the other main beverage station reduces congestion at the middle beverage station.
Create collective menu and Nebu map	• Estimated cost of **$2,000** for two menus • Estimation based on online research of large digital display boards	Place a large digital display outside of the primary entrances (entrance 1 and entrance 3). The display would show a combined menu listing all food options in the café and indicate which station each option is located. The display will also include a basic layout map of Nebu café showing where all the stations are located. The digital aspect of the display will allow Nebu to alter the menu as the food options change throughout the year.	A collective menu and map allows customers to compare their food options and select an item outside of the system so they will spend less time inside the system selecting/finding their desired food. This will reduce the time in system for the customer, reduce congestion in the café, and make navigating the café simpler for the customer.

Idea	Cost Estimate	Proposed Design	Benefit Estimates
Redesign/Order new trays	• Estimated cost of **$2,000** for 1200 trays • Estimation based on online research of 12" x 16" trays	Order food trays that correctly fit on the tray return conveyor so the tray will not jam the conveyor when it travels around the corner	New food trays will eliminate conveyor jams, which will benefit the employees cleaning and restocking the dishes.
Have customers not empty their tray at the tray return	• Estimated cost of **$25** for 3 14"x10" aluminum signs near the tray return instructing customers to not empty their trays. • Estimation based on online research of aluminum cafeteria signs	Remove the trashcans and recycle bins at all of the tray return stations to remove the option for customers to clear their own plates. Implement basic signage to indicate to customers that all utensils, trays, trash, and leftover food should be placed on the tray return conveyor.	Removing the task of customers emptying their trays will reduce the time the customer spends at the tray return and will save the café money with the reduction of lost silverware.
Designate clear entrance and exit for tray return areas	• Estimated cost of **$40** for 5 14"x10" aluminum signs near the tray return entrances and exits. • Estimation based on online research of aluminum cafeteria signs	Implement signage displaying "Enter" and "Exit" on either side of the tray return station. This will indicate to customers the expected flow of the station and reduce potential congestion as they move in front of the tray return conveyor.	Customers will all enter the tray return area from one side improving process flow, reducing congestion, and reducing the time to return a tray.

8 Recommendations

The recommendations to Devon Energy and Nebu café are listed below. The first list involves major construction/renovation while the second list does not involve major construction/renovation, the recommendations are in order, with the team's strongest recommendations first, the next strongest second, and so on. The recommendations take into account every idea's feasibility, experimental analysis, and cost analysis. The annual cost of implementation is shown beside it to help Nebu to determine what should be implemented based on their budget.

Recommendation involving Major Construction/Renovation

1. Create Tray Rests at the beverage stations with fountain drinks - $500
2. Dedicate entrances and exits - $1,350

Recommendation not involving Major Construction/Renovation

1. Rearrange the number of workers at specific stations – no cost
2. Eliminate the line overlap of the Well Bistro and the Grill – no cost
3. Move the fresh juice option to a less busy beverage station – no cost
4. Do not have customers empty their tray at the tray return - $25
5. Designate clear entrance and exit for tray return areas - $40
6. Include paper order forms for customers to fill out in the Deli BYO station line - $500
7. Implement incentive system to distribute customer arrivals, but only if 20% of customers that normally come during the peak hour take advantage of it - $720
8. Add cold premade deli sandwiches and sides to NebuLOCAL station for pickup - $8,000
9. Create a collective menu and Nebu map besides each entrance - $2,000
10. Redesign the trays to correctly fit the tray return conveyor and avoid conveyor jams - $2,000

The team expects that implementing these recommendations will streamline the food buying process by reducing the amount of time spent by customers in the café to more acceptable levels and improve navigation of the café by reducing customer congestion, improving signage, and rearranging the café's entrance/exit layout. All of these benefits will ultimately make eating at the Nebu café for lunch an even more satisfying experience for the customer.

9 References

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[2] "Foodservice Firesale," [Online]. Available: foodservicefiresale.com. [Accessed 23 March 2016].

[3] "Envelopes.com," [Online]. Available: envelopes.com. [Accessed 31 March 2016].

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10 Appendices

10.1 Appendix A: Project Proposal

February 2016

Improving Customer Experiences at Nebu Café

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1.0 Background

Nebu Café was opened in March 2012 by Devon Energy Corporation and has become a popular eatery for Oklahoma City's downtown workforce. It is open to both Devon employees and the public from 6:30 a.m. to 9:30 a.m. for breakfast and 11:00 a.m. to 1:30 p.m. for lunch on weekdays. The café was built to be aesthetically pleasing and functional for the customer, but Nebu has been experiencing more customer traffic during the lunch periods than originally planned. This has led to customer experience issues, primarily due to lengthy queues and difficulty navigating the café.

Nebu has taken notice of the issues and has begun to implement technologies and strategies to reduce the total time in the café for the customer. Nebu has recently begun using point of sale technology from Nextep® at the cash registers to collect data on how long the check-out process takes and the volume of sales by menu item and by customer. Improvement strategies the café has implemented are to have both made-to-order items and pre-made items available at certain stations and to cross-train the majority of their food service staff to be able to work at any station. Even with these improvements, the customer experience issues are still apparent and management has requested the services of a senior design team at Oklahoma State to observe the system and develop recommendations to improve the overall experience of purchasing food at Nebu.

2.0 Problem Statement

Nebu management has received customer complaints due to the time it takes to enter the café, navigate the food stations, obtain food, checkout, and leave. The project will be to observe, model, and analyze the current system during the café lunch hours to find ways to reduce the total time in the café for the customer, while also maintaining the current level of quality and service. The scope of the problem includes: customers entering the system, selecting a food station, queueing in front of the station, obtaining food/beverages/tableware, checking out at the cash register, exiting the checkout line, and returning their tray and dishware. Based on the observations and collected data, the team will investigate and identify:

1. Process improvements to reduce the time to gather information to make a food purchase decision, find/locate the desired food station, beverage, and tableware, obtain the desired food, beverage, and tableware, and pay at the cashier.
2. Changes to the current layout that do not require additional labor or construction costs that can potentially reduce wait-times at bottleneck stations.
3. Unrestricted changes to the current layout that can potentially reduce wait-times at bottleneck stations.

Improving Customer Experiences at Nebu Café

3.0 Anticipated Methodology/Tasks

Phase I: Current Situation

- Understand the scope and constraints of Nebu's current situation by communicating with the client and observing the café during regular lunch hours
- Collect the café layout blueprints and historical data from the Nextep® software which includes: number of transactions, number of sales, how much of each item sold, and the checkout time
- Create data collection plan to record necessary data for analysis, such as arrival rates, processing times at each station, queue lengths, customer's flow through the café, etc. through time observations
- Perform data collection as planned
- Compile, organize, and analyze the collected data from historical information, and observations

Phase II: Model the Current System

- Create an as-is flowchart of common customer paths through the café
- Analyze raw data and design a representative model to develop and analyze the current system
- Analyze the model. Analysis may include queueing analysis, simulation modeling, or other operations research techniques

Phase III: Test and verify the analysis model of the current system

- Confirm accuracy of the analysis model using testing against observations
- Make necessary adjustments, validate, and confirm model use with the client

Phase IV: Create process improvement ideas and test analysis model of an improved system

- Assess potential improvement ideas using quantitative metrics e.g., total distance traveled, time in system, station processes, and improving signage
- Create alternative café layouts considering constraints
- Create alternative café layouts without considering constraints
- Seek to identify the best layout with facility layout software and historical data
- Identify the most effective layout and improvement ideas based on the client's desired criteria for a more enjoyable experience for the customer

Phase V: Finalize and implement recommendations

- Arrange and have a mid-project progress meeting with Devon
- Develop and submit a report including all findings and recommendations
- Prepare and deliver a project presentation including all findings and recommendations

Improving Customer Experiences at Nebu Café

4.0 Anticipated Schedule

A Gantt chart of the anticipated senior design team schedule is shown below:

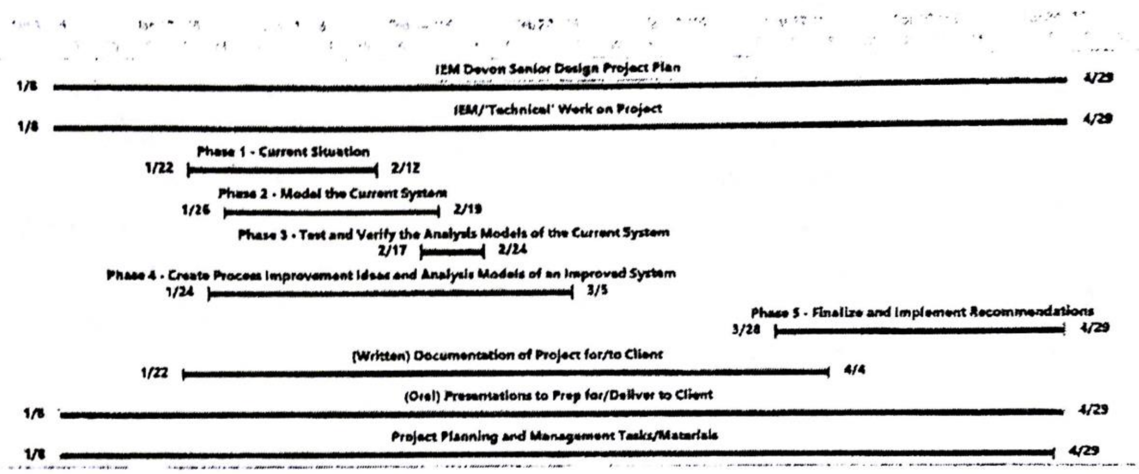


Figure 1. Screenshot of Anticipated Project Schedule from Microsoft Project

5.0 Anticipated Deliverables

A list of the anticipated deliverables are shown below:

- Collected data from Nebu
- Diagrams that show the flow of customers from entrance to the café to exit from the café
- Material and customer flow analysis for the current layout and alternative layouts
- A comparison of the current system and alternative systems with analysis and recommendations
    - Recommended strategies with construction
    - Recommended strategies without construction
- A suggested implementation plan of recommended solutions
- A cost-benefit analysis of the recommended solutions
- Final report and presentation that documents data gathered, analyses, findings, and recommendations

6.0 Anticipated Benefits

A better customer experience will result from:

- A streamlined food buying processes that reduces the amount of time spent by customers in the cafe
- Simpler navigation of the café and menus by potentially reducing the distance traveled by customers, improving signage, and/or rearranging the café layout

Improving Customer Experiences at Nebu Café

7.0 Risks and Risk Mitigation Strategy

Table 2. Risks and risk mitigation strategies

No.	Risks	Risk mitigation strategies
1	Inability to observe/gather sufficient sample data for desired statistical confidence	The team will seek historical sales data from Mark Vannasdall to guarantee precision and correctness. Statistical analysis/extrapolation may be applied and will be clearly documented, if necessary.
2	Changes to employment numbers in the area may increase or decrease the customers that attend Nebu for lunch.	All observations will be compared with historical data that has been previously collected for the past year, and analysis will account for possible increase/decrease

Endorsements – Endorsement below acknowledges receipt and acceptance of the proposal of the Senior Design Team from Oklahoma State University's School of Industrial Engineering and Management. Project will be executed on a 'best effort' basis and no warranty is stated or implied. All modifications to this proposal shall be provided, in writing, to all signatories for approval and acceptance.

