OMIS4000
MODELS & APPLICATIONS IN OPERATIONAL RESEARCH

PROJECT REPORT

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EXECUTIVE SUMMARY

The Ten Spot is an "anti-spa" with over 20 locations in Canada. [1] The company's mission is to ensure customers leave feeling like a ten by providing excellent quality service at an affordable price. [1] Customers are considered top priority in running the business and are considered in many aspects of decision making.

The Ten Spot recognizes that its employees are the key to providing quality service and prides itself in giving their employees reasonable compensation. With high wages and an emphasis on customer quality, the company must find a balance between how many employees to staff at a time that would decrease costs but keep customer service quality high. As such, The Ten Spot requires an employee scheduling method that would increase efficiency while maintaining high customer service scores. The underlying problem currently faced by The Ten Spot is how to minimize customer turnaways (that arise from understaffing) by efficiently scheduling employees.

In order to find a solution to this issue, we have developed a goal program to optimize scheduling for the Beaches location. Using data records, we have derived a mathematical model to find an optimal solution within constraints and assumptions that will further be discussed. Preliminary calculations of averages and determination of patterns in demand are incorporated into our model.

An analysis of data collected highlighted certain patterns that were useful in our calculations. Demand, as well as peak and off-peak hours were determined from this data. This data was used in calculating average service prices and the corresponding service duration (that are used in the model), as well as the cost of turnaways. The data also highlighted that 21 situations (3 shifts per day, 7 days per week) needed to be outlined within our model.

The resulting output of our model is how many employees to schedule per shift in order to minimize turnaway costs, and thus our recommendation is to implement this schedule. Although our model is robust and has factored in seasonality, peak and off-peak demand, laws and regulations, and is created based on historical data and facts, there are certain limitations. Our model can only be as good as the data collected, and there will always be randomness and variations between actuals and predictions. However this model is feasible and is believed to be effective in practice.

1. INTRODUCTION

The Ten Spot currently uses a booking system to schedule clients, however, as the business has expanded, it is vital that they remain competitive by ensuring that they have the appropriate amount of staff on hand to meet the continuously increasing demand.

Based on our conversation with Jackie, we were made aware of 2 goals:

1. To efficiently schedule staff in order to meet demand and minimize idle time
2. Minimize the cost associated with turning away customers

The Ten Spot currently seeks to schedule enough employees in order to meet daily demand, as well as minimizing the cost associated with turning away customers due to lack of staff on hand. This requires an optimized schedule for all employees, particularly *experts*, whom are essential in servicing clients. Achieving the aforementioned objective also helps optimize costs associated with overstaffing and understaffing. This report utilizes goal programming in order to minimize staffing discrepancies, which in turn allows us to minimize turn-away's and hence reduce the cost associated with each lost sale.

Firstly, this report focuses on optimizing staff-scheduling for the Beaches location. The assumptions listed in the report will underpin our analysis. The report further highlights what data in particular was collected, reasoning behind its collection and the analysis from the data. Lastly, the report expands how the solution was implemented through *python* programming, and offers a recommendation while keeping in mind its limitations as well.

2. THE PROBLEM

Managing employee schedules is critical for The Ten Spot's success, and is responsible for a high percentage of revenue. Therefore, staff-scheduling is one of the most important aspects that determines the businesses financial health.

In 2017, as per our calculations, The Ten Spot lost approximately **$94/day** in turnaway costs (Appendix 1). In other words, on average, the company lost $94 each day due to its inability to fulfill incoming demand due to staff shortage. This figure was calculated by totalling the turnaway cost for 2017, and dividing it by the total working days during that period.

To minimize this opportunity cost, which is represented by each lost sale, and to satisfy appointment and walk in demand, a goal programming model has been created. The model attempts to minimize the cost associated with each turnaway recorded in each shift, for each day of the week. This is done through optimized scheduling, resulting in a schedule that is not only viable for all 8 employees currently working at the Beaches location, but also meets the incoming demand for each shift, for all 7 working-days of the week. Furthermore, an indirect implication of implementing such a model is that the cost associated with *idle time* is minimized. In other words, the amount of time that each *expert* is free, or not providing service is minimized. Thus, maximizing the utilization of each expert as well. Implementing the model will help The Ten Spot minimize a major portion of the businesses operating costs.

