CAPSTONE PROJECT: THE BATTLE OF THE NEIGHBOURHOODS

Caitlin van der Heever

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1. INTRODUCTION

This assignment is targeted at stakeholders wanting to open a sit-down restaurant in a popular area.

London is one of the most popular cities in the world, it is home to 7.5 million of people and welcomes million of visitors each year [1]. The number of residents as well as tourists visiting London each year brings a boost to businesses and therefore London was chosen to analyze in the assignment.

London is made up of unique neighbourhoods, each with their own characteristics, however only the 10 best neighbourhoods to explore in London, according to source [2], were analyzed. This is because these 10 neighbourhoods are distinct and thus popular and have numerous people passing through each day making them an ideal area to open a restaurant.

The distance of the neighbourhood to London central is investigated. The closer the restaurant is to London central results in more circulation of people in and out and thus a higher potential for customers. We will also look at what types of restaurants are common and popular in each neighbourhood helping us decide what type of restaurant to open.

Data analysis will be used on each of the neighbourhoods so that the best choice can be made by the stakeholders.

2. DATA

The 10 London neighbourhoods that we are analyzing were obtained from source [2], which include:

- Mayfair
- Shoreditch
- Chelsea
- Greenwich
- Southwark
- Brixton
- Notting Hill
- Camden
- Soho
- Kensington

The coordinates of each of these neighbourhoods as well as London central was obtained through the geocoder module which converts an address into latitude and longitude coordinates.

Foursquare API was used to find data on the nearby venues within a radius of 500m from each neighbourhood. It was also used to find location data for a more specific type of restaurant nearby each neighbourhood, as well as to find reviews on the narrows down restaurants.

3. METHODOLOGY AND ANALYSIS

3.1. Coordinates of the Neighbourhoods

The coordinates of Central London as well as the coordinates of each of the 10 neighbourhoods we are comparing were found using the geocoder function. We need to specify a user_agent to define an instance of the geocoder, and so we named our agent london_agent.

The coordinates of Central London were found to be:
latitude: 51.5073219, longitude: -0.1276474

Once all the coordinates of each of the neighbourhoods were determined, they were placed in a dataframe called *dfcoordinates* as shown in the figure below.

	Neighbourhood	Latitude	Longitude
0	Mayfair	51.511087	-0.147058
1	Shoreditch	51.526669	-0.079893
2	Chelsea	51.487542	-0.168220
3	Greenwich	51.482084	-0.004542
4	Southwark	51.502922	-0.103458
5	Brixton	51.456804	-0.116796
6	Notting Hill	51.510999	-0.205527
7	Camden	51.542305	-0.139560
8	Soho	51.513163	-0.131175
9	Kensington	51.498995	-0.199123

Figure 1: Dataframe of each neighbourhood in London that we are comparing with their coordinates

3.2. Distance to London Center

The distance of each neighbourhood from London center was determined. This is because we would favor areas as close to the city central as possible as it increases the potential of more customers entering and eating at the restaurant due to the busy city center. The method used to calculate the distance between each of the two locations was calculated using the haversine formula. The haversine formula is a precise way of calculating the distance between two points on a spherical surface (i.e. the earth) using the latitude and longitude coordinates of the two points [3].

The distance is calculated as follows:

$$a = sin^2\left(\varphi B - \frac{\varphi A}{2}\right) + \cos(\varphi A) * \cos(\varphi B) * sin^2\left(\frac{\lambda A}{2}\right) \quad (1)$$

$$c = 2 * atan2(\sqrt{a}, \sqrt{1-a} \quad (2)$$

$$d = R * c \quad (3)$$

Where:

$\varphi = latitude$
$\lambda = longitude$
$R = radius\ of\ the\ earth = 6371km$
$A = 1st\ location$
$B = 2nd\ location$

A new dataframe called *Distancedf* was created containing each of the neighbourhoods with their coordinates and their distance from London center in kilometers as shown below.