On Behalf of Nebu Café

Mark Vannasdall — Date: 2-11-16

On Behalf of Devon Energy Corporation

Kent Chrisman — Date: 2/10/16

On Behalf of the Senior Design Team

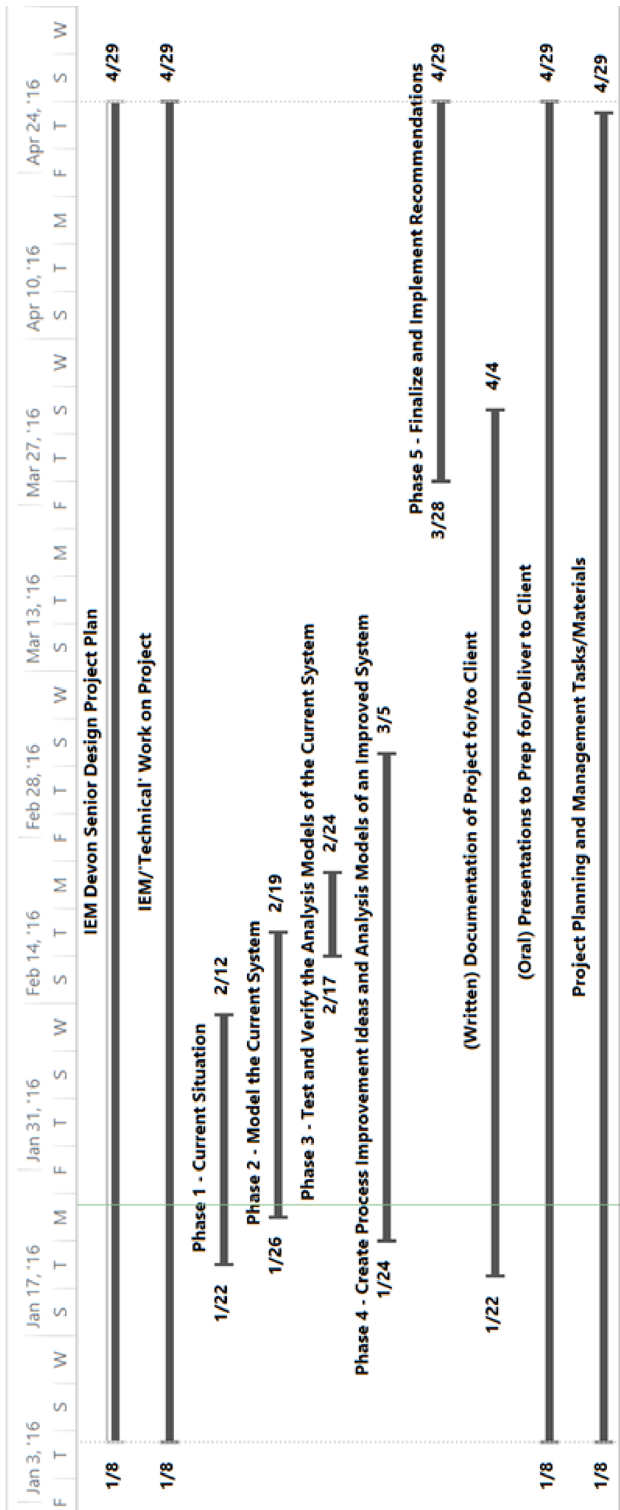
Connor Mojo — Date: 2/15/16

Carly Reaves — Date: 2/15/16

Hao Pan — Date: 2/15/16

10.2 Appendix B: Detailed Project Schedule

A detailed Gantt chart of the anticipated senior design team schedule is shown below:



10.3 Appendix C: Customer Flow Matrix

				1	2	3	4	5	6	7	8	9	10	11	12A	12B	12C	13	14A	14B	14C	14D	14E
	en1	en2	en3	Deli right	deli left	Grill	Well Bistro	Asian	Global	Pizza	Taqueria	Health Bar	Sushi	Desserts	middle Beverage	Beverages	Beverages	nebu LOCAL	cashier	cashier	cashier	cashier	cashier
31				1												2			3				
32				1																	2		
53				1												3	2				4		
33					1										3		2				4		
58					1																	2	
34						1											2				3		
50						1											2						
51						1															3		
54						1													2				
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56												1									2		
1													1						2				
18													1										
20													1							2			
23													1										
36														1	2							3	
37															1					2			
19																1				2			
44																		1		2			
45																		1		2			

10.4 Appendix D: List of the Input Errors in Nextep® and the Consolidated Food Items

Original Input	Correction Made
Two Asian categories were being used: Exhibition – Asian and Exhibition - Asaian	The items categorized under Exhibition – Asaian were added to the Exhibition – Asian category
Two Grill categories were being used: Grill – Grill and Grill - Gtill	The items categorized under Grill - Gtill were added to the Grill – Grill category
Cookie and Brownie were categorized under Snacks – Snacks not Desserts	Cookie and Brownie items were included in the Dessert category
Two Beverage categories were being used: Beverages – Retail Drinks and Beverages	The items categorized under Beverages – Retail Drinks were added to the Beverages category
Many HealthBar – HealthBar category items had another item with the same item name.	Items in the HealthBar – HealthBar section with the same names were consolidated to a single line with a new item and sales total.

10.5 Appendix E: ExpertFit® Analysis

10.5.1 Entrance

10.5.1.1 Entrance 1

Based on the analyzed data set of customers' inter-arrival time at Entrance 1, the team could not pick a proper distribution for entrance 1. The data set had 645 observations with a mean value of 5.7938. Johnson-SB distribution ranked as the best fit by ExpertFit®, but it did not pass Kolmogorov-Smirnov Test or Chis-Square Tests. Thus, the team would not use any parametric distribution to represent distribution of inter-arrival time at entrance 1.

10.5.1.2 Entrance 2

Based on the analyzed data set of customers' inter-arrival time at Entrance 2, the team selected a Beta distribution. The data set had 17 observations with a mean value of 218.53 and the Beta distribution closely followed the histogram, shown in Appendix F. Beta distribution ranked as the best fit by ExpertFit® and it also passed Kolmogorov-Smirnov Test to the alpha = 0.15level. A Chi-square test did not apply to this entrance because there were less than 6 intervals within the data set.

10.5.1.3 Entrance 3

Based on the analyzed data set of customers' inter-arrival time at Entrance 3, the team selected a Beta distribution. The data set had 38 observations with a mean value of 90.03 and the Beta distribution closely followed the histogram, shown in Appendix F. Beta distribution ranked as the best fit by ExpertFit® and it also passed both the Kolmogorov-Smirnov Test and the Chi-Square Test to the alpha = 0.15 level.

10.5.2 Deli Stations

For the Deli station, there are two different lines, pre-made Deli (Deli Station) and Deli Build Your Own (Deli BYO). Observation and analysis has been divided into two parts for the two lines,

10.5.2.1 Deli Station

Based on the analyzed data set of customers' inter-arrival time at Deli Station, the team selected a Beta distribution. The data set had 25 observations with a mean value of 111.28 and the Beta distribution closely followed the histogram, shown in Appendix F. Beta distribution ranked as the best fit by ExpertFit® and it also passed the Kolmogorov-Smirnov Test at alpha = 0.15 level. A Chi-square test did not apply to this station because there were less than 6 intervals within the data set.

10.5.2.2 Deli BYO

Based on the analyzed data set of customers' inter-arrival time at Deli BYO station, the team selected a Weibull distribution. The data set had 26 observations with a mean value of 197.38 and the Weibull distribution closely followed the histogram, shown in Appendix F. Weibull distribution ranked as the best fit by ExpertFit® and it also passed both the Kolmogorov-Smirnov Test and the Chi-Square Test to the alpha = 0.25 level.

10.5.3 Grill Station

Based on the analyzed data set of customers' inter-arrival time at the Grill station, the team selected a Log-Logistic distribution. The data set had 30 observations with a mean value of 113.80 and the Log-

Logistic distribution closely followed the histogram, shown in Appendix F. Log-Logistic distribution ranked as the best fit by ExpertFit® and it also passed both the Kolmogorov-Smirnov Test at alpha = 0.01 level and the Chi-Square Test to the alpha = 0.25 level.

10.5.4 Well Bistro Station

Based on the analyzed data set of customers' inter-arrival time at Well Bistro station, the team selected a Johnson SB distribution. The data set had 55 observations with a mean value of 40.09 and the Johnson SB distribution closely followed the histogram, shown in Appendix F. Johnson SB distribution ranked as the best fit by ExpertFit® and it also passed both the Kolmogorov-Smirnov Test at alpha = 0.15 level and the Chi-Square Test to the alpha = 0.25 level.

10.5.5 Asian Exhibition Station

Based on the analyzed data set of customers' inter-arrival time at Asian Exhibition station, the team selected a Log-Logistic distribution. The data set had 33 observations with a mean value of 286.03 and the Log-Logistic distribution closely followed the histogram, shown in Appendix F. Log-Logistic distribution ranked as the best fit by ExpertFit® and it also passed both the Kolmogorov-Smirnov Test at alpha = 0.1 level and the Chi-Square Test to the alpha = 0.25 level.

10.5.6 Global Exhibition Station

Based on the analyzed data set of customers' inter-arrival time at the Global Exhibition station, the team selected a Log-Logistic distribution. The data set had 33 observations with a mean value of 59.13 and the Log-Logistic distribution closely followed the histogram, shown in Appendix F. Log-Logistic distribution ranked as the best fit by ExpertFit® and it also passed both the Kolmogorov-Smirnov Test at alpha = 0.1 level and the Chi-Square Test to the alpha = 0.25 level.

10.5.7 Pizza Station

Based on the analyzed data set of customers' inter-arrival time at Pizza station, the team selected a Beta distribution. The data set had 24 observations with a mean value of 50.88 and the Beta distribution closely followed the histogram, shown in Appendix F. Beta distribution ranked as the best fit by ExpertFit® and it passed the Kolmogorov-Smirnov Test at alpha = 0.15 level. A Chi-square test did not apply to this station because there were less than 6 intervals within the data set.

10.5.8 Taqueria Station

Based on the analyzed data set of customers' inter-arrival time at Taqueria station, the team selected a Johnson SB distribution. The data set had 36 observations with a mean value of 71.28 and the Johnson SB distribution closely followed the histogram, shown in Appendix F. Johnson SB distribution ranked as the best fit by ExpertFit® and it also passed both the Kolmogorov-Smirnov Test at alpha = 0.15 level and the Chi-Square Test to the alpha = 0.25 level.

10.5.9 Health Bar and Soup Station

Based on the analyzed data set of customers' inter-arrival time at Health Bar and Soup station, the team selected a Johnson SB distribution. The data set had 31 observations with a mean value of 98.16 and the Johnson SB distribution closely followed the histogram, shown in Appendix F. Johnson SB distribution ranked as the best fit by ExpertFit® and it also passed both the Kolmogorov-Smirnov Test at alpha = 0.15 level and the Chi-Square Test to the alpha = 0.25 level.

10.5.10 Sushi Station

Based on the analyzed data set of customers' inter-arrival time at the Sushi station, the team selected a Johnson SB distribution. The data set had 49 observations with a mean value of 125.77 and the Johnson SB distribution closely followed the histogram, shown in Appendix F. Johnson SB distribution ranked as the best fit by ExpertFit® and it passed both the Kolmogorov-Smirnov Test at alpha = 0.15 level and the Chi-square Test at alpha = 0.25 level.

10.5.11 Dessert Station

The dessert station only contains premade desserts that are in reach of the customer. The processing time, the time it takes to grab a dessert, was not needed because it is near zero with almost no variation.

10.5.12 Beverage Stations

10.5.12.1 Beverage Station A

Beverage station A only contains drinks in the form of bottles and cans. There is no cups to be filled at this station so a processing time, the time it takes to grab a drink, was not needed because it is near zero with almost no variation.

10.5.12.2 Beverage Station B

Based on the analyzed data set of customers' inter-arrival time at Beverage B station, the team selected a Rayleigh(E) distribution. The data set had 34 observations with a mean value of 19.47 and Rayleigh(E) distribution closely followed the histogram, shown in Appendix F. Rayleigh(E) distribution ranked as the best fit by ExpertFit® and it passed both the Kolmogorov-Smirnov Test at alpha = 0.15 level and the Chi-square Test to the alpha = 0.25 level.

10.5.12.3 Beverage Station C

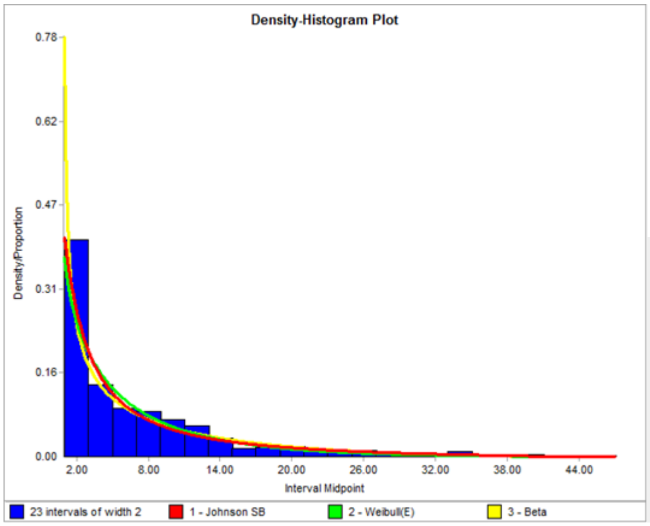
Based on the analyzed data set of customers' inter-arrival time at Beverage C station, the team selected a Beta distribution. The data set had 35 observations with a mean value of 24.66 and Beta distribution closely followed the histogram, shown in Appendix F. Beta distribution ranked as the best fit by ExpertFit® and it passed both the Kolmogorov-Smirnov Test at alpha = 0.15 level and the Chi-square Test at alpha = 0.25 level.