3. DATA COLLECTION & ANALYSIS

- Detailed explanation of each data-set that was collected, and methods used to analyze it
- Steps taken to obtain data
- Why certain modeling decisions were made
- Why the model faithfully addresses the problem
- Reasoning for certain assumptions
- Demonstrate that the optimization solution is applicable and profiting

Peak vs. off-peak

Overall, based on monthly revenue, we have found a peak in demand during the months of June and December. [2] For the Beaches location in particular, we have concluded that the top three services are waxing, pedicures and manicures, respectively. [2] As such, we prioritized the demand of these service categories, ensuring that there will be sufficient staff equipped with the ability to fulfil the demand.

The Ten Spot also experiences seasonality when the data is observed from a daily perspective. As can be seen on the graph in Appendix 2, which represents daily demand from 2015 to 2018, **Fridays** and **Saturdays** historically bring in significantly more revenue than other days of the week. [2] The difference in revenue amongst the other weekdays (Monday-Thursday) are not as significant. Appendix 3 shows that during each business day, The Ten Spot also experiences a peak in demand between **12PM and 5PM**, with Index representing the hour of the day.

Service Duration

In our simulations, we averaged the service time for each respective service offered, such as waxing, threading, manicure etc. This value is used in goal programming to simplify our model. Averages were used because based on the skill level of the employee, or the needs of the customer, service times can differ significantly. Using averages gives The Ten Spot greater flexibility in applying our model while business fluctuates. Generating a model based on exact values would be more accurate,, however, it would not likely represent future figures. Averages prevent data from being skewed which is essential given that future demand for each service cannot be accurately predicted. In addition, it accounts for randomness found in data.

Furthermore, our team collectd data highlighting the total number of hours all *experts* worked, as well as the total number of services provided by these employees for the past 1.5 years. From this data, we were able to conclude that on average an *expert* can provide 1.2 services per hour. [2] Hence, in 1 shift (4 hours), an *expert* is capable of serving approximately 4.8 customers. This is an important finding since it gives us an approximate number of employees to schedule depending on the demand for each shift. Moreover, using the average service times for each service type, it is possible to come up with a reasonable range for the above statistic. For instance, the service-type with the highest average service time are *facials*, taking on average 47.5 minutes, meanwhile *manicures* only require about 17.5 minutes on average. [2] In other words, an employee performing a *facial* and a *manicure* would at most be able to serve **2** customers. Also, a customer may come in for multiple services, thus significantly reducing the amount of customers served per hour.

Therefore, a range between 2 and 6 customers can be used for the variable, representing the number of customers served by each employee in a shift given the wide range of unknown variables affecting service time, and respecting the average of 4.8 customers served per 4 hour shift.

Cost of Turnaway

Given that our objective is to find the optimal number of employees to schedule for each particular shift in order to minimize turn-away, the cost associated with each turnaway is crucial. Based on the turnaway data of the past year (Jan 2017 - Dec 2017), the average cost of one customer being turned away is $65 (Appendix 1). In other words, on average, it cost The Ten Spot $65 for each customer they were unable to serve. This value was derived from averaging the expected revenue from each cancelled appointment in 2017. We then further dissected the costs associated with turning away customers by finding the probability of being turned away, the average demand for each of the 3 shifts per day we are proposing, the probability of being turned away on a given day of the week, the turn away per shift, and finally the cost of turnaways incurred each shift on each of day of the week (Appendix 4).

4. FORMULATION

I. Assumptions

The simulation was modeled using real-time factors and data gathered from the Beaches location from Booker. For other figures, some assumptions were made:

- The Ten Spot opens at 8AM and closes at 8PM every working day (Monday-Sunday).

- Each employee can only work a maximum of 8 hours a day (two shifts) and 44 hours a week (11 shifts) due to provincial regulations.

- Each shift is 4 hours long. **Shift 1** starts at 8AM and ends at 12PM, **Shift 2** starts at 12PM and ends at 4PM, and **Shift 3** starts at 4PM and ends at 8PM.

