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Harmonious balance between Supply and Demand in Communication center:

Name: Jayanta Pal

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1. Executive Summary

The service industry works hard to satisfy their customers. Most organizations face challenges to minimize the disparity between their supply and the demand of their customers. Therefore, most of resources remain underutilized or lead to failure in fulfilling the customer demand. However, what matters the most is achieving success in this competition than just surviving the competition.

In business world, success, growth, profit and goodwill go hand in hand along with efficiency. Efficient use of available resources can undoubtedly scale-up business. From this perspective, 'Intra-day Capacity' being an integral aspect to business, can be considered as one among the many aspects where efficiency can be achieved through optimization. If achieved then it would help to build structured growth to ensure that the business maintains a competitive edge in a market. Efficiency of capacity planning can accelerate the performance of an organization.

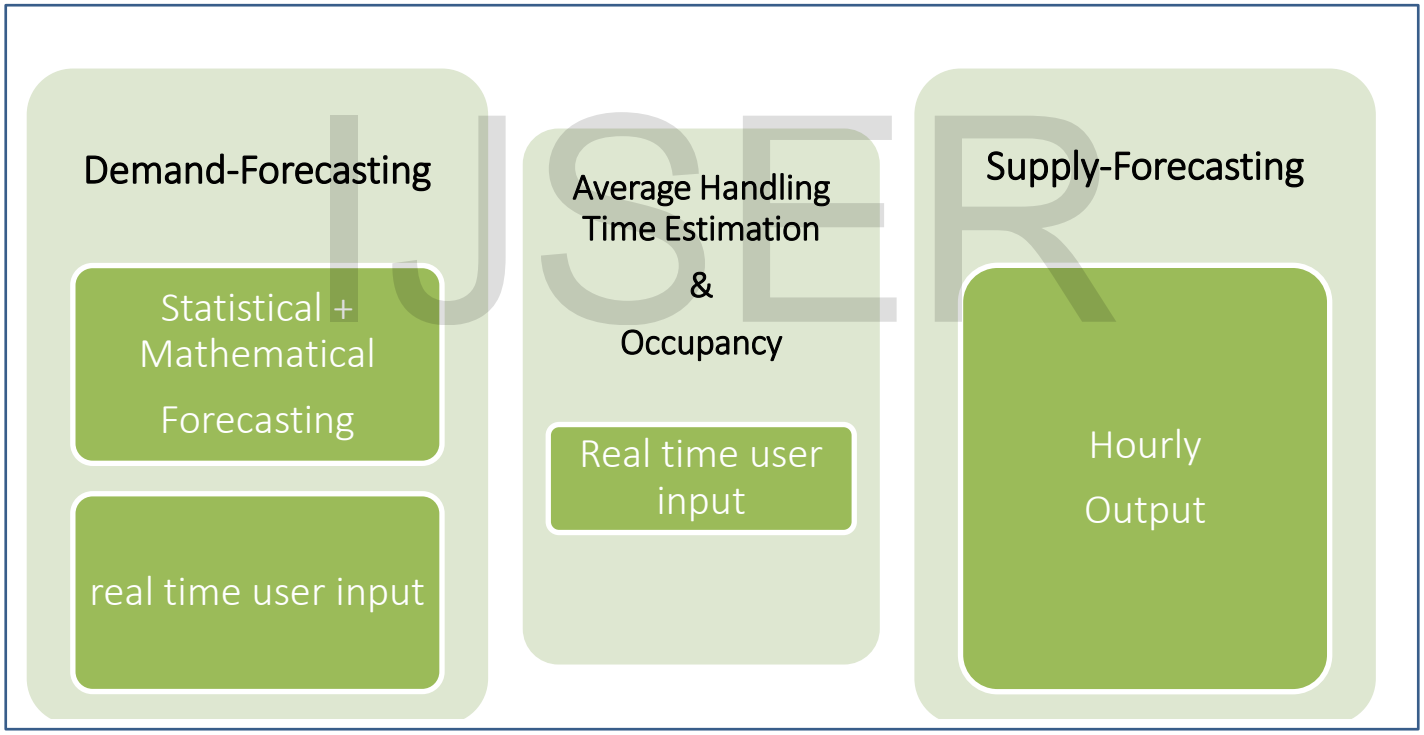
In today's challenging business environment, it is a major challenge for customer contact centers to transform themselves from being cost centers to profit centers and emerge as a source of competitive advantage, adding value to the whole enterprise. However this requires balance between operational efficiency and delivering outstanding service to the customers.