10.5.13 NebuLOCAL Station

NebuLOCAL station only contains premade drinks and food in easy reach of the customer. There is no cups to be filled at this station and no food that needs to be prepared so a processing time was not needed because it is near zero with almost no variation.

10.6 Appendix F: ExpertFit® Tables and Plots

Entrance 1:



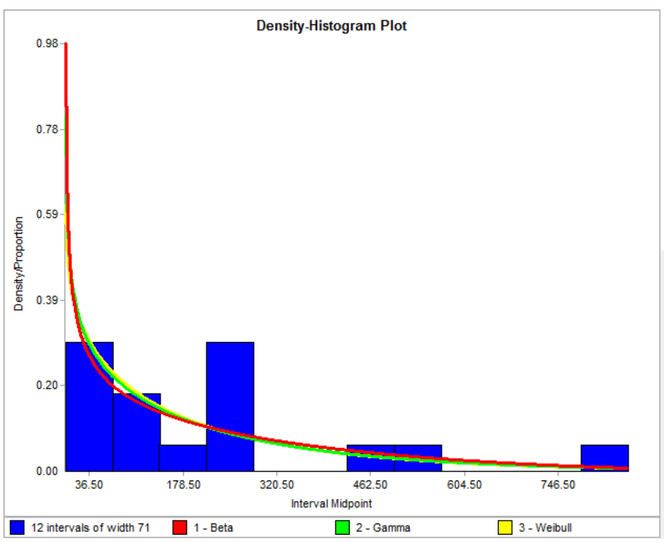
Kolmogorov-Smirnov Test with Model 1 - Johnson SB

Sample size 537
Normal test statistic 0.17735
Modified test statistic 4.10979

Note: No critical values exist for this special case. The following critical values are for the case where all parameters are known, and are conservative.

Sample Size	Critical Values for Level of Significance (alpha)				
	0.150	0.100	0.050	0.025	0.010
537	1.132	1.217	1.351	1.472	1.619
Reject?	Yes				

Entrance 2:



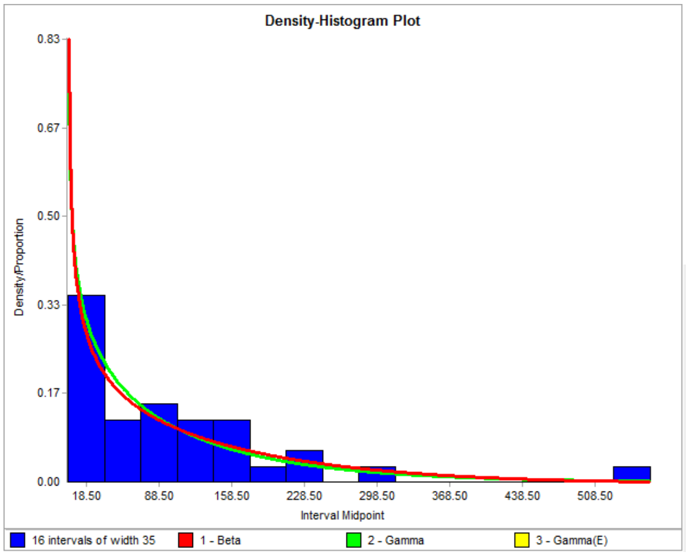
Kolmogorov-Smirnov Test with Model 1 - Beta

Sample size 17
Normal test statistic 0.13124
Modified test statistic 0.54113

Note: No critical values exist for this special case. The following critical values are for the case where all parameters are known, and are conservative.

Sample Size	Critical Values for Level of Significance (alpha)				
	0.150	0.100	0.050	0.025	0.010
17	1.099	1.182	1.311	1.429	1.572
Reject?	No				

Entrance 3:



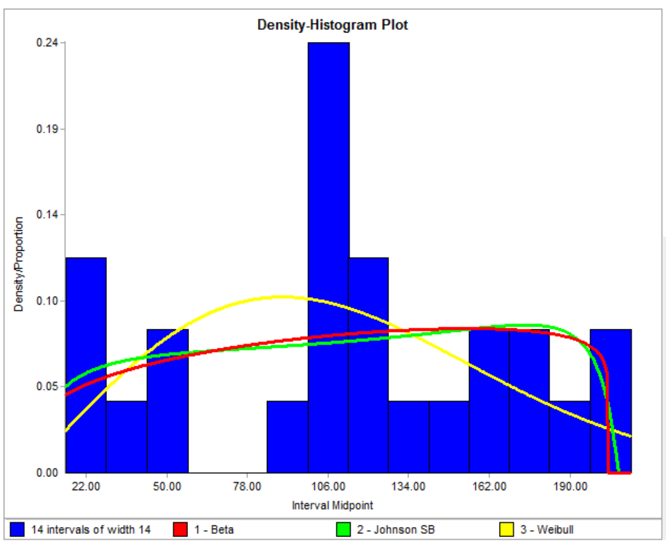
Kolmogorov-Smirnov Test with Model 1 - Random Walk

Sample size	38
Normal test statistic	0.14248
Modified test statistic	0.87828

Note: No critical values exist for this special case. The following critical values are for the case where all parameters are known, and are conservative.

	Critical Values for Level of Significance (alpha)				
Sample Size	0.150	0.100	0.050	0.025	0.010
38	1.113	1.197	1.328	1.448	1.592
Reject?	No				

Deli:



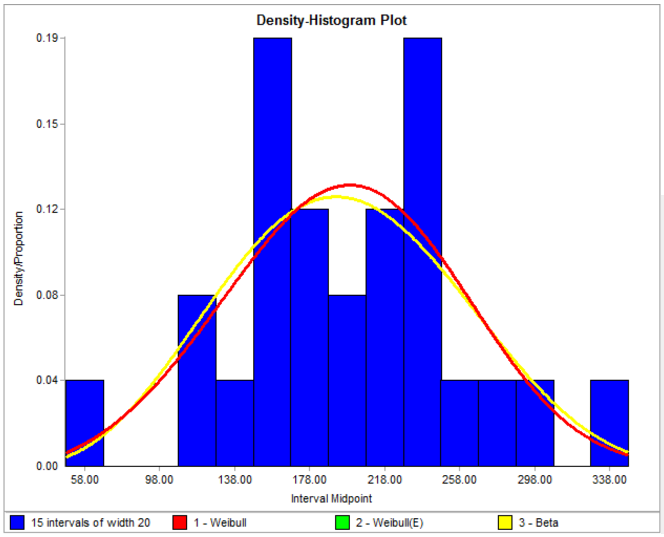
Kolmogorov-Smirnov Test with Model 1 - Beta

Sample size	25
Normal test statistic	0.14605
Modified test statistic	0.73027

Note: No critical values exist for this special case. The following critical values are for the case where all parameters are known, and are conservative.

	Critical Values for Level of Significance (alpha)				
Sample Size	0.150	0.100	0.050	0.025	0.010
25	1.107	1.190	1.320	1.439	1.583
Reject?	No				

BYO Deli:



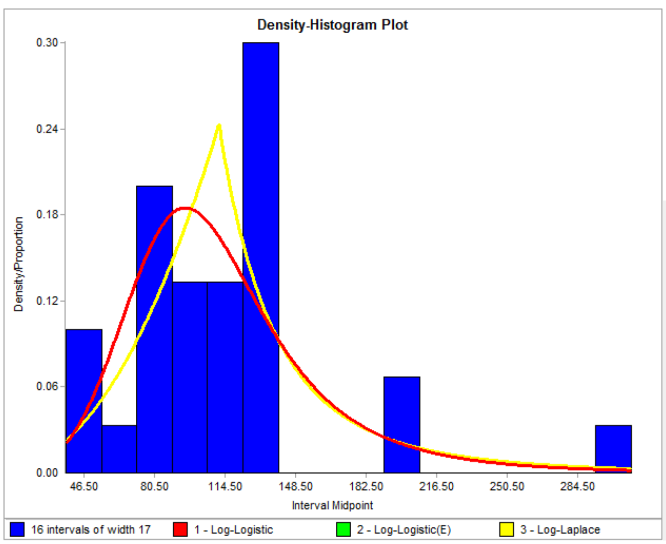
Kolmogorov-Smirnov Test with Model 1 - Weibull

Sample size	26
Normal test statistic	0.10285
Modified test statistic	0.52445

Note: The following critical values are exact.

Sample Size	Critical Values for Level of Significance (alpha) 0.100	0.050	0.025	0.010
20	0.779	0.843	0.907	0.973
50	0.790	0.856	0.922	0.988
Reject?	No			

Grill:



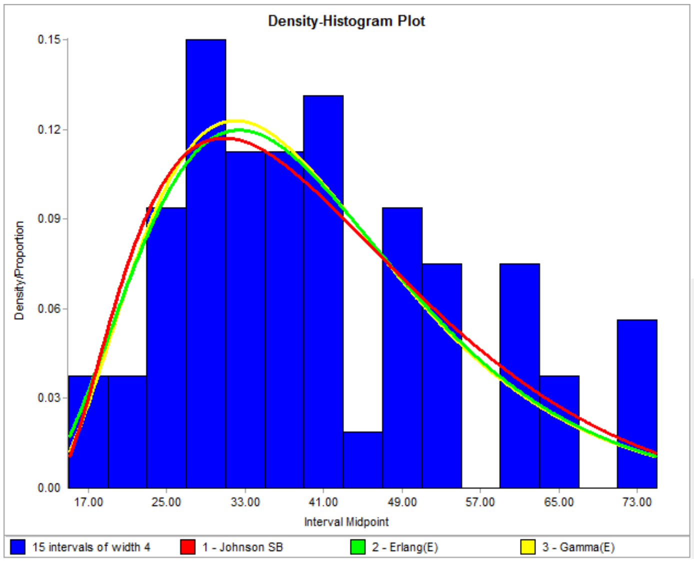
Kolmogorov-Smirnov Test with Model 1 - Log-Logistic

Sample size	30
Normal test statistic	0.15131
Modified test statistic	0.82878

Note: The following critical values are exact.

Sample Size	Critical Values for Level of Significance (alpha) 0.100	0.050	0.025	0.010
20	0.698	0.755	0.800	0.854
50	0.708	0.770	0.817	0.873
Reject?	Yes			No

Well Bistro:



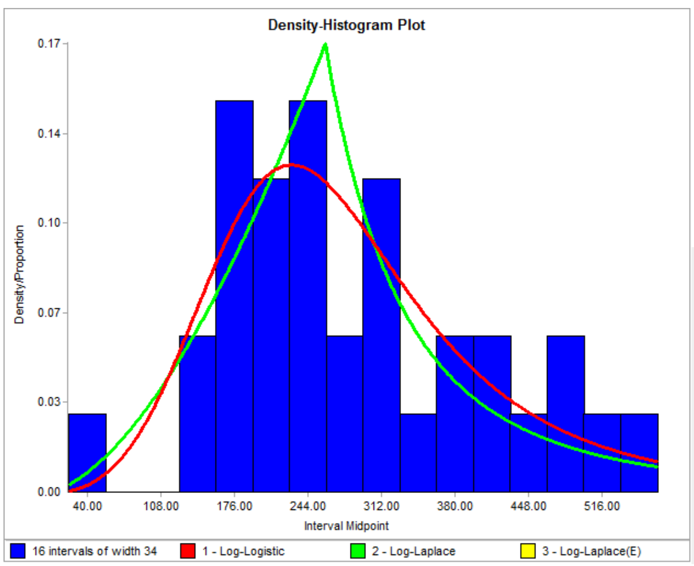
Kolmogorov-Smirnov Test with Model 1 - Johnson SB

Sample size 55
Normal test statistic 0.04791
Modified test statistic 0.35531

Note: No critical values exist for this special case.
The following critical values are for the case where all parameters are known, and are conservative.