Note: *These three shifts were chosen based on data evidence that there is a pattern in daily demand (not busy 8AM - 10AM , busy 10AM - 12PM, busiest 12PM - 5PM, busy 5PM - 6PM, not busy 6PM - 8PM).*
To simplify the model and provide reasonable shift hours to employees, the time between 8AM to 12PM, and 5PM to 8PM were grouped as a shift. Furthermore, these times experienced similar demand.

- Since the demand for each time period is different, each shift would require a different minimum number of employees, however the maximum number of employees per shift is 8 on any given day, as there are only 8 employees working at the location.

- The number of shifts an employee can be assigned is integral. There are no fractional shifts and thus employees will work a multiple of 4 hours a day if they are working.

- No overtime is allowed. As well, employees can be assigned a maximum of 44 hours per week. Thus, avoiding any overtime costs as well.

- Customers can schedule an appointment by phone or walk-ins

- Customers can walk-in at any time of the day.
    - We retrieved the following data by averaging the walk-ins for every day of the week from February 2015 - February 2018 (Appendix 5)
        - 1 walk -in (Sunday - Friday)
        - 2 walk- ins per weekend (Saturday)

- One employee can only serve one customer at a time.

- Each employee is equipped with the same skills and training, thus are of similar ability.

- There are a total of 8 employees at any given time available to be scheduled.

- The total number of staffs will remain constant--if one employee is let go or quits, a new employee will be hired. Thus, staff members can be replaced but not added.

- There are no statutory holidays.

II. Constraints

In our model, we have defined both soft and hard constraints. Hard constraints are set conditions that must be satisfied, while soft constraints represent goals that have greater flexibility in meeting the obligation. In the objective function, which we will discuss in the following section, soft constraints have some variable values that represents the penalization in case the conditions are not met.

Hard Constraints:

- Meeting daily minimum staff level - regardless of whether the time of day is peak or non-peak, there must be at least two employees for every shift. The lowest demand per shift is Monday which is 6 customers/shift (Appendix 6). 2 employees are enough to cover for 6 customers in 4 hours. In order for The Ten Spot to be functional during business hours, it must have employees working in every shift at all times.

- Maximum Shifts per employee - Each employee can have a maximum of two (4-hour) shifts per day (8 working hours per day) and 11 shifts per week (44 working hours per week).

- Minimum Shifts per employee - each employee must work at least one shift if it is decided they are working that day, and they must work at least one shift per week. If employees are scheduled less than once per week, it is likely they will leave the company as they are not receiving enough hours

- The number of shifts a person can work in a day or week are integral. That is, an employee cannot work half a shift (or any other fractional value).

- Binary Constraint - an employee can either be working a shift or not

Soft constraints:

- Since the exact number of walk-ins and appointment bookings are unpredictable and random, daily demand will deviate from predictions, thus the demand constraint must be flexible to capture this.

III. Objective Function

$$\text{Min } Z = 31.35 \sum_{s=1}^{3} P_d(\delta_{sd}^{-} + \delta_{sd}^{+}) \qquad \forall d$$

Our objective is to minimize the cost associated with each turnaway observed in each of the 3 shifts, on each of the 7 working days. Firstly, we collected the cost of turnaway over two years, then we divided it per day and lastly, and multiplied the turnaway cost by the % of demand per shift. Hence $31.35 is the average cost of turnaway per shift per day being experienced by The Ten Spot right now (Appendix 4).

IV. Decision Variables

Before getting into our model, we have set some notations for simplicity of our problem. First is setting 'n' as the # of employees to schedule for shift 's' on day 'd'. There is also a binary decision variable of y = 1, if employee n works on shift 's', day'd' and 0, if otherwise. We also look at the number of customers 'x' (a continuous variable) that are served on shift 's' on day 'd'. Where: n = number of employee (1-8), x = number of customer served, s = shifts (1-3); d = day (1-7).