This paper is focused on the development of a model that establishes a balance between the demand (inbound calls, outbound calls) and the supply (the advisors) in a call center. It describes the Intra-day Forecasting and Staffing Tool's approach in estimating intra-day demand and building a feasible and optimal capacity plan with the application of analytical methods.

Keywords: Prophet Forecasting, Intra-day forecasting, Average Handling Time, Occupancy, Optimized Staffing

1a. Intra-day Forecasting and Staffing Tool - IFAST

Intra-day Forecasting and Staffing Tool (IFAST) maintains a harmonious balance between supply and demand in call centers and helps in achieving Call Center KPI's benchmark. It also assists in deploying resources within Backoffice and Call Center. This tool utilizes Prophet forecasting, mathematical and intra-day pattern method to determine the Intra-day Staffing needs. The tool consists of some real time features which help the managers to run what-if scenarios and arrive at the desired goal of optimal resource allocation.



2. Demand Forecasting in IFAST

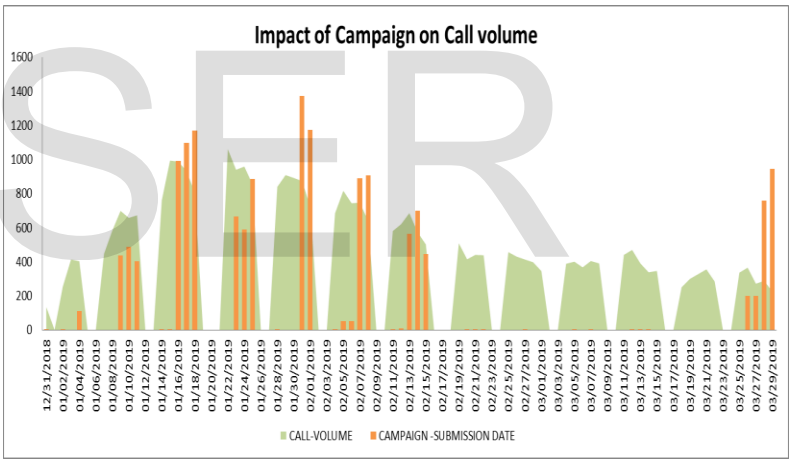
The importance of demand forecasting can be understood by the following lines:

- To decide the number of call reps required to achieve the desired service levels.
- To determine when and how many call reps are required.
- To calculate how much additional resources are required to achieve the desire goal.

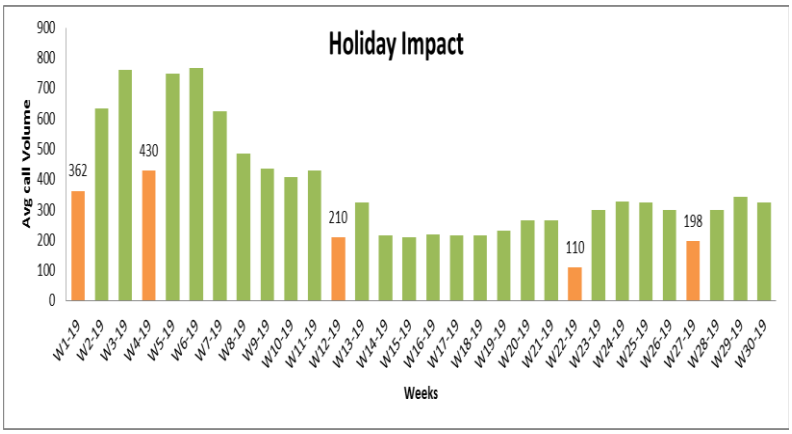
a. Exploratory data analysis and research

Prior to demand forecasting, an enterprise must perform some exploratory data analysis and research in order to understand "What happened in past?" and "Why it happened? ".Running exploratory data analysis on the historical data helps to determine the factors (e.g. regular and irregular Holiday, Campaigns and Demand pattern at different time lag etc.) impacting the demand.

Graph1: Impact of Campaign-submission date on call volume. 14% rise in average call volume with successive submission weeks. Clients had reached out to the call center prior to the submission date to clarify their doubts.