	Neighbourhood	Latitude	Longitude	Distance from London Central (km)
0	Mayfair	51.511087	-0.147058	1.407073
1	Shoreditch	51.526669	-0.079893	3.942992
2	Chelsea	51.487542	-0.168220	3.567368
3	Greenwich	51.482084	-0.004542	8.972561
4	Southwark	51.502922	-0.103458	1.744228
5	Brixton	51.456804	-0.116796	5.667328
6	Notting Hill	51.510999	-0.205527	5.405249
7	Camden	51.542305	-0.139560	3.976241
8	Soho	51.513163	-0.131175	0.693854
9	Kensington	51.498995	-0.199123	5.033128

Figure 2: Dataframe showing each neighbourhood in London that we are comparing with their respective distances from London center (km)

A bar chart was then created representing the data in the *Distancedf* dataframe, making it visually easy to see the distance of each neighbourhood from London center, which is displayed in figure 3 below.

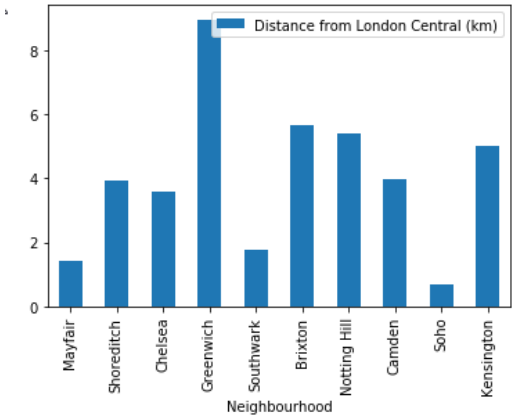

Figure 3: Bar chart showing the distances of each of the neighbourhoods we are comparing to London center (km)

It is clear from figure 3 that Soho is the closest neighbourhood to London center and Greenwich is the furthest neighbourhood from London center out of the 10 neighbourhoods we are comparing.

A map was created to visualize the data we have collected so far which is London center and each of the neighbourhoods.