Sample Size	Critical Values for Level of Significance (alpha)				
	0.150	0.100	0.050	0.025	0.010
55	1.118	1.202	1.334	1.454	1.599
Reject?	No				

Asian Exhibition:



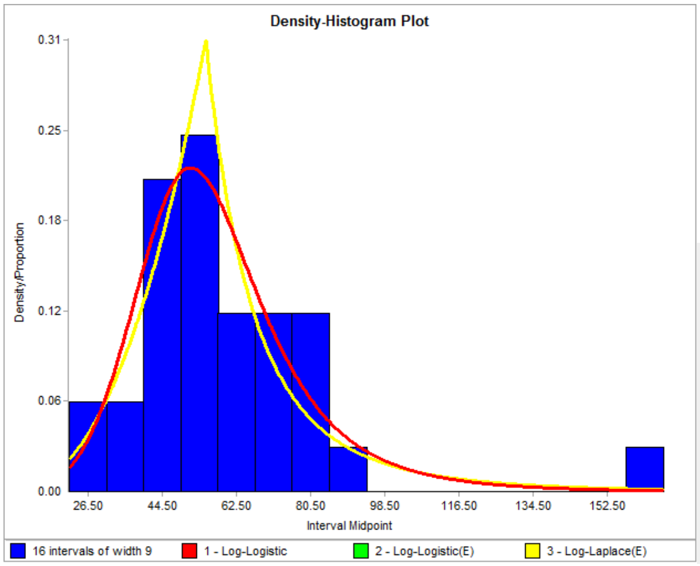
Kolmogorov-Smirnov Test with Model 1 - Log-Logistic

Sample size 33
Normal test statistic 0.05991
Modified test statistic 0.34416

Note: The following critical values are exact.

Sample Size	Critical Values for Level of Significance (alpha)			
	0.100	0.050	0.025	0.010
20	0.698	0.755	0.800	0.854
50	0.708	0.770	0.817	0.873
Reject?	No			

Global Exhibition:



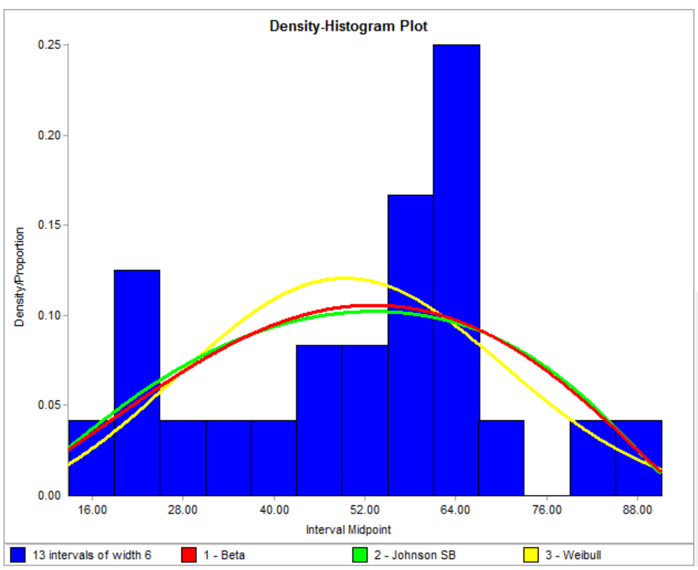
Kolmogorov-Smirnov Test with Model 1 - Log-Logistic

Sample size	33
Normal test statistic	0.06086
Modified test statistic	0.34963

Note: The following critical values are exact.

	Critical Values for Level of Significance (alpha)			
Sample Size	0.100	0.050	0.025	0.010
20	0.698	0.755	0.800	0.854
50	0.708	0.770	0.817	0.873
Reject?	No			

Pizza:



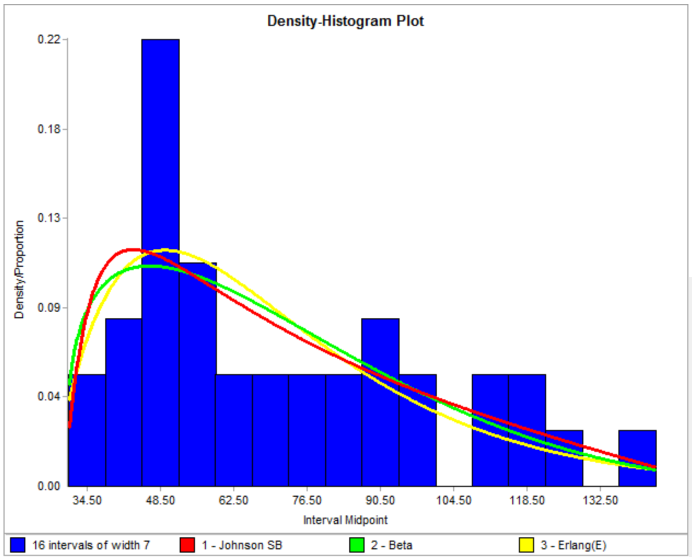
Kolmogorov-Smirnov Test with Model 1 - Beta

Sample size	24
Normal test statistic	0.14127
Modified test statistic	0.69205

Note: No critical values exist for this special case. The following critical values are for the case where all parameters are known, and are conservative.

	Critical Values for Level of Significance (alpha)				
Sample Size	0.150	0.100	0.050	0.025	0.010
24	1.106	1.189	1.320	1.438	1.582
Reject?	No				

Taqueria:



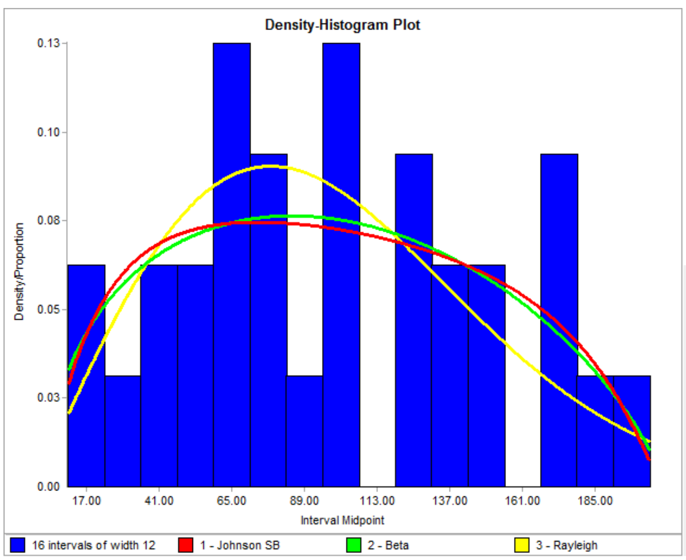
Kolmogorov-Smirnov Test with Model 1 - Johnson SB

Sample size 36
Normal test statistic 0.08220
Modified test statistic 0.49319

Note: No critical values exist for this special case. The following critical values are for the case where all parameters are known, and are conservative.

	Critical Values for Level of Significance (alpha)				
Sample Size	0.150	0.100	0.050	0.025	0.010
36	1.112	1.196	1.327	1.447	1.591
Reject?	No				

Health Bar and Soup:



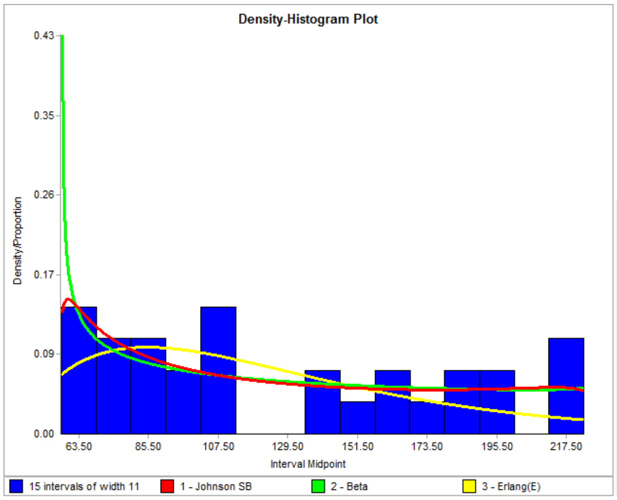
Kolmogorov-Smirnov Test with Model 1 - Johnson SB

Sample size 31
Normal test statistic 0.06363
Modified test statistic 0.35427

Note: No critical values exist for this special case. The following critical values are for the case where all parameters are known, and are conservative.

	Critical Values for Level of Significance (alpha)				
Sample Size	0.150	0.100	0.050	0.025	0.010
31	1.110	1.194	1.325	1.444	1.588
Reject?	No				

Sushi:



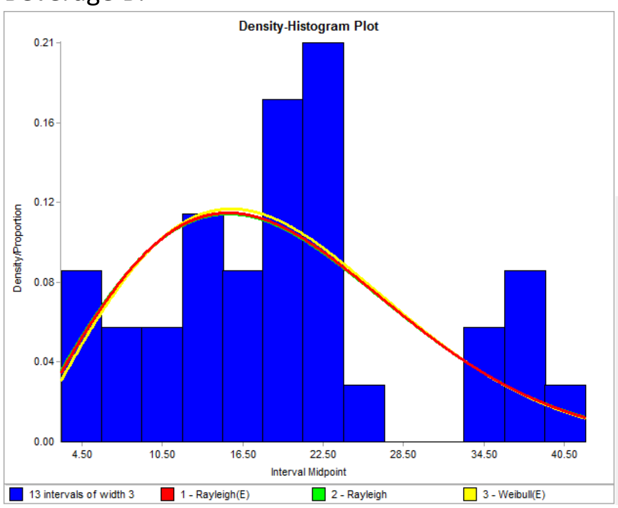
Kolmogorov-Smirnov Test with Model 1 - Johnson SB

Sample size 29
Normal test statistic 0.08908
Modified test statistic 0.47973

Note: No critical values exist for this special case. The following critical values are for the case where all parameters are known, and are conservative.

	Critical Values for Level of Significance (alpha)				
Sample Size	0.150	0.100	0.050	0.025	0.010
29	1.109	1.193	1.323	1.442	1.587
Reject?	No				

Beverage B:



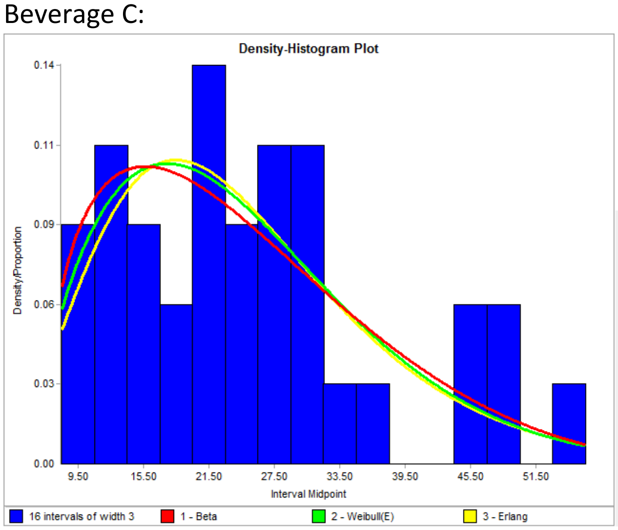
Kolmogorov-Smirnov Test with Model 1 - Rayleigh(E)

Sample size 34
Normal test statistic 0.12411
Modified test statistic 0.72370

Note: No critical values exist for this special case. The following critical values are for the case where all parameters are known, and are conservative.

	Critical Values for Level of Significance (alpha)				
Sample Size	0.150	0.100	0.050	0.025	0.010
34	1.112	1.196	1.326	1.446	1.590
Reject?	No				

Beverage C:



Kolmogorov-Smirnov Test with Model 1 - Beta

Sample size 35
Normal test statistic 0.07878
Modified test statistic 0.46609

Note: No critical values exist for this special case. The following critical values are for the case where all parameters are known, and are conservative.