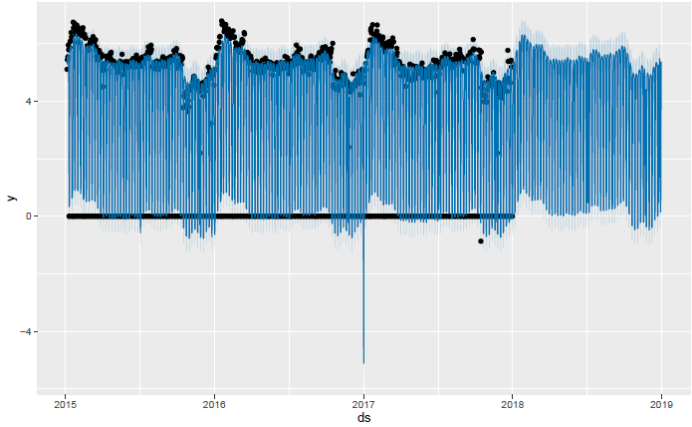


Graph2: Impact of holidays on weekly average call volume. Regular and irregular holidays also have significant impact on call volume. Orange bars are significantly below the adjacent weeks



b. Advanced Statistical Forecasting

An accurate forecasting tool that helps the workforce management to deal with making decision for future, relying mainly on past (analysis on trend, seasonality, holiday events etc.) is very much requisite for an optimized supply planning.



Graph3: Daily forecasting

There are tons of time series modelling techniques in the analytics world with numerous tuning parameters that can be used for forecasting. However, not using the correct technique for the right data type leads to inaccurate forecasting. Prophet oversees the above challenge and also combines automatic forecasting with analyst-in-the-loop forecasting for special cases. Using this technique, it is possible to cover a wide variety of business use-cases.

i. Prophet model description

Prophet follows additive regression model with four components:

Y(t) = g(t) + s(t) + h(t) + e(t).------(1)

where

- **g (t)** = f (linear / logistic trend)
- **s(t)** = f(X : yearly seasonal component) +
  f(X : weekly seasonal component) + f(X : daily seasonal component)
- **h(t)** = user defined holiday component
- **e(t)** = error

ii. Modelling Trend

Prophet helps to model "Trend" in two ways:

1) Non- Linear Saturating growth which is represented by the **Logistic growth model**.

$$g(t)= \frac{C}{1+e^{-K(t-m)}} \text{ ----- (2)}$$

Where
C = carrying capacity value

K = growth rate of the curve

m = the offset parameter

2) Second method is Simple Linear Model which we can use in such business scenarios where we can expect no saturation in trend growth.

iii. Modelling Holiday

Prophet helps us to study the effect of regular and irregular holiday, country holiday and special kind of events in past which might throw remarkable impact on future. It must include all occurrences of the holiday, both in the past and in the future. If in future, irregular holidays are not meant to occur then Prophet will not consider their impact while forecasting.

'Lower_window' and 'Upper_window' are the two parameters using which we can derive impression on pre and post holidays. For instance, if we want to include Christmas Eve in addition to the Christmas day then include lower_window=-1, upper_window=0. On the other hand, if we want to use Black Friday in addition to Thanksgiving, we include lower_window=0,upper_window=1. We can also include a parameter 'prior_scale' to set the prior scale separately for each holidays, as described below.