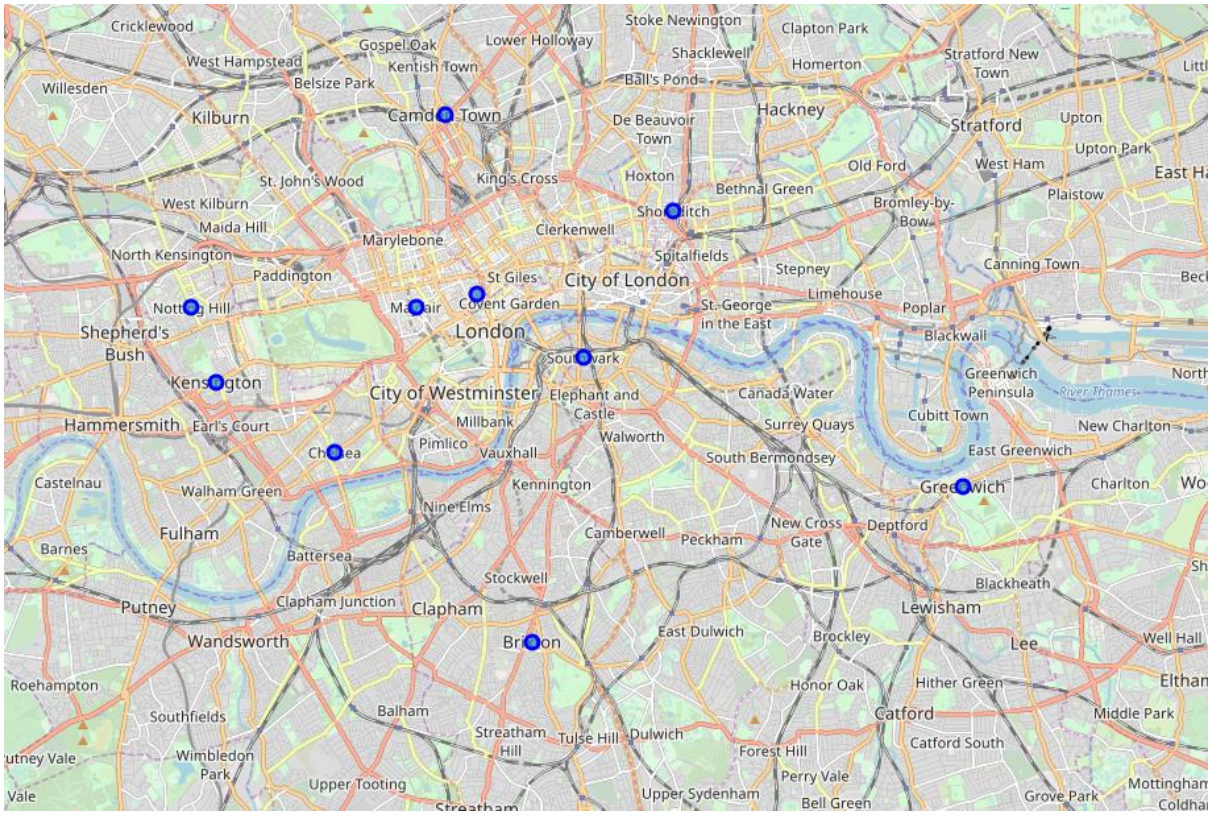

Figure 4: A folium map showing each of the neighbourhoods superimposed on top of London's coordinates

3.3. Foursquare API

In order to utilize the Foursquare API we needed to define our foursquare credentials and version. Once this was compete we could explore the neighbourhoods in our dataframe. A function was created called *getNearbyVenues* in order to obtain the top 100 venues and their data for each neighbourhood within a radius of 500m .

Once this function was run on our previously created dataframe *dfcoordinates* it was determined that there were 721 venues surrounding all the neighbourhoods within a radius of 500m. We then needed to narrow down our venue search by filtering for venue categories that are restaurants. Note that a venue category just called *Restaurant* was not included in the search as it was not specific enough. This filtering brought down the number of venues surrounding these neighbourhoods to 161 venues.

This data was then plotted with folium in order to visualize the number of restaurants within a 500m radius from each of the neighbourhoods, superimposed on London center coordinates, as shown below.