	Critical Values for Level of Significance (alpha)				
Sample Size	0.150	0.100	0.050	0.025	0.010
35	1.112	1.196	1.327	1.446	1.591
Reject?	No				

10.7 Appendix G: Empirical Distribution of Customers' Inter-arrival Time

Original Inter-Arrival Time:

Random.Continuous(0.000000, 0.1661, 1.000000, 0.4224, 2.000000, 0.5031, 3.000000, 0.5637, 4.000000, 0.6149, 5.000000, 0.6584, 6.000000, 0.6894, 7.000000, 0.7283, 8.000000, 0.7593, 9.000000, 0.7919, 10.000000, 0.8168, 11.000000, 0.8354, 12.000000, 0.8649, 13.000000, 0.8789, 14.000000, 0.8944, 15.000000, 0.9053, 16.000000, 0.9068, 17.000000, 0.9146, 18.000000, 0.9208, 19.000000, 0.9270, 20.000000, 0.9363, 21.000000, 0.9441, 22.000000, 0.9488, 23.000000, 0.9519, 24.000000, 0.9550, 25.000000, 0.9596, 26.000000, 0.9643, 27.000000, 0.9689, 28.000000, 0.9720, 29.000000, 0.9736, 30.000000, 0.9767, 31.000000, 0.9783, 32.000000, 0.9814, 33.000000, 0.9891, 35.000000, 0.9907, 38.000000, 0.9922, 39.000000, 0.9953, 41.000000, 0.9969, 43.000000, 0.9984, 45.000000, 1.0000)

The above empirical distribution of inter-arrival time consists of several pairs of inter-arrival time and percentage of customers coming in within the respective inter-arrival time. For example, the first two numbers in the parenthesis are 0.000000, 0.1661, which means the percentage of customers coming into the café within 0.000000 seconds after their previous customers' entering is 0.1661, the second pair, 1.000000, 0.4224, means that the percentage of customers coming into the café within 1.000000 seconds after their previous customers' entering is 0.4224, and so on.

10.8 Appendix H: Results Table for the Simulation of the Current System

			Avg. of 1000 customers	Avg. of 1400 customers	Avg. of 1800 customers
Customer Time in System (minutes)		Avg.	4.397	6.117	8.495
		Avg. St. Dev.	0.417	0.585	0.994
		Max.	27.696	56.255	72.540
		Max. St. Dev.	9.097	8.749	7.848
Queue Length (customers)	Deli	Avg.	2.893	15.927	30.547
		Avg. St. Dev.	2.369	5.717	6.547
		Max.	9.86	31.55	57.21
		Max. St. Dev.	4.831	9.515	11.255
	Deli BYO	Avg.	2.126	7.307	12.626
		Avg. St. Dev.	1.569	3.404	3.988
		Max.	6.63	14.72	23.64
		Max. St. Dev.	3.136	5.678	6.190
	Grill	Avg.	0.290	2.682	13.047
		Avg. St. Dev.	0.205	2.470	6.592
		Max.	4.60	12.61	30.68
		Max. St. Dev.	1.664	6.270	11.411
	Bistro	Avg.	0.268	1.440	10.340
		Avg. St. Dev.	0.141	0.897	7.129
		Max.	5.48	11.12	29.89
		Max. St. Dev.	1.856	3.937	13.559
	Asian	Avg.	0.120	0.819	2.626
		Avg. St. Dev.	0.125	0.892	2.195
		Max.	2.39	5.17	9.03
		Max. St. Dev.	1.205	2.450	3.953
	Global Exhibition	Avg.	0.009	0.020	0.052
		Avg. St. Dev.	0.008	0.015	0.029
		Max.	1.43	1.80	2.53
		Max. St. Dev.	0.573	0.765	0.784
	Pizza	Avg.	0.001	0.003	0.008
		Avg. St. Dev.	0.002	0.005	0.007
		Max.	1.07	1.30	1.59
		Max. St. Dev.	0.256	0.595	0.740

			Avg. of 1000 customers	Avg. of 1400 customers	Avg. of 1800 customers
Queue Length (customers)	Taqueria	Avg.	0.050	0.175	0.392
		Avg. St. Dev.	0.031	0.106	0.243
		Max.	2.43	3.89	5.16
		Max. St. Dev.	0.879	1.449	1.879
	Health Bar and Soup	Avg.	0.023	0.128	0.449
		Avg. St. Dev.	0.024	0.096	0.282
		Max.	2.39	4.55	7.14
		Max. St. Dev.	1.399	1.811	2.523
	Sushi	Avg.	0.562	3.102	8.370
		Avg. St. Dev.	0.441	2.533	4.790
		Max.	3.98	9.25	17.55
		Max. St. Dev.	1.614	4.693	7.513
	Middle Beverage Station	Avg.	0.042	0.140	0.329
		Avg. St. Dev.	0.020	0.044	0.107
		Max.	3.70	5.13	6.98
		Max. St. Dev.	1.235	1.178	1.746
	Register A	Avg.	0.073	0.169	0.308
		Avg. St. Dev.	0.015	0.041	0.066
		Max.	2.17	3.15	3.90
		Max. St. Dev.	0.587	0.892	1.010
	Register B	Avg.	0.084	0.189	0.331
		Avg. St. Dev.	0.016	0.042	0.064
		Max.	2.26	3.19	4.01
		Max. St. Dev.	0.525	0.907	0.969
	Register C	Avg.	0.125	0.308	0.629
		Avg. St. Dev.	0.026	0.071	0.184
		Max.	2.63	4.01	5.54
		Max. St. Dev.	0.720	0.980	1.366
	Register D	Avg.	0.116	0.296	0.606
		Avg. St. Dev.	0.025	0.069	0.182
		Max.	2.62	4.05	5.47
		Max. St. Dev.	0.678	0.903	1.359
	Register E	Avg.	0.000	0.001	0.001
		Avg. St. Dev.	0.001	0.001	0.001
		Max.	1.00	1.02	1.01
		Max. St. Dev.	0.000	0.141	0.100

10.9 Appendix I: Utilization Results Table for the Current System

			Avg. of 1000 customers	Avg. of 1400 customers	Avg. of 1800 customers
Station Utilization (%)	Deli	Avg.	69.618	90.303	93.681
		St. Dev.	10.715	3.797	2.944
	Deli BYO	Avg.	78.568	92.892	94.641
		St. Dev.	9.304	4.033	3.301
	Grill	Avg.	51.627	73.131	90.167
		St. Dev.	4.639	5.845	4.048
	Bistro	Avg.	45.746	66.053	82.663
		St. Dev.	3.648	4.472	5.129
	Asian	Avg.	43.721	63.108	78.433
		St. Dev.	8.399	9.048	9.147
	Global Exhibition	Avg.	16.872	22.962	29.781
		St. Dev.	2.575	2.948	3.460
	Pizza	Avg.	10.769	15.226	19.290
		St. Dev.	1.445	1.995	1.860
	Taqueria	Avg.	29.336	41.117	52.564
		St. Dev.	3.049	4.766	4.873
	Health Bar and Soup	Avg.	31.810	44.808	56.656
		St. Dev.	2.929	3.534	4.134
	Sushi	Avg.	56.609	80.242	91.716
		St. Dev.	9.190	10.038	6.108
	Middle Beverage Station	Avg.	32.373	44.834	55.564
		St. Dev.	2.050	2.265	2.304
	Register A	Avg.	32.283	45.163	56.345
		St. Dev.	2.152	2.669	2.974
	Register B	Avg.	33.963	47.145	58.169
		St. Dev.	2.592	2.504	2.677
	Register C	Avg.	40.243	55.190	67.707
		St. Dev.	2.650	2.907	3.318
	Register D	Avg.	39.003	54.308	67.170
		St. Dev.	2.635	2.877	3.159
	Register E	Avg.	2.253	3.014	3.655
		St. Dev.	0.614	0.813	0.879

10.10 Appendix J: Results Table for the Mobile and Online Ordering Experiment Guaranteed Time

			Avg. of 1000 customers	Avg. of 1400 customers	Avg. of 1800 customers
Customer Time in System (minutes)		**Avg.**	4.397	5.995	8.930
		Avg. St. Dev.	0.723	0.845	1.219
		Max.	34.251	66.871	88.480
		Max. St. Dev.	11.924	11.311	9.288
Queue Length (customers)	**Deli**	**Avg.**	6.543	25.286	45.377
		Avg. St. Dev.	4.516	7.152	8.557
		Max.	13.570	39.010	67.930
		Max. St. Dev.	6.453	9.432	11.863
	Deli BYO	**Avg.**	3.115	10.394	19.671
		Avg. St. Dev.	2.737	4.701	5.262
		Max.	7.110	16.280	29.420
		Max. St. Dev.	3.763	6.087	7.282
	Grill	**Avg.**	0.517	5.781	25.482
		Avg. St. Dev.	0.350	5.104	10.664
		Max.	5.600	16.610	42.920
		Max. St. Dev.	1.923	8.505	14.576
	Bistro	**Avg.**	0.392	2.595	23.713
		Avg. St. Dev.	0.196	1.878	10.780
		Max.	6.200	13.340	46.070
		Max. St. Dev.	1.990	5.455	15.606
	Asian	**Avg.**	0.226	1.321	5.288
		Avg. St. Dev.	0.204	1.280	4.077
		Max.	3.030	6.100	11.830
		Max. St. Dev.	1.446	2.823	5.931
	Global Exhibition	**Avg.**	0.013	0.035	0.072
		Avg. St. Dev.	0.012	0.027	0.046
		Max.	1.540	2.130	2.780
		Max. St. Dev.	0.731	0.917	0.980
	Pizza	**Avg.**	0.001	0.002	0.005
		Avg. St. Dev.	0.003	0.003	0.007
		Max.	1.050	1.080	1.320
		Max. St. Dev.	0.261	0.273	0.649

			Avg. of 1000 customers	Avg. of 1400 customers	Avg. of 1800 customers
Queue Length (customers)	Taqueria	Avg.	0.072	0.227	0.739
		Avg. St. Dev.	0.047	0.138	0.652
		Max.	2.530	3.790	6.320
		Max. St. Dev.	0.958	1.358	2.696
	Health Bar and Soup	Avg.	0.011	0.065	0.235
		Avg. St. Dev.	0.016	0.054	0.159
		Max.	1.630	3.230	5.290
		Max. St. Dev.	0.884	1.370	1.893
	Sushi	Avg.	0.879	5.190	13.795
		Avg. St. Dev.	0.745	3.516	6.509
		Max.	4.440	10.990	22.170
		Max. St. Dev.	1.971	4.666	8.514
	Middle Beverage Station	Avg.	0.027	0.077	0.166
		Avg. St. Dev.	0.014	0.031	0.052
		Max.	2.910	3.910	5.280
		Max. St. Dev.	0.944	1.026	1.471
	Register A	Avg.	0.060	0.125	0.204
		Avg. St. Dev.	0.015	0.027	0.045
		Max.	1.960	2.560	3.080
		Max. St. Dev.	0.530	0.671	0.761
	Register B	Avg.	0.069	0.135	0.223
		Avg. St. Dev.	0.015	0.029	0.049
		Max.	1.910	2.490	3.140
		Max. St. Dev.	0.570	0.628	0.804
	Register C	Avg.	0.093	0.207	0.342
		Avg. St. Dev.	0.021	0.047	0.072
		Max.	2.120	3.050	3.770
		Max. St. Dev.	0.433	0.869	0.874
	Register D	Avg.	0.089	0.192	0.327
		Avg. St. Dev.	0.019	0.040	0.073
		Max.	2.020	3.070	3.820
		Max. St. Dev.	0.402	0.782	0.925
	Register E	Avg.	0.000	0.000	0.001
		Avg. St. Dev.	0.001	0.001	0.002
		Max.	1.000	1.000	1.010
		Max. St. Dev.	0.000	0.000	0.100