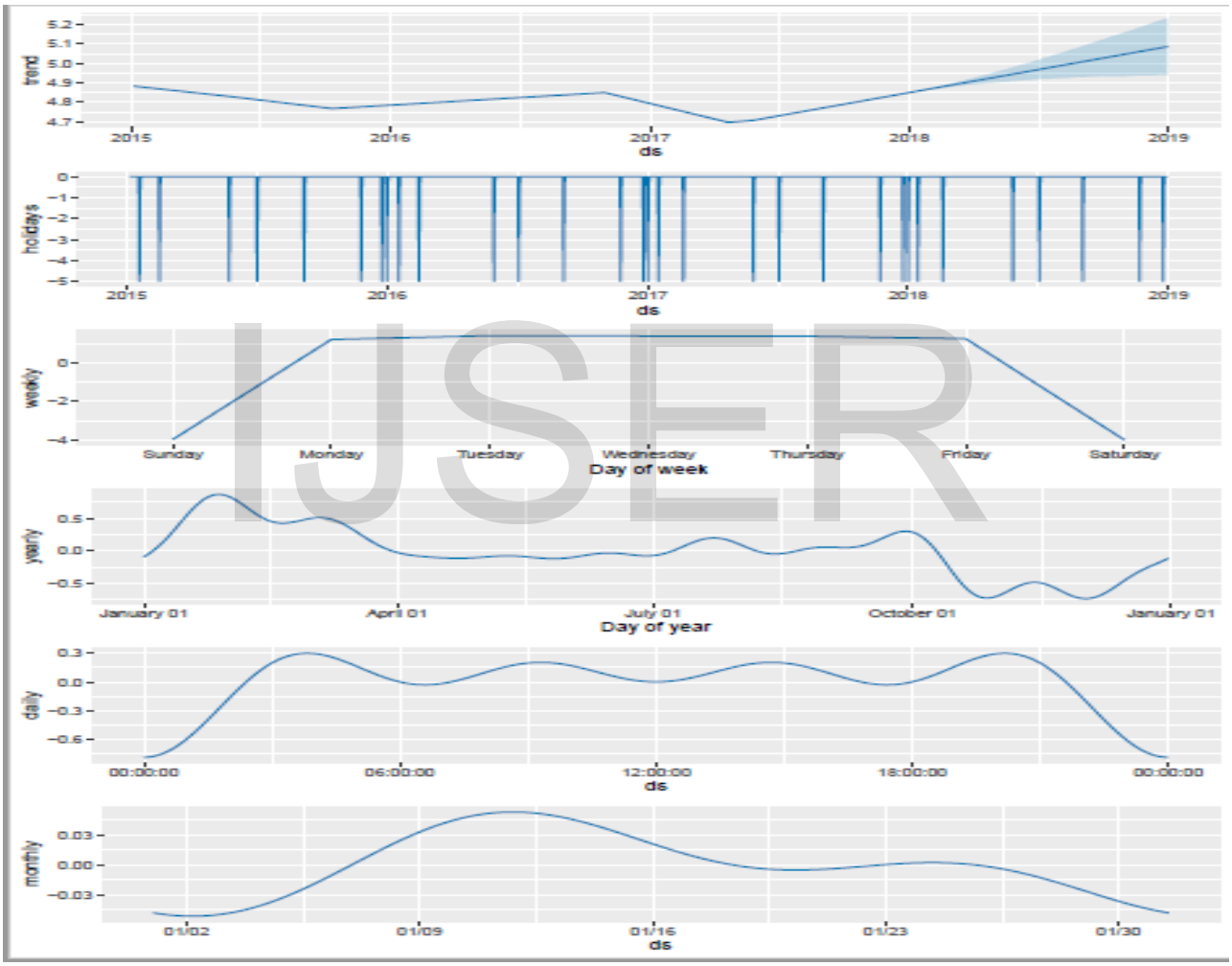
iv. Modelling Seasonality

Prophet relies on Fourier series to fit and forecast the effect of seasonality.

$$S(t) = \sum_{n=1}^{N}\left(an\ Cos\left(\frac{2\pi nt}{P}\right) + \mathbf{bn\ Sin}\left(\frac{2\pi nt}{P}\right)\right) \text{ ------ (3)}$$

Where

- P is the period (365.25 for yearly data and 7 for weekly data)
- Parameters [a_1, b_1, ….., a_N, b_N] need to be estimated for a given N to model seasonality. N Fourier terms correspond to 2N variables
- N is the order of Fourier series. Higher N will increase overfitting and lower N tends to underfitting.
- By default, Yearly seasonality Fourier series order is 10 & weekly seasonality Fourier order is 4.



Graph 4: Components plot from Prophet forecasting.

The above component plot gives us detailed idea on trend pattern, impact of holidays, weekly, yearly, daily and monthly call pattern.

Advantages of Prophet forecasting:

1. Handles yearly, monthly, weekly and daily data.
2. Irregular and regular holidays can be included in the model.
3. Events can be included in the model.
4. Yearly, Monthly, Weekly and daily seasonality can be incorporated in the model.
5. Changepoint (inflection points where trend changes) can be taken care by the parameters.
6. Outliers can be handled well through this model.

If the forecast goes beyond the limit from the business aspect, then this situation can be handled by trend growth, cap and floor parameters.

c. Mathematical Forecasting

This model is conducted post Prophet model. Here the mathematical split% method (based on historical data) over daily forecast is applied to achieve the Intra-day Forecast.

Intra-day Forecast = split% * prophet daily forecast

$$\text{Split\%} = \frac{\boldsymbol{Hourly\ call\ volume}}{\boldsymbol{Total\ call\ volume\ in\ a\ day}}$$

Note:-
IFAST allows playing with the forecasted number as a user input.