V. Formulations & Constraints

1) $\sum_{s=1}^{3} Y_{nsd} \leq 2 \qquad \forall n, d$

2) $\sum_{n=1}^{8} Y_{nsd} \leq 8 \qquad \forall d, s$

3) $\sum_{n=1}^{8} Y_{nsd} \geq 2 \qquad \forall d, s$

4) $2Y_{nsd} \leq X_{nsd} \leq 6Y_{nsd} \qquad \forall n, s, d$

5) $\sum_{n=1}^{8} X_{nsd} + \delta_{sd}^{-} - \delta_{sd}^{+} = A_{sd} + W_{sd} \qquad \forall s, d$

6) $Y_{n1d} + Y_{n3d} \leq 1$

7) $\sum_{d=1}^{7} \sum_{s=1}^{3} Y_{nsd} \leq 11 \quad \forall n$

$$n = 1, 2, 3 \ldots 8$$

$$d = 1, 2, 3, ..7$$

$$s = 1, 2, 3$$

$$Y_{nsd} = \{0,1\}, 1\ if\ employee\ n\ is\ working\ on\ shift\ s\ on\ day\ d, 0\ if\ otherwise$$

$$X_{nsd} - the\ number\ of\ customers\ served\ by\ employee\ n\ on\ shift\ s\ on\ day\ d$$

$$P_d - probability\ of\ one\ walk - in\ for\ every\ shift\ on\ every\ day$$

$$A_{sd} - appointment\ for\ every\ shift\ on\ every\ day$$

$$W_{sd} - walk - ins\ for\ every\ shift\ on\ every\ day$$

The deviational variables $_{1}(\delta_{sd}^{-} + \delta_{sd}^{+})$ represent underperformance and over performance of demand for each shift on each day.

Equation (1) - Each employee works a maximum of 2 shifts in a day
Equation (2) - There is a maximum of 8 workers on each shift on any day
Equation (3) - There is a minimum of 2 workers on each shift on any day
Equation (4) - Each employee serves between 2 to 6 customer on each shift on each day
Equation (5) - This equates the demand for each day to the total number of walk-ins plus the total of number of appointments for the day. We included the deviational variables to the equation to ensure that the equation would balance regardless of over-demand or under-demand.
Equation (6) - This equation ensures that the employees are not working both shifts 1 and shifts 3. Thus, if they work 2 shifts, those have to be consecutive shifts. Shifts 1 & 2 or Shifts 2 & 3, but not Shifts 1 & 3.
Equation (7) - Since each employee is only allowed to work a maximum of 44 hours a week due to labour laws, 44 hours/4 hours-shifts = 11 shifts. Hence there is a total of 11 shifts per worker per week

5. RECOMMENDATIONS

We believe The Ten Spots' objective of minimizing cost associated with turnaways and effectively scheduling the employees can be achieved with the recommended scheduling pattern posted below. Our model considers the cost of turnaway and ensures that there are enough employees to more than comfortably cover incoming demand, either walk in or call in to make appointments.

Furthermore, we ensure that the utilization of each employee is maximized to save cost. Before our model, The Ten Spot was losing approximately $94 a day due to customers being turned away; hence this is a loss of $31 a shift (assuming the 3 shifts pattern). However, with our scheduling model, we were able to cut the cost to $8.31 per shift, saving about $22.7 per shift and $68 a day. Thus, we believe that The Ten Spot will not only save the cost of turn aways but also minimize the idle time of employees through our optimization model.