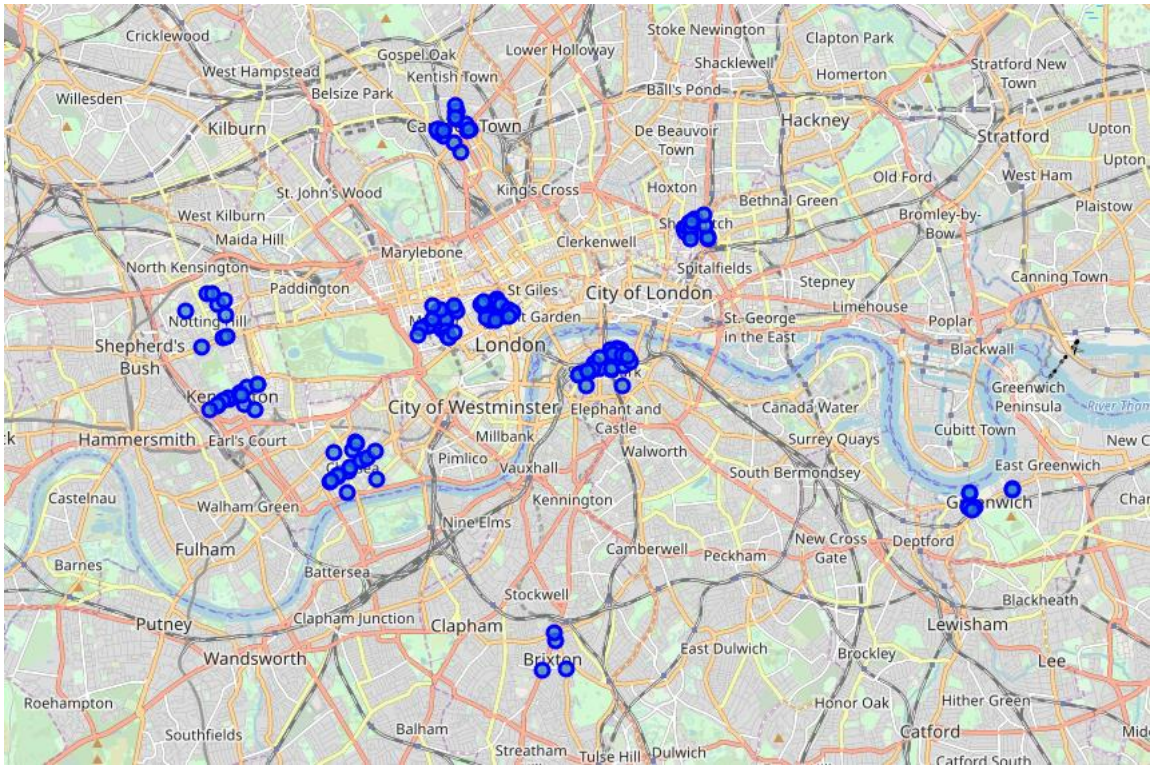

Figure 5: Visual representation of the number of venues surrounding each of the neighbourhoods within a 500m radius, superimposed on top of London's coordinates

The different types of restaurants surrounding the neighbourhoods are were determined and are represented in the figure below. As one can see, there is a vast variety of types of restaurants and so the top 10 most common restaurants of each neighbourhood was determined and placed in a new dataframe displayed in figure 6.

```
array(['French Restaurant', 'Cantonese Restaurant', 'Indian Restaurant',
       'South American Restaurant', 'Italian Restaurant',
       'Seafood Restaurant', 'Japanese Restaurant',
       'Modern European Restaurant', 'Chinese Restaurant',
       'English Restaurant', 'Korean Restaurant', 'Vietnamese Restaurant',
       'Asian Restaurant', 'Peruvian Restaurant',
       'Vegetarian / Vegan Restaurant', 'Turkish Restaurant',
       'Thai Restaurant', 'American Restaurant',
       'Middle Eastern Restaurant', 'Sushi Restaurant',
       'Portuguese Restaurant', 'Argentinian Restaurant',
       'Eastern European Restaurant', 'Israeli Restaurant',
       'Ramen Restaurant', 'Tapas Restaurant', 'Mexican Restaurant',
       'Spanish Restaurant', 'Fast Food Restaurant',
       'Caribbean Restaurant', 'Australian Restaurant',
       'Latin American Restaurant', 'Kebab Restaurant',
       'Malay Restaurant', 'African Restaurant', 'Sri Lankan Restaurant',
       'Udon Restaurant', 'Japanese Curry Restaurant',
       'Dim Sum Restaurant', 'Mediterranean Restaurant',
       'Persian Restaurant', 'Filipino Restaurant'], dtype=object)
```

Figure 6: A list of all the different types of restaurants surrounding the neighbourhoods within a 500m radius

4. RESULTS

4.1. Top 10 Common Restaurants

As mentioned above, there are 42 different types of restaurants surrounding the neighbourhoods. Therefore, in order to narrow down this data, the top 10 most common restaurants of each neighbourhood was determined, as displayed below.