3. AHT Forecasting in IFAST

It is an important key performance indicator for call-center, utilized for measuring average duration of one transaction. AHT is a prime factor when deciding call center staffing levels.

$$\text{AHT} = \frac{\boldsymbol{CallDuration}}{\boldsymbol{Total\ number\ of\ calls}}$$

Intra-day forecasting and staffing tool estimates the Hourly Average handling time, with the guidance of **hourly ratio pattern analysis** on the historical data and user (Analyst) input standard AHT.

Hourly Average handling time = Grand ratio (GR) * standard AHT

$$GRj = \frac{1}{n}\sum_{i=1}^{n} Yij \;;$$

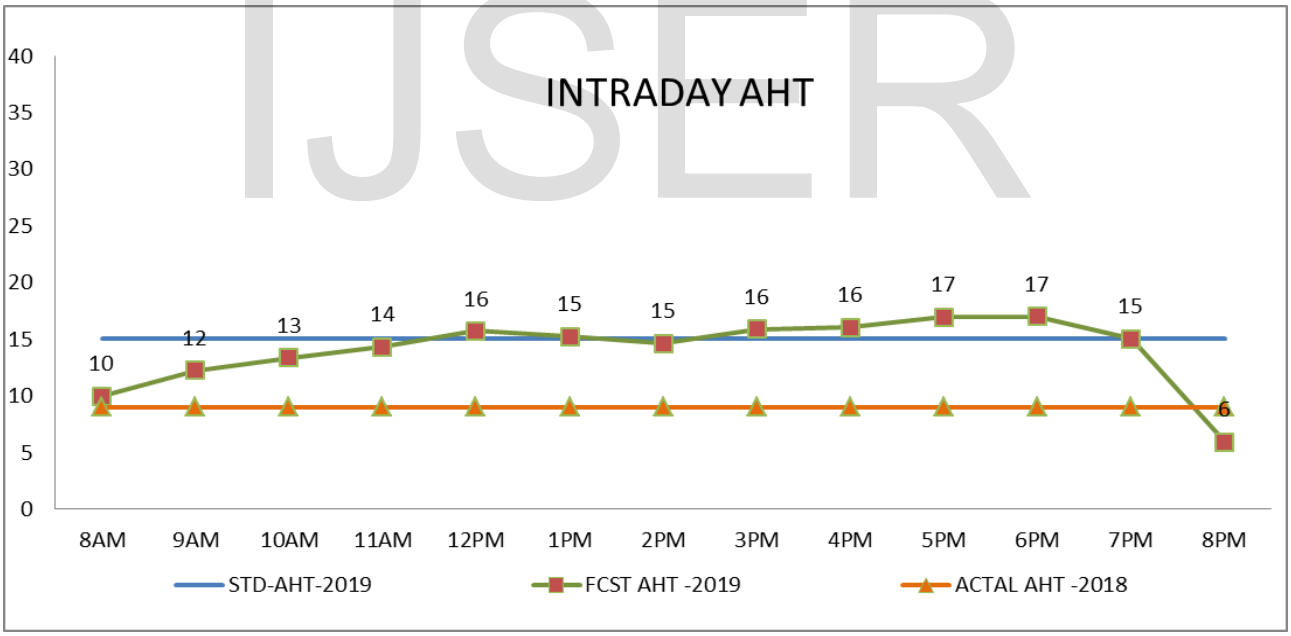
- j = 8 am, 9am, 10am …. 6 pm
- n = number of years,
- Yij = AHT at ith year and jth hour

$$Yij = \frac{\frac{1}{\Sigma Vij}\sum_{i=1}^{n} XijVij}{Quarterly\ AHT}$$

- n = number of observation
- j = 8am, 9am ……, 6pm
- Xij = AHT for ith observation and jth hour.
- Vij = Forecasted Call Volumes for ith observation and jth hour.

Notes:-

- Helps with respective historical weekly AHT for postulation of current weekly standard (user input).