6. IMPLEMENTATION

Customers Served Per Employee, Per Shift, Per Day	Employees Working Per Shift, Per Day	Deviational Variables
x(0,0,0) = 0.0	y(0,0,0) = 0.0	delta_negative(0,0) = 0.255
x(0,0,1) = 0.0	y(0,0,1) = 0.0	delta_negative(0,1) = 0.255
x(0,0,2) = 0.0	y(0,0,2) = 0.0	delta_negative(0,2) = 0.255
x(0,0,3) = 0.0	y(0,0,3) = 0.0	delta_negative(0,3) = 0.255
x(0,0,4) = 6.0	y(0,0,4) = 1.0	delta_negative(0,4) = 0.255
x(0,0,5) = 6.0	y(0,0,5) = 1.0	delta_negative(0,5) = 0.0
x(0,0,6) = 6.0	y(0,0,6) = 1.0	delta_negative(0,6) = 0.255
x(0,1,0) = 6.0	y(0,1,0) = 1.0	delta_negative(1,0) = 0.447
x(0,1,1) = 6.0	y(0,1,1) = 1.0	delta_negative(1,1) = 0.447
x(0,1,2) = 0.0	y(0,1,2) = 0.0	delta_negative(1,2) = 0.447
x(0,1,3) = 2.0	y(0,1,3) = 1.0	delta_negative(1,3) = 0.447
x(0,1,4) = 6.0	y(0,1,4) = 1.0	delta_negative(1,4) = 0.447
x(0,1,5) = 6.0	y(0,1,5) = 1.0	delta_negative(1,5) = 0.0
x(0,1,6) = 6.0	y(0,1,6) = 1.0	delta_negative(1,6) = 0.447
x(0,2,0) = 0.0	y(0,2,0) = 0.0	delta_negative(2,0) = 0.297
x(0,2,1) = 0.0	y(0,2,1) = 0.0	delta_negative(2,1) = 0.297
x(0,2,2) = 5.0	y(0,2,2) = 1.0	delta_negative(2,2) = 0.297
x(0,2,3) = 6.0	y(0,2,3) = 1.0	delta_negative(2,3) = 0.297
x(0,2,4) = 0.0	y(0,2,4) = 0.0	delta_negative(2,4) = 0.297
x(0,2,5) = 0.0	y(0,2,5) = 0.0	delta_negative(2,5) = 0.0
x(0,2,6) = 0.0	y(0,2,6) = 0.0	delta_negative(2,6) = 0.297
x(1,0,0) = 4.0	y(1,0,0) = 1.0	delta_positive(0,0) = 0.0
x(1,0,1) = 0.0	y(1,0,1) = 0.0	delta_positive(0,1) = 0.0
x(1,0,2) = 0.0	y(1,0,2) = 0.0	delta_positive(0,2) = 0.0
x(1,0,3) = 0.0	y(1,0,3) = 0.0	delta_positive(0,3) = 0.0
x(1,0,4) = 6.0	y(1,0,4) = 1.0	delta_positive(0,4) = 0.0
x(1,0,5) = 6.0	y(1,0,5) = 1.0	delta_positive(0,5) = 0.489
x(1,0,6) = 0.0	y(1,0,6) = 0.0	delta_positive(0,6) = 0.0
x(1,1,0) = 5.0	y(1,1,0) = 1.0	delta_positive(1,0) = 0.0

This above result is generated from Python. The first column shows the number of customers served per employee per shift on a day. The second column shows the binary variable if

Customers Served																						
	Monday			Tuesday			Wednesday			Thursday			Friday			Saturday			Sunday			Total Customers Served Per Employee by Week
	Shift 1: 8 AM - 12 PM	Shift 2: 12 PM - 4 PM	Shift 3: 4 PM - 8 PM	Shift 1: 8 AM - 12 PM	Shift 2: 12 PM - 4 PM	Shift 3: 4 PM - 8 PM	Shift 1: 8 AM - 12 PM	Shift 2: 12 PM - 4 PM	Shift 3: 4 PM - 8 PM	Shift 1: 8 AM - 12 PM	Shift 2: 12 PM - 4 PM	Shift 3: 4 PM - 8 PM	Shift 1: 8 AM - 12 PM	Shift 2: 12 PM - 4 PM	Shift 3: 4 PM - 8 PM	Shift 1: 8 AM - 12 PM	Shift 2: 12 PM - 4 PM	Shift 3: 4 PM - 8 PM	Shift 1: 8 AM - 12 PM	Shift 2: 12 PM - 4 PM	Shift 3: 4 PM - 8 PM	
Employee 1	0	6	0	0	6	0	0	0	5	0	2	6	6	6	0	6	6	0	6	6	0	61
Employee 2	4	5	0	0	5	0	0	6	6	0	6	6	6	6	0	6	0	0	0	2	0	58
Employee 3	0	0	2	5	0	0	0	6	0	0	5	0	0	6	6	3	6	0	0	6	6	51
Employee 4	2	0	0	0	0	3	0	4	0	6	6	0	0	3	6	0	5	0	0	0	3	38
Employee 5	0	0	5	0	0	6	3	0	0	5	0	0	0	0	2	0	0	6	2	0	0	29
Employee 6	0	0	0	2	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8
Employee 7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	6	0	0	0	8
Employee 8	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	6	5	0	0	0	13
Total Customers Served Per Shift	6	11	7	7	13	9	9	16	11	11	19	12	12	21	14	15	25	17	8	14	9	266 Total Customers Served by All Employees
Total Historical Demand Per Shift	6	11	7	7	13	9	9	16	11	11	19	12	12	21	14	14	24	16	8	14	9	263 Total Historical Customers Served by All Employees

employee n is working on shift s on day n. The last column shows the deviational variables.