	Neighbourhood	1st Most Common Restaurant	2nd Most Common Restaurant	3rd Most Common Restaurant	4th Most Common Restaurant	5th Most Common Restaurant	6th Most Common Restaurant	7th Most Common Restaurant	8th Most Common Restaurant	9th Most Common Restaurant	10th Most Common Restaurant
0	Brixton	Tapas Restaurant	Indian Restaurant	Caribbean Restaurant	Modern European Restaurant	Vietnamese Restaurant	English Restaurant	Japanese Curry Restaurant	Italian Restaurant	Israeli Restaurant	French Restaurant
1	Camden	Italian Restaurant	Vegetarian / Vegan Restaurant	Caribbean Restaurant	Vietnamese Restaurant	Ramen Restaurant	American Restaurant	Asian Restaurant	French Restaurant	Kebab Restaurant	Malay Restaurant
2	Chelsea	English Restaurant	Japanese Restaurant	Italian Restaurant	French Restaurant	Sushi Restaurant	Middle Eastern Restaurant	Vietnamese Restaurant	American Restaurant	Cantonese Restaurant	Caribbean Restaurant
3	Greenwich	Italian Restaurant	Japanese Restaurant	Portuguese Restaurant	Argentinian Restaurant	Sushi Restaurant	French Restaurant	English Restaurant	Japanese Curry Restaurant	Israeli Restaurant	Indian Restaurant
4	Kensington	Italian Restaurant	Modern European Restaurant	Portuguese Restaurant	Filipino Restaurant	Mediterranean Restaurant	Fast Food Restaurant	Middle Eastern Restaurant	Persian Restaurant	English Restaurant	Japanese Restaurant
5	Mayfair	Indian Restaurant	French Restaurant	Japanese Restaurant	Italian Restaurant	Cantonese Restaurant	Seafood Restaurant	Modern European Restaurant	Chinese Restaurant	South American Restaurant	English Restaurant
6	Notting Hill	Italian Restaurant	Latin American Restaurant	Fast Food Restaurant	Japanese Restaurant	Australian Restaurant	Caribbean Restaurant	Indian Restaurant	Japanese Curry Restaurant	Israeli Restaurant	French Restaurant
7	Shoreditch	Italian Restaurant	Vietnamese Restaurant	Peruvian Restaurant	Japanese Restaurant	Asian Restaurant	English Restaurant	Indian Restaurant	Vegetarian / Vegan Restaurant	Modern European Restaurant	Korean Restaurant
8	Soho	Italian Restaurant	Seafood Restaurant	Japanese Restaurant	Sushi Restaurant	Vietnamese Restaurant	French Restaurant	Israeli Restaurant	Japanese Curry Restaurant	English Restaurant	Dim Sum Restaurant
9	Southwark	Italian Restaurant	Chinese Restaurant	Turkish Restaurant	English Restaurant	Ramen Restaurant	Vietnamese Restaurant	Modern European Restaurant	Argentinian Restaurant	Asian Restaurant	Eastern European Restaurant

Figure 7: Dataframe showing the top 10 most common restaurants for each neighbourhood

It is clear from the above dataframe that Italian restaurants are the most common types of restaurant in 7 out of the 10 neighbourhoods. In the three neighbourhoods where it is not the most common restaurant, it is still within these neighbourhoods top 10 common restaurants. Therefore, it was decided that the type of restaurant that would be most profitable to open would be an Italian restaurant since it is very common and thus a popular choice amongst customers. We then filtered just for the Italian restaurants and the results are shown in figure 8.