Graph5: Hourly Intra-day -AHT

4. Occupancy Factor

Another essential key performance indictor in call center for staff planning, is the percentage of time that an agent actually spends handling incoming calls against the available time.

$$\text{Occupancy} = \frac{\textit{Total Call duration (Talk+Hold+Wrap)}}{\textit{Total available time to take call}}$$

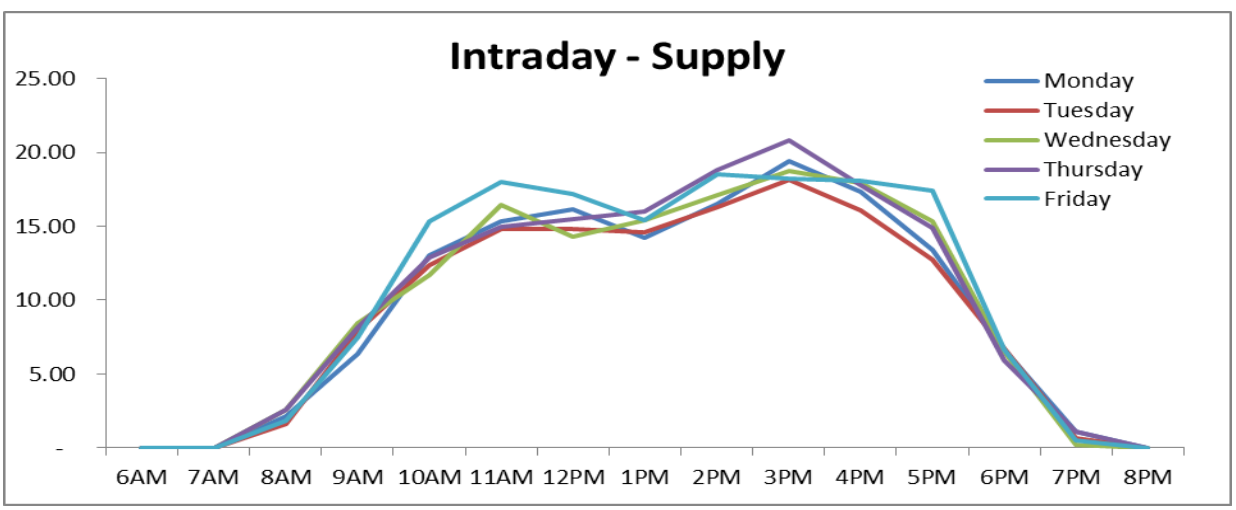
5. Forecasting Headcount Requirement

Following the development of precise forecasting, now comes the major part of the model, here we will focus on forecasting supply (advisors) at intra-day level.

$$\textbf{Forecasted Headcount Requirement } (S_{ij}) = \frac{\textit{intra-day volume Forecast} * \frac{\textit{Intraday Forecasted AHT}}{60}}{\textit{Occupancy}}$$

$$Sij = \frac{Fij * \frac{Yij}{60}}{Occupancy}$$

- j = 8am, 9am ……, 6pm.
- Fij = Forecasted call volumes for ith observation and jth hour.
- Yij = AHT for ith observation and jth hour.



Graph 6: Supply Forecasting

There are significant decline in supply around 12 pm to 2 pm, this significant valley is mainly driven by the nourishment breaks.

6. Staffing Strategy

Tool helps the process manager to decide on intra-day staffing from the heat map view. This heat map helps the manager to minimize the gap between forecasted Headcount and Staffing.

GAP	8AM	9AM	10AM	11AM	12PM	1PM	2PM	3PM	4PM	5PM	6PM	7PM	8PM	Overall Discretionary
Monday	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tuesday	(1)	(12)	(6)	3	4	1	4	2	(3)	(6)	(9)	0	-	(2)
Wednesday	(1)	(11)	(6)	(1)	2	(0)	2	2	(1)	(5)	(9)	1	0	(2)
Thursday	(1)	(12)	(6)	0	3	2	2	(1)	1	(4)	(10)	0	-	(2)
Friday	(0)	(9)	(4)	(1)	2	1	5	(1)	1	(2)	(9)	1	0	(1)
Avg Capacity	**(1)**	**(11)**	**(6)**	**0**	**3**	**1**	**3**	**1**	**(1)**	**(4)**	**(9)**	**1**	**0**	**(2)**

Table1: Daily discretionary and intra-day gap.
From the above table we can make decision in which hour block is overstaffed and understaffed. Green is overstaffed and yellow is understaffed.

7. Conclusion

This model helps to derive different scenarios at intra-day level with respect to parameters like volume and weekly 'standard average handling time' (Std. AHT). This method can be employed for determining the volume-demand in a specific way. It helps to eliminate the subjective aspects of the conventional methods of demand and supply estimation procedures. The success of the underlying mechanism of the tool depends on advanced forecasting scope. However, final demand requires estimation of model output and organization strategy in order to achieve unambiguous results.

8. References

i. https://facebook.github.io/prophet/docs/seasonality,_holiday_effects,_and_regressors.html#modelling-holidays-and-special-events
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