This table shows the number of customers served per shift on each day of the week. We modelled this closely to the historical annual average demand of The Ten Spot.

This table shows the number of employees working per shift on each given day of the week. The number of staff per shift is based on the demand of the shift and the random demand based on the day of the week.

7. LIMITATION

Although we have attempted to consider most of the important aspects when creating the model, there were some limitations and shortcomings. First, most data we gathered to get the quantitative figures were only based on 1-3 years. Although the numbers would have been more accurate with more data, the information we accessed from The Ten Spots Booker system was limited to how long the location has been open.

Regarding peak times, there were some limitations in gathering variation of peak-time depending on locations and customer segment. As mentioned in our assumptions, all our data was gathered from the Beaches location. The location of the store is an important consideration that will determine the “peak-time” significantly; stores near offices will have a peak time during lunch time, or after work on week-days, whereas stores near neighborhoods will have peak times during weekends. Another factor to consider when determining peak time depends on customer segments; non-working moms are more likely to visit The Ten Spot after they drop off their kids to school, whereas working moms are more likely to go after work or on weekends. There are also high-school, and university students that we could have taken into consideration.

Furthermore, although we maximized the employee utilization time with our programming model, there is still a loss of $8.31 per shift. This is due to variation in length of service times among services. For example, although employees are constrained to serve at least two customers per shift, waxing on average takes only 18 minutes. [2] Thus, if an employee was to provide two waxing services in an hour, it would still leave them with 24 minutes of idle time.

Lastly, our model does not consider any unexpected cases such as an employee having to leave work in the middle of their shift due to emergencies. Instead, we just assumed that employees must fulfill one whole shift.

8. CONCLUSION

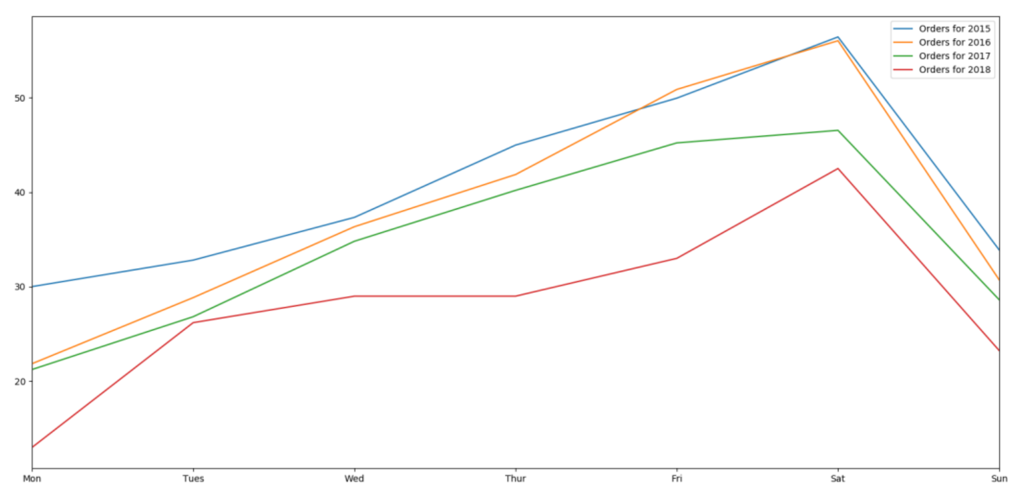
To conclude, our team seeks to minimize turn away and the cost associated with it. This ensures that The Ten Spot would be able to serve most, if not all, its customers, be it walk-ins or phone appointments. We attempt to model the simulation according to real life variables and constraints. We managed to save close to $22.7 per shift and that allows The Ten Spot to save $24,856.50 in a year if they apply our model. The current model is robust as it has factored in seasonality, peak and off peak, laws and regulations and is based on data and facts provided. While we agree that there are indeed limitations, these limitations can be overcome but at the cost of complexity. Overall, we believe that this model is effective, feasible and easy to comprehend.

9. APPENDICES

1.