	Neighbourhood	Neighbourhood Latitude	Neighbourhood Longitude	Venue	Venue Latitude	Venue Longitude	Venue Category
0	Mayfair	51.511087	-0.147058	Delfino	51.510248	-0.148704	Italian Restaurant
1	Mayfair	51.511087	-0.147058	C London	51.511253	-0.147638	Italian Restaurant
2	Shoreditch	51.526669	-0.079893	Popolo	51.526104	-0.082098	Italian Restaurant
3	Shoreditch	51.526669	-0.079893	Via Emilia	51.527335	-0.080484	Italian Restaurant
4	Shoreditch	51.526669	-0.079893	Gloria by Big Mamma	51.524964	-0.081305	Italian Restaurant
5	Shoreditch	51.526669	-0.079893	Bottega Prelibato	51.526099	-0.081391	Italian Restaurant
6	Chelsea	51.487542	-0.168220	La Mia Mamma	51.486100	-0.172131	Italian Restaurant
7	Chelsea	51.487542	-0.168220	Made in Italy	51.486218	-0.171981	Italian Restaurant
8	Chelsea	51.487542	-0.168220	Buona Sera at the Jam	51.485402	-0.173892	Italian Restaurant
9	Greenwich	51.482084	-0.004542	Franco Manca	51.481200	-0.010054	Italian Restaurant
10	Greenwich	51.482084	-0.004542	Zizzi	51.483521	-0.009759	Italian Restaurant
11	Southwark	51.502922	-0.103458	Macellaio RC	51.503367	-0.101696	Italian Restaurant
12	Southwark	51.502922	-0.103458	Capricci	51.506468	-0.100317	Italian Restaurant
13	Southwark	51.502922	-0.103458	Marco's New York Italian	51.505199	-0.099841	Italian Restaurant
14	Southwark	51.502922	-0.103458	Coco di Mama	51.505604	-0.098964	Italian Restaurant
15	Notting Hill	51.510999	-0.205527	Osteria Basilico	51.515416	-0.205728	Italian Restaurant
16	Notting Hill	51.510999	-0.205527	NEGOZIO CLASSICA	51.513559	-0.203054	Italian Restaurant
17	Notting Hill	51.510999	-0.205527	Chucs Restaurant	51.514329	-0.201183	Italian Restaurant
18	Camden	51.542305	-0.139560	Casa Tua	51.541589	-0.138167	Italian Restaurant
19	Camden	51.542305	-0.139560	Domo94 Italian Restaurant	51.541427	-0.138727	Italian Restaurant
20	Camden	51.542305	-0.139560	Anima e Cuore	51.544560	-0.141435	Italian Restaurant
21	Soho	51.513163	-0.131175	Vapiano	51.513272	-0.133858	Italian Restaurant
22	Soho	51.513163	-0.131175	Lina Stores	51.514148	-0.130986	Italian Restaurant
23	Soho	51.513163	-0.131175	Bocca Di Lupo	51.511607	-0.133939	Italian Restaurant
24	Soho	51.513163	-0.131175	Sartori	51.511784	-0.128021	Italian Restaurant
25	Kensington	51.498995	-0.199123	Pizzicotto	51.498587	-0.199649	Italian Restaurant
26	Kensington	51.498995	-0.199123	Il Portico	51.498611	-0.199999	Italian Restaurant
27	Kensington	51.498995	-0.199123	La Piccola Dely	51.496744	-0.193208	Italian Restaurant

Figure 8: The Italian restaurants surrounding each neighbourhood

Figure 9: A map of the Italian restaurants surrounding each neighbourhood overlaid on top of London's coordinates

Figure 9 shows a folium map of the Italian restaurants surrounding each neighbourhood, where the data was obtained from the dataframe in figure 8. A new dataframe was created showing each neighbourhood and the number of Italian restaurants within a 500m radius as well as the restaurant names, as displayed in figure 10.

	Neighbourhood	No. Italian Restauraunts	Venue
0	Mayfair	2	Delfino, C London
1	Shoreditch	4	Popolo, Via Emilia, Gloria by Big Mamma, Botte...
2	Notting Hill	3	Osteria Basilico, NEGOZIO CLASSICA, Chucs Rest...
3	Camden	3	Casa Tua, Domo94 Italian Restaurant, Anima e C...
4	Southwark	4	Macellaio RC, Capricci, Marco's New York Itali...
5	Soho	4	Vapiano, Lina Stores, Bocca Di Lupo, Sartori
6	Chelsea	3	La Mia Mamma, Made in Italy, Buona Sera at the...
7	Greenwich	2	Franco Manca, Zizzi
8	Kensington	3	Pizzicotto, Il Portico, La Piccola Dely

Figure 10: Dataframe showing the number and names of the Italian restaurants surrounding each neighbourhood within a 500m radius

Since Mayfair and Greenwich have the least number of Italian restaurants within its neighbourhood, they were investigated further to see which would be the better choice to open a restaurant in. The ratings as well as the tips on the restaurants in Mayfair and Greenwhich were found using Foursquare API and are displayed in the table below.

Table 1: Ratings of each of the Italian restaurants in Mayfair and Greenwich

Neighbourhood	Italian Restaurant	Rating	Number of Tips	Tip
Mayfair	Delfino	8.7	92	“Upstairs, delfino do the best pizzas aro und. Pure and