10.11 Appendix K: Utilization Results Table for the Mobile and Online Ordering Experiment Guaranteed Time

			Avg. of 1000 customers	Avg. of 1400 customers	Avg. of 1800 customers
Station Utilization (%)	Deli	Avg.	86.209	99.622	99.920
		St. Dev.	13.538	1.238	0.550
	Deli BYO	Avg.	88.304	99.432	99.958
		St. Dev.	9.942	2.188	0.323
	Grill	Avg.	57.962	83.657	98.853
		St. Dev.	6.146	7.527	2.510
	Bistro	Avg.	50.870	73.111	94.104
		St. Dev.	3.808	5.324	4.302
	Asian	Avg.	50.098	72.472	90.703
		St. Dev.	8.898	9.883	8.860
	Global Exhibition	Avg.	18.385	25.823	33.329
		St. Dev.	2.847	3.328	3.767
	Pizza	Avg.	9.780	13.255	17.079
		St. Dev.	1.814	2.079	2.042
	Taqueria	Avg.	32.911	46.491	59.378
		St. Dev.	4.186	4.753	6.140
	Health Bar and Soup	Avg.	28.164	40.400	50.751
		St. Dev.	3.347	3.837	4.381
	Sushi	Avg.	63.363	90.270	98.664
		St. Dev.	10.520	8.748	3.904
	Middle Beverage Station	Avg.	29.636	40.072	49.353
		St. Dev.	1.952	2.431	2.321
	Register A	Avg.	29.582	41.140	50.159
		St. Dev.	2.657	3.001	3.036
	Register B	Avg.	31.679	42.693	52.289
		St. Dev.	2.767	3.144	3.210
	Register C	Avg.	36.600	50.715	60.833
		St. Dev.	2.911	3.045	2.869
	Register D	Avg.	36.289	48.930	60.006
		St. Dev.	2.388	2.736	3.069
	Register E	Avg.	2.049	2.770	3.308
		St. Dev.	0.777	0.848	0.917

10.12 Appendix L: Results Table for the Mobile and Online Ordering Experiment No Guaranteed Time

			Avg. of 1000 customers	Avg. of 1400 customers	Avg. of 1800 customers
Customer Time in System (minutes)		Avg.	4.258	5.744	8.523
		Avg. St. Dev.	0.585	0.615	1.078
		Max.	30.369	59.292	78.073
		Max. St. Dev.	10.963	7.692	7.137
Queue Length (customers)	Deli	Avg.	4.802	19.479	36.856
		Avg. St. Dev.	3.902	5.090	6.964
		Max.	12.780	37.200	68.590
		Max. St. Dev.	6.605	9.130	12.380
	Deli BYO	Avg.	2.511	8.144	15.261
		Avg. St. Dev.	1.773	3.686	4.976
		Max.	6.990	16.300	28.540
		Max. St. Dev.	3.145	6.127	8.096
	Grill	Avg.	0.472	4.002	21.096
		Avg. St. Dev.	0.405	3.556	8.591
		Max.	5.670	14.860	44.380
		Max. St. Dev.	2.137	7.665	14.835
	Bistro	Avg.	0.386	2.239	19.408
		Avg. St. Dev.	0.208	1.716	9.138
		Max.	6.270	13.600	46.880
		Max. St. Dev.	2.300	5.485	16.081
	Asian	Avg.	0.210	1.207	4.582
		Avg. St. Dev.	0.207	1.235	3.395
		Max.	3.250	6.440	12.480
		Max. St. Dev.	1.720	3.316	5.880
	Global Exhibition	Avg.	0.010	0.030	0.073
		Avg. St. Dev.	0.009	0.018	0.042
		Max.	1.430	2.110	3.000
		Max. St. Dev.	0.655	0.777	1.064
	Pizza	Avg.	0.001	0.002	0.004
		Avg. St. Dev.	0.001	0.003	0.005
		Max.	1.020	1.120	1.300
		Max. St. Dev.	0.141	0.456	0.503

			Avg. of 1000 customers	Avg. of 1400 customers	Avg. of 1800 customers
Queue Length (customers)	Taqueria	Avg.	0.072	0.219	0.556
		Avg. St. Dev.	0.053	0.102	0.314
		Max.	2.610	4.060	5.970
		Max. St. Dev.	0.920	1.188	2.027
	Health Bar and Soup	Avg.	0.013	0.058	0.218
		Avg. St. Dev.	0.020	0.039	0.170
		Max.	1.840	3.190	5.630
		Max. St. Dev.	1.126	1.245	2.043
	Sushi	Avg.	0.693	3.595	10.221
		Avg. St. Dev.	0.485	2.708	4.621
		Max.	4.350	10.000	20.650
		Max. St. Dev.	1.648	4.934	7.231
	Middle Beverage Station	Avg.	0.023	0.069	0.157
		Avg. St. Dev.	0.012	0.024	0.041
		Max.	2.800	4.090	5.430
		Max. St. Dev.	0.876	1.016	1.208
	Register A	Avg.	0.054	0.113	0.177
		Avg. St. Dev.	0.013	0.021	0.033
		Max.	1.890	2.580	3.020
		Max. St. Dev.	0.549	0.699	0.864
	Register B	Avg.	0.062	0.126	0.195
		Avg. St. Dev.	0.013	0.023	0.032
		Max.	1.910	2.540	3.000
		Max. St. Dev.	0.570	0.771	0.739
	Register C	Avg.	0.091	0.185	0.311
		Avg. St. Dev.	0.019	0.035	0.071
		Max.	2.230	3.040	3.790
		Max. St. Dev.	0.548	0.751	0.998
	Register D	Avg.	0.081	0.169	0.296
		Avg. St. Dev.	0.018	0.032	0.072
		Max.	2.190	3.010	3.870
		Max. St. Dev.	0.526	0.659	0.960
	Register E	Avg.	0.000	0.000	0.001
		Avg. St. Dev.	0.001	0.001	0.001
		Max.	1.000	1.000	1.010
		Max. St. Dev.	0.000	0.000	0.100

10.13 Appendix M: Utilization Results Table for the Mobile and Online Ordering Experiment No Guaranteed Time

			Avg. of 1000 customers	Avg. of 1400 customers	Avg. of 1800 customers
Station Utilization (%)	Deli	Avg.	77.044	91.513	93.847
		St. Dev.	10.576	2.954	3.029
	Deli BYO	Avg.	81.921	93.333	95.244
		St. Dev.	7.965	3.893	3.264
	Grill	Avg.	55.723	77.566	93.072
		St. Dev.	5.353	6.752	2.600
	Bistro	Avg.	49.199	70.023	88.875
		St. Dev.	4.174	4.241	4.255
	Asian	Avg.	47.507	67.078	84.002
		St. Dev.	7.499	9.750	8.063
	Global Exhibition	Avg.	17.613	25.404	32.570
		St. Dev.	2.415	3.157	3.231
	Pizza	Avg.	9.268	12.761	16.956
		St. Dev.	1.397	1.480	1.889
	Taqueria	Avg.	31.900	45.128	56.883
		St. Dev.	3.850	4.156	5.246
	Health Bar and Soup	Avg.	27.546	38.865	48.823
		St. Dev.	2.992	3.016	3.697
	Sushi	Avg.	60.824	82.854	92.756
		St. Dev.	9.201	9.496	4.898
	Middle Beverage Station	Avg.	28.008	38.280	47.319
		St. Dev.	1.866	2.238	2.076
	Register A	Avg.	27.992	38.980	47.594
		St. Dev.	2.374	2.500	2.579
	Register B	Avg.	29.568	40.627	49.424
		St. Dev.	2.228	2.383	2.334
	Register C	Avg.	35.408	47.482	57.978
		St. Dev.	2.348	2.521	2.880
	Register D	Avg.	34.057	46.445	56.746
		St. Dev.	2.578	2.261	2.670
	Register E	Avg.	1.962	2.597	3.313
		St. Dev.	0.609	0.884	0.882

10.14 Appendix N: Results Table for the Incentives to Balance Customer Arrivals (10%)

			Avg. of 1000 customers	Avg. of 1400 customers	Avg. of 1800 customers
Customer Time in System (minutes)		Avg.	4.394	6.045	8.452
		Avg. St. Dev.	0.440	0.488	0.914
		Max.	26.188	54.502	72.085
		Max. St. Dev.	8.441	10.455	7.503
Queue Length (customers)	Deli	Avg.	3.184	16.848	29.902
		Avg. St. Dev.	2.798	5.931	6.355
		Max.	10.220	32.930	56.080
		Max. St. Dev.	5.383	9.933	10.735
	Deli BYO	Avg.	1.724	6.194	13.419
		Avg. St. Dev.	1.186	2.924	4.006
		Max.	5.640	12.920	25.140
		Max. St. Dev.	2.272	4.952	6.674
	Grill	Avg.	0.288	2.588	13.456
		Avg. St. Dev.	0.194	2.111	7.195
		Max.	4.800	12.260	31.390
		Max. St. Dev.	1.700	5.128	12.112
	Bistro	Avg.	0.241	1.384	9.365
		Avg. St. Dev.	0.118	0.968	6.491
		Max.	4.970	10.840	28.730
		Max. St. Dev.	1.432	4.175	12.734
	Asian	Avg.	0.141	0.658	2.882
		Avg. St. Dev.	0.221	0.636	3.048
		Max.	2.450	4.870	9.220
		Max. St. Dev.	1.344	2.092	5.397
	Global Exhibition	Avg.	0.008	0.026	0.057
		Avg. St. Dev.	0.006	0.021	0.039
		Max.	1.230	2.080	2.690
		Max. St. Dev.	0.423	0.907	0.907
	Pizza	Avg.	0.001	0.002	0.008
		Avg. St. Dev.	0.002	0.003	0.008
		Max.	1.030	1.120	1.580
		Max. St. Dev.	0.171	0.356	0.878

			Avg. of 1000 customers	Avg. of 1400 customers	Avg. of 1800 customers
Queue Length (customers)	Taqueria	Avg.	0.054	0.169	0.408
		Avg. St. Dev.	0.044	0.109	0.235
		Max.	2.480	3.810	5.270
		Max. St. Dev.	1.078	1.454	1.836
	Health Bar and Soup	Avg.	0.022	0.133	0.399
		Avg. St. Dev.	0.022	0.111	0.234
		Max.	2.290	4.770	7.000
		Max. St. Dev.	1.217	1.917	2.318
	Sushi	Avg.	0.599	2.554	7.883
		Avg. St. Dev.	0.676	1.841	3.433
		Max.	3.970	8.140	16.920
		Max. St. Dev.	1.845	3.399	5.745
	Middle Beverage Station	Avg.	0.039	0.141	0.343
		Avg. St. Dev.	0.014	0.050	0.110
		Max.	3.370	5.210	7.210
		Max. St. Dev.	0.906	1.635	1.629
	Register A	Avg.	0.072	0.158	0.304
		Avg. St. Dev.	0.015	0.026	0.067
		Max.	2.160	2.890	4.050
		Max. St. Dev.	0.507	0.618	0.903
	Register B	Avg.	0.082	0.176	0.327
		Avg. St. Dev.	0.018	0.028	0.065
		Max.	2.080	2.910	4.000
		Max. St. Dev.	0.526	0.712	0.985
	Register C	Avg.	0.117	0.296	0.620
		Avg. St. Dev.	0.022	0.071	0.168
		Max.	2.480	3.890	5.730
		Max. St. Dev.	0.659	1.034	1.601
	Register D	Avg.	0.110	0.278	0.604
		Avg. St. Dev.	0.023	0.068	0.165
		Max.	2.440	3.870	5.700
		Max. St. Dev.	0.656	1.022	1.685
	Register E	Avg.	0.000	0.001	0.001
		Avg. St. Dev.	0.001	0.001	0.001
		Max.	1.000	1.020	1.020
		Max. St. Dev.	0.000	0.141	0.141

10.15 Appendix O: Utilization Results Table for the Incentives to Balance Customer Arrivals (10%)

			Avg. of 1000 customers	Avg. of 1400 customers	Avg. of 1800 customers
Station Utilization (%)	Deli	Avg.	70.143	91.149	93.384
		St. Dev.	12.228	3.494	3.150
	Deli BYO	Avg.	77.023	92.583	94.684
		St. Dev.	10.493	4.957	3.294
	Grill	Avg.	51.080	72.700	90.291
		St. Dev.	4.388	6.322	4.544
	Bistro	Avg.	45.007	65.013	82.314
		St. Dev.	3.212	3.978	4.724
	Asian	Avg.	44.318	61.992	79.205
		St. Dev.	7.303	7.547	9.663
	Global Exhibition	Avg.	16.577	23.522	29.494
		St. Dev.	2.538	3.090	3.128
	Pizza	Avg.	10.544	14.822	19.282
		St. Dev.	1.657	1.932	1.821
	Taqueria	Avg.	29.255	41.249	52.684
		St. Dev.	4.038	4.514	5.037
	Health Bar and Soup	Avg.	31.479	45.030	55.562
		St. Dev.	3.224	3.459	3.954
	Sushi	Avg.	55.418	78.287	91.724
		St. Dev.	10.626	9.996	4.419
	Middle Beverage Station	Avg.	32.060	44.864	55.729
		St. Dev.	1.719	2.022	2.251
	Register A	Avg.	32.212	44.758	56.317
		St. Dev.	2.582	2.403	2.652
	Register B	Avg.	33.952	47.105	58.116
		St. Dev.	2.580	2.203	2.846
	Register C	Avg.	39.660	55.093	67.072
		St. Dev.	2.586	2.683	2.572
	Register D	Avg.	38.318	53.986	66.913
		St. Dev.	2.367	2.703	2.542
	Register E	Avg.	2.009	3.071	3.665
		St. Dev.	0.669	0.855	0.851