Turn Away Cost In 2017		Occurences
Jan	$ 1,571.00	30
Feb	$ 1,476.00	32
Mar	$ 4,830.00	76
Apr	$ 4,658.00	81
May	$ 4,523.00	66
Jun	$ 5,964.00	74
Jul	$ 3,551.00	62
Aug	$ 3,410.00	49
Sep	$ 987.00	13
Oct	$ 1,747.00	27
Nov	$ 358.00	8
Dec	$ 1,831.00	20
Total	**$34,906.00**	**538**
Average Cost / Customer	**$ 64.88**	
Average Cost / Day	**$ 94.06**	

2.



3.

Index	Booked	Cancelled	Checked-in	Confirmed	No Show	Paid/Complete
8	0	86	0	2	8	554
9	4	236	2	0	7	1577
10	9	461	0	0	27	3306
11	3	483	1	7	20	3333
12	11	505	8	3	33	3887
13	5	498	2	3	25	3891
14	4	508	8	5	22	3944
15	5	419	8	3	16	3638
16	2	493	3	2	26	3520
17	4	410	2	3	25	3077
18	3	340	4	1	21	2263
19	7	202	2	1	13	1342
20	1	38	0	0	4	277
21	0	0	0	0	0	3

4.

% Demand Per Shift			
	Hours	**# of Orders**	**% Demand**
Shift 1	8AM - 12 PM	8770	**26%**
Shift 2	12PM - 4 PM	15360	**45%**
Shift 3	4PM - 8 PM	10202	**30%**

2017 Turn Away Data					
	Turned Away	**# of Days**	**Turned Away/Day**	**Demand/Day**	**Probability of Being Turned Away**
Monday	65	52	1.25	24	5%
Tuesday	56	52	1.08	29	4%
Wednesday	62	52	1.19	36	3%
Thursday	64	52	1.23	42	3%
Friday	66	52	1.27	48	3%
Saturday	109	52	2.10	53	4%
Sunday	90	53	1.70	31	5%
Average			**1.40**	**37.57**	**4%**

Turn Away / Shift			
	Shift 1	Shift 2	Shift 3
Monday	0.32	0.56	0.37
Tuesday	0.28	0.48	0.32
Wednesday	0.30	0.53	0.35
Thursday	0.31	0.55	0.37
Friday	0.32	0.57	0.38
Saturday	0.54	0.94	0.62
Sunday	0.43	0.76	0.50

Turn Away Cost / Shift				
	S1	S2	S3	Average
Monday	$ 24.03	$ 42.08	$ 27.95	$ 31.35
Tuesday	$ 24.03	$ 42.08	$ 27.95	$ 31.35
Wednesday	$ 24.03	$ 42.08	$ 27.95	$ 31.35
Thursday	$ 24.03	$ 42.08	$ 27.95	$ 31.35
Friday	$ 24.03	$ 42.08	$ 27.95	$ 31.35
Saturday	$ 24.03	$ 42.08	$ 27.95	$ 31.35
Sunday	$ 24.03	$ 42.08	$ 27.95	$ 31.35
Average Turn Away Cost / Day = $94				

5.

Walk In's Per Shift						
	# of Walk In's	# of Mondays	Walk Ins / Day	Shift 1	Shift 2	Shift 3
Monday	132	156	0.8	0.26	0.45	0.30
Tuesday	127	157	0.8	0.26	0.45	0.30
Wednesday	139	157	0.9	0.26	0.45	0.30
Thursday	186	156	1.2	0.26	0.45	0.30
Friday	176	156	1.1	0.26	0.45	0.30
Saturday	269	156	1.7	0.51	0.89	0.59
Sunday	189	156	1.2	0.26	0.45	0.30

6.

Appointments Per Shift				
	Total Demand	Shift 1	Shift 2	Shift 3
Monday	24	6	11	7
Tuesday	29	7	13	9
Wednesday	36	9	16	11
Thursday	42	11	19	12
Friday	48	12	21	14
Saturday	53	14	24	16
Sunday	31	8	14	9

10. REFERENCES

[1] About. (n.d.). Retrieved March 31, 2018, from https://www.thetenspot.com/about/

[2] Spot, T. T. (n.d.). {{model.custom.accountName}}. Retrieved March 31, 2018, from https://app.secure-booker.com/App/SpaAdmin/Appointments/Calendar.aspx