10.16 Appendix P: Results Table for the Incentives to Balance Customer Arrivals (20%)

			Avg. of 1000 customers	Avg. of 1400 customers	Avg. of 1800 customers
Customer Time in System (minutes)		Avg.	4.331	5.921	8.068
		Avg. St. Dev.	0.442	0.509	0.836
		Max.	25.052	53.511	70.829
		Max. St. Dev.	8.729	10.050	8.294
Queue Length (customers)	Deli	Avg.	2.722	15.738	29.223
		Avg. St. Dev.	2.114	5.474	6.444
		Max.	9.370	30.780	54.730
		Max. St. Dev.	4.165	8.936	10.540
	Deli BYO	Avg.	1.782	6.552	12.614
		Avg. St. Dev.	1.418	3.009	4.159
		Max.	5.750	13.450	23.520
		Max. St. Dev.	2.765	5.008	7.209
	Grill	Avg.	0.258	1.850	10.651
		Avg. St. Dev.	0.176	1.410	5.842
		Max.	4.510	10.090	26.510
		Max. St. Dev.	1.648	4.533	10.206
	Bistro	Avg.	0.236	1.233	7.973
		Avg. St. Dev.	0.119	0.903	6.124
		Max.	5.120	10.020	25.840
		Max. St. Dev.	1.725	3.874	12.222
	Asian	Avg.	0.127	0.657	2.415
		Avg. St. Dev.	0.156	0.672	2.467
		Max.	2.440	4.800	8.560
		Max. St. Dev.	1.328	2.366	4.556
	Global Exhibition	Avg.	0.009	0.022	0.052
		Avg. St. Dev.	0.009	0.017	0.033
		Max.	1.340	1.870	2.580
		Max. St. Dev.	0.555	0.837	0.901
	Pizza	Avg.	0.001	0.003	0.006
		Avg. St. Dev.	0.002	0.003	0.006
		Max.	1.090	1.210	1.460
		Max. St. Dev.	0.321	0.456	0.688

			Avg. of 1000 customers	Avg. of 1400 customers	Avg. of 1800 customers
Queue Length (customers)	Taqueria	Avg.	0.055	0.159	0.401
		Avg. St. Dev.	0.040	0.104	0.249
		Max.	2.390	3.570	5.270
		Max. St. Dev.	0.952	1.225	1.830
	Health Bar and Soup	Avg.	0.020	0.108	0.378
		Avg. St. Dev.	0.027	0.089	0.255
		Max.	2.200	4.160	6.660
		Max. St. Dev.	1.271	1.644	2.319
	Sushi	Avg.	0.472	2.355	7.721
		Avg. St. Dev.	0.489	2.087	4.472
		Max.	3.600	7.720	16.490
		Max. St. Dev.	1.633	3.499	7.398
	Middle Beverage Station	Avg.	0.036	0.125	0.304
		Avg. St. Dev.	0.016	0.040	0.098
		Max.	3.370	5.160	6.780
		Max. St. Dev.	0.928	1.261	1.673
	Register A	Avg.	0.072	0.160	0.287
		Avg. St. Dev.	0.017	0.030	0.071
		Max.	2.130	3.010	3.880
		Max. St. Dev.	0.597	0.718	0.977
	Register B	Avg.	0.079	0.172	0.313
		Avg. St. Dev.	0.019	0.035	0.073
		Max.	2.130	2.910	3.920
		Max. St. Dev.	0.677	0.668	0.992
	Register C	Avg.	0.118	0.279	0.569
		Avg. St. Dev.	0.023	0.061	0.186
		Max.	2.390	3.820	5.160
		Max. St. Dev.	0.601	1.019	1.475
	Register D	Avg.	0.107	0.265	0.552
		Avg. St. Dev.	0.019	0.058	0.185
		Max.	2.520	3.710	5.260
		Max. St. Dev.	0.627	1.028	1.522
	Register E	Avg.	0.000	0.001	0.001
		Avg. St. Dev.	0.001	0.002	0.002
		Max.	1.000	1.030	1.010
		Max. St. Dev.	0.000	0.171	0.100

10.17 Appendix Q: Utilization Results Table for the Incentives to Balance Customer Arrivals (20%)

			Avg. of 1000 customers	Avg. of 1400 customers	Avg. of 1800 customers
Station Utilization (%)	Deli	Avg.	68.627	90.583	93.818
		St. Dev.	12.631	3.145	3.104
	Deli BYO	Avg.	76.951	91.861	95.186
		St. Dev.	11.287	5.105	3.201
	Grill	Avg.	49.814	71.049	89.082
		St. Dev.	5.307	5.385	4.710
	Bistro	Avg.	44.964	64.194	80.895
		St. Dev.	3.369	4.105	5.235
	Asian	Avg.	43.112	62.344	76.174
		St. Dev.	7.350	8.683	10.040
	Global Exhibition	Avg.	16.418	22.777	29.465
		St. Dev.	2.512	3.251	3.491
	Pizza	Avg.	10.601	15.030	18.897
		St. Dev.	1.560	1.796	2.017
	Taqueria	Avg.	29.346	41.917	52.198
		St. Dev.	3.714	4.271	4.816
	Health Bar and Soup	Avg.	30.968	43.763	55.049
		St. Dev.	2.739	3.457	3.850
	Sushi	Avg.	54.118	77.613	91.460
		St. Dev.	9.766	9.488	5.075
	Middle Beverage Station	Avg.	31.721	44.217	54.598
		St. Dev.	1.753	2.134	2.326
	Register A	Avg.	31.923	44.628	54.900
		St. Dev.	2.389	2.422	2.869
	Register B	Avg.	33.167	45.902	56.973
		St. Dev.	2.609	2.747	3.059
	Register C	Avg.	39.335	54.243	66.330
		St. Dev.	2.566	2.798	3.167
	Register D	Avg.	38.030	53.242	65.970
		St. Dev.	2.150	2.664	3.073
	Register E	Avg.	2.082	2.986	3.742
		St. Dev.	0.684	0.839	0.983

10.18 Appendix R: Results Table for the Premade Sandwich Pick-up Experiment

			Avg. of 1000 customers	Avg. of 1400 customers	Avg. of 1800 customers
Customer Time in System (minutes)		Avg.	4.215	5.763	8.334
		Avg. St. Dev.	0.430	0.559	0.993
		Max.	24.124	50.175	65.964
		Max. St. Dev.	8.462	10.399	9.265
Queue Length (customers)	Deli	Avg.	1.844	9.550	21.227
		Avg. St. Dev.	2.230	4.910	6.011
		Max.	7.29	20.57	40.73
		Max. St. Dev.	4.248	8.195	10.395
	Deli BYO	Avg.	1.817	6.968	12.633
		Avg. St. Dev.	1.561	3.517	4.394
		Max.	5.76	14.27	23.53
		Max. St. Dev.	2.871	5.736	7.124
	Grill	Avg.	0.329	2.802	14.090
		Avg. St. Dev.	0.276	2.884	7.707
		Max.	4.95	12.20	32.46
		Max. St. Dev.	2.012	6.233	12.976
	Bistro	Avg.	0.275	1.421	11.233
		Avg. St. Dev.	0.132	1.342	6.423
		Max.	5.44	10.99	32.24
		Max. St. Dev.	1.783	5.096	11.866
	Asian	Avg.	0.165	0.825	2.763
		Avg. St. Dev.	0.180	0.727	2.594
		Max.	2.87	5.39	9.23
		Max. St. Dev.	1.397	2.344	4.905
	Global Exhibition	Avg.	0.008	0.025	0.055
		Avg. St. Dev.	0.008	0.018	0.033
		Max.	1.37	1.99	2.74
		Max. St. Dev.	0.646	0.916	1.021
	Pizza	Avg.	0.001	0.004	0.007
		Avg. St. Dev.	0.002	0.006	0.007
		Max.	1.04	1.38	1.56
		Max. St. Dev.	0.243	0.678	0.656

			Avg. of 1000 customers	Avg. of 1400 customers	Avg. of 1800 customers
Queue Length (customers)	Taqueria	Avg.	0.051	0.197	0.440
		Avg. St. Dev.	0.043	0.196	0.332
		Max.	2.43	3.94	5.28
		Max. St. Dev.	1.139	1.619	2.175
	Health Bar and Soup	Avg.	0.025	0.138	0.499
		Avg. St. Dev.	0.032	0.092	0.455
		Max.	2.36	4.67	7.23
		Max. St. Dev.	1.404	1.712	2.824
	Sushi	Avg.	0.593	3.000	8.002
		Avg. St. Dev.	0.462	2.431	4.579
		Max.	4.06	8.84	17.27
		Max. St. Dev.	1.863	4.431	7.898
	Middle Beverage Station	Avg.	0.035	0.121	0.301
		Avg. St. Dev.	0.015	0.042	0.097
		Max.	3.32	4.82	6.80
		Max. St. Dev.	0.942	1.226	1.664
	Register A	Avg.	0.073	0.168	0.316
		Avg. St. Dev.	0.016	0.037	0.081
		Max.	2.22	2.98	4.11
		Max. St. Dev.	0.484	0.804	1.286
	Register B	Avg.	0.082	0.183	0.341
		Avg. St. Dev.	0.019	0.042	0.085
		Max.	2.20	2.95	4.16
		Max. St. Dev.	0.512	0.744	1.261
	Register C	Avg.	0.129	0.324	0.703
		Avg. St. Dev.	0.027	0.077	0.203
		Max.	2.69	4.23	6.02
		Max. St. Dev.	0.662	1.053	1.576
	Register D	Avg.	0.118	0.310	0.684
		Avg. St. Dev.	0.028	0.077	0.200
		Max.	2.68	4.18	6.00
		Max. St. Dev.	0.764	1.029	1.544
	Register E	Avg.	0.001	0.001	0.002
		Avg. St. Dev.	0.001	0.001	0.002
		Max.	1.00	1.00	1.04
		Max. St. Dev.	0.000	0.000	0.197

10.19 Appendix S: Utilization Results Table for the Premade Sandwich Pick-up Experiment

			Avg. of 1000 customers	Avg. of 1400 customers	Avg. of 1800 customers
Station Utilization (%)	Deli	Avg.	58.855	85.992	92.081
		St. Dev.	12.904	6.619	3.332
	Deli BYO	Avg.	76.732	92.619	95.324
		St. Dev.	10.857	4.112	3.090
	Grill	Avg.	51.766	73.012	90.458
		St. Dev.	5.054	6.832	4.003
	Bistro	Avg.	45.926	65.547	83.757
		St. Dev.	3.655	4.024	4.671
	Asian	Avg.	45.102	63.166	78.507
		St. Dev.	7.551	8.613	9.952
	Global Exhibition	Avg.	16.342	23.339	29.959
		St. Dev.	2.114	2.994	3.152
	Pizza	Avg.	10.580	15.083	19.463
		St. Dev.	1.572	2.038	2.180
	Taqueria	Avg.	28.945	41.386	52.813
		St. Dev.	3.166	4.078	5.270
	Health Bar and Soup	Avg.	31.336	45.232	56.702
		St. Dev.	2.778	3.960	3.928
	Sushi	Avg.	57.522	80.265	91.188
		St. Dev.	9.080	9.512	5.328
	Middle Beverage Station	Avg.	30.927	43.636	54.465
		St. Dev.	1.802	2.327	2.212
	Register A	Avg.	31.844	45.484	56.363
		St. Dev.	2.324	2.556	2.419
	Register B	Avg.	33.622	46.941	58.344
		St. Dev.	2.503	2.955	2.671
	Register C	Avg.	40.541	55.827	69.081
		St. Dev.	2.539	2.857	2.907
	Register D	Avg.	38.952	54.867	68.537
		St. Dev.	2.419	2.960	2.794
	Register E	Avg.	2.275	3.120	4.066
		St. Dev.	0.638	0.882	0.980

10.20 Appendix T: Results Table for the Deli Order Forms Experiment

			Avg. of 1000 customers	Avg. of 1400 customers	Avg. of 1800 customers
Customer Time in System (minutes)		Avg.	4.302	5.917	8.423
		Avg. St. Dev.	0.465	0.571	0.919
		Max.	22.172	51.023	68.892
		Max. St. Dev.	7.761	10.627	7.571
Queue Length (customers)	Deli	Avg.	2.917	15.642	29.048
		Avg. St. Dev.	2.601	5.356	6.094
		Max.	9.71	31.37	55.40
		Max. St. Dev.	4.538	9.390	10.806
	Deli BYO	Avg.	1.391	4.438	9.653
		Avg. St. Dev.	1.210	2.596	3.768
		Max.	5.20	10.50	18.97
		Max. St. Dev.	2.441	4.444	6.565
	Grill	Avg.	0.317	2.658	13.582
		Avg. St. Dev.	0.308	2.274	6.747
		Max.	4.73	11.80	32.30
		Max. St. Dev.	1.863	5.003	11.248
	Bistro	Avg.	0.273	1.278	10.447
		Avg. St. Dev.	0.143	0.697	5.829
		Max.	5.52	10.09	31.07
		Max. St. Dev.	1.772	3.493	12.395
	Asian	Avg.	0.165	0.750	3.037
		Avg. St. Dev.	0.205	0.778	2.695
		Max.	2.82	5.19	9.67
		Max. St. Dev.	1.452	2.557	5.009
	Global Exhibition	Avg.	0.009	0.029	0.055
		Avg. St. Dev.	0.009	0.022	0.029
		Max.	1.45	2.05	2.66
		Max. St. Dev.	0.657	0.857	0.977
	Pizza	Avg.	0.001	0.003	0.007
		Avg. St. Dev.	0.002	0.006	0.010
		Max.	1.02	1.26	1.53
		Max. St. Dev.	0.141	0.597	0.745

			Avg. of 1000 customers	Avg. of 1400 customers	Avg. of 1800 customers
Queue Length (customers)	Taqueria	Avg.	0.054	0.150	0.438
		Avg. St. Dev.	0.037	0.106	0.276
		Max.	2.39	3.44	5.44
		Max. St. Dev.	0.898	1.274	1.956
	Health Bar and Soup	Avg.	0.022	0.133	0.560
		Avg. St. Dev.	0.024	0.099	0.447
		Max.	2.22	4.53	7.90
		Max. St. Dev.	1.133	1.617	3.030
	Sushi	Avg.	0.581	2.833	7.976
		Avg. St. Dev.	0.438	2.234	4.191
		Max.	4.06	8.61	16.98
		Max. St. Dev.	1.626	4.085	6.686
	Middle Beverage Station	Avg.	0.040	0.157	0.340
		Avg. St. Dev.	0.015	0.064	0.099
		Max.	3.46	5.68	7.34
		Max. St. Dev.	0.937	1.681	1.810
	Register A	Avg.	0.074	0.169	0.314
		Avg. St. Dev.	0.017	0.041	0.074
		Max.	2.16	3.12	4.08
		Max. St. Dev.	0.545	0.868	1.169
	Register B	Avg.	0.085	0.185	0.341
		Avg. St. Dev.	0.017	0.042	0.078
		Max.	2.24	3.09	4.10
		Max. St. Dev.	0.452	0.922	1.150
	Register C	Avg.	0.121	0.310	0.642
		Avg. St. Dev.	0.027	0.071	0.221
		Max.	2.60	4.08	5.78
		Max. St. Dev.	0.651	1.079	1.643
	Register D	Avg.	0.113	0.297	0.620
		Avg. St. Dev.	0.025	0.067	0.222
		Max.	2.53	4.04	5.76
		Max. St. Dev.	0.658	1.118	1.603
	Register E	Avg.	0.0003	0.001	0.001
		Avg. St. Dev.	0.001	0.001	0.001
		Max.	1.01	1.00	1.00
		Max. St. Dev.	0.100	0.000	0.000

10.21 Appendix U: Utilization Results Table for the Deli Order Forms Experiment

			Avg. of 1000 customers	Avg. of 1400 customers	Avg. of 1800 customers
Station Utilization (%)	Deli	Avg.	68.765	90.364	93.343
		St. Dev.	11.481	3.548	3.192
	Deli BYO	Avg.	70.481	88.500	93.750
		St. Dev.	11.565	5.665	3.796
	Grill	Avg.	51.339	73.945	90.116
		St. Dev.	5.135	6.372	4.759
	Bistro	Avg.	45.769	64.731	82.859
		St. Dev.	3.489	3.907	4.334
	Asian	Avg.	44.360	62.607	79.735
		St. Dev.	7.166	7.997	8.938
	Global Exhibition	Avg.	16.638	23.855	29.735
		St. Dev.	2.200	3.311	3.094
	Pizza	Avg.	10.734	15.472	19.046
		St. Dev.	1.696	1.803	2.012
	Taqueria	Avg.	29.502	41.392	52.790
		St. Dev.	4.014	4.472	4.634
	Health Bar and Soup	Avg.	31.716	44.704	57.281
		St. Dev.	3.398	3.598	3.950
	Sushi	Avg.	56.556	78.572	92.028
		St. Dev.	9.103	9.952	5.054
	Middle Beverage Station	Avg.	32.585	45.307	56.008
		St. Dev.	1.848	2.011	2.161
	Register A	Avg.	32.464	45.322	56.445
		St. Dev.	2.427	2.767	2.724
	Register B	Avg.	34.374	47.250	58.333
		St. Dev.	2.617	2.540	2.662
	Register C	Avg.	39.969	55.381	68.432
		St. Dev.	2.588	2.485	3.012
	Register D	Avg.	38.993	54.683	67.569
		St. Dev.	2.543	2.616	3.013
	Register E	Avg.	2.155	3.280	3.845
		St. Dev.	0.644	0.791	1.023

10.22 Appendix V: Results Table for the Rearrange Amount of Workers Experiment

			Avg. of 1000 customers	Avg. of 1400 customers	Avg. of 1800 customers
Customer Time in System (minutes)		Avg.	3.884	5.086	8.198
		Avg. St. Dev.	0.136	0.625	0.868
		Max.	14.663	26.562	50.352
		Max. St. Dev.	3.298	7.202	8.262
Queue Length (customers)	Deli	Avg.	0.419	4.220	18.926
		Avg. St. Dev.	0.335	3.028	6.266
		Max.	4.790	14.660	40.230
		Max. St. Dev.	1.976	6.422	10.678
	Deli BYO	Avg.	0.251	0.678	1.859
		Avg. St. Dev.	0.128	0.359	1.449
		Max.	3.090	4.410	7.160
		Max. St. Dev.	1.074	1.564	3.457
	Grill	Avg.	0.077	0.418	2.217
		Avg. St. Dev.	0.067	0.294	2.209
		Max.	3.250	6.110	11.840
		Max. St. Dev.	1.641	2.305	5.759
	Bistro	Avg.	0.290	1.517	10.906
		Avg. St. Dev.	0.134	1.229	6.517
		Max.	5.570	10.940	31.190
		Max. St. Dev.	1.701	4.278	13.036
	Asian	Avg.	0.144	0.802	2.801
		Avg. St. Dev.	0.117	0.886	2.913
		Max.	2.810	5.080	9.150
		Max. St. Dev.	1.237	2.612	4.768
	Global Exhibition	Avg.	0.112	0.340	0.866
		Avg. St. Dev.	0.075	0.196	0.523
		Max.	2.560	4.040	5.960
		Max. St. Dev.	0.880	1.385	2.136
	Pizza	Avg.	0.001	0.004	0.007
		Avg. St. Dev.	0.003	0.006	0.006
		Max.	1.080	1.350	1.550
		Max. St. Dev.	0.367	0.575	0.702

			Avg. of 1000 customers	Avg. of 1400 customers	Avg. of 1800 customers
Queue Length (customers)	Taqueria	Avg.	0.697	4.059	14.860
		Avg. St. Dev.	0.463	3.152	5.134
		Max.	5.140	12.330	29.420
		Max. St. Dev.	1.990	6.235	8.676
	Health Bar and Soup	Avg.	0.032	0.134	0.546
		Avg. St. Dev.	0.035	0.100	0.505
		Max.	2.540	4.650	7.730
		Max. St. Dev.	1.306	1.743	3.222
	Sushi	Avg.	0.615	2.664	8.198
		Avg. St. Dev.	0.560	2.183	4.064
		Max.	4.120	8.300	17.350
		Max. St. Dev.	1.996	4.213	6.554
	Middle Beverage Station	Avg.	0.039	0.143	0.329
		Avg. St. Dev.	0.016	0.041	0.087
		Max.	3.470	5.370	6.920
		Max. St. Dev.	0.958	1.292	1.426
	Register A	Avg.	0.073	0.177	0.331
		Avg. St. Dev.	0.014	0.037	0.078
		Max.	2.280	3.110	4.170
		Max. St. Dev.	0.570	0.790	1.074
	Register B	Avg.	0.085	0.195	0.352
		Avg. St. Dev.	0.017	0.041	0.080
		Max.	2.140	3.110	4.130
		Max. St. Dev.	0.493	0.815	1.041
	Register C	Avg.	0.129	0.347	0.778
		Avg. St. Dev.	0.026	0.083	0.256
		Max.	2.690	4.260	6.390
		Max. St. Dev.	0.748	1.011	1.814
	Register D	Avg.	0.116	0.332	0.764
		Avg. St. Dev.	0.025	0.084	0.252
		Max.	2.680	4.170	6.370
		Max. St. Dev.	0.695	0.954	1.790
	Register E	Avg.	0.000	0.001	0.001
		Avg. St. Dev.	0.001	0.001	0.002
		Max.	1.000	1.000	1.030
		Max. St. Dev.	0.000	0.000	0.171

10.23 Appendix W: Utilization Results Table for the Rearrange Amount of Workers Experiment

			Avg. of 1000 customers	Avg. of 1400 customers	Avg. of 1800 customers
Station Utilization (%)	Deli	Avg.	37.761	69.052	88.602
		St. Dev.	6.493	9.771	4.942
	Deli BYO	Avg.	43.002	60.863	74.871
		St. Dev.	6.876	8.065	6.612
	Grill	Avg.	38.825	55.333	70.462
		St. Dev.	3.429	3.840	5.523
	Bistro	Avg.	45.872	65.464	83.524
		St. Dev.	3.661	4.935	4.635
	Asian	Avg.	44.516	62.929	78.535
		St. Dev.	6.868	9.838	8.863
	Global Exhibition	Avg.	33.558	47.356	60.831
		St. Dev.	4.949	6.175	6.806
	Pizza	Avg.	10.644	15.329	19.843
		St. Dev.	1.292	1.742	2.014
	Taqueria	Avg.	58.152	80.312	93.704
		St. Dev.	6.500	8.551	3.102
	Health Bar and Soup	Avg.	31.825	44.870	56.650
		St. Dev.	2.734	3.533	4.390
	Sushi	Avg.	57.164	78.411	91.268
		St. Dev.	9.885	10.192	6.079
	Middle Beverage Station	Avg.	32.502	45.751	56.694
		St. Dev.	1.614	2.234	2.206
	Register A	Avg.	32.361	46.236	57.776
		St. Dev.	2.184	2.512	3.014
	Register B	Avg.	34.323	48.285	59.226
		St. Dev.	2.282	3.034	2.799
	Register C	Avg.	40.418	56.732	70.063
		St. Dev.	2.655	3.104	2.986
	Register D	Avg.	39.025	56.386	69.495
		St. Dev.	2.516	2.981	2.856
	Register E	Avg.	2.244	3.146	3.984
		St. Dev.	0.694	0.925	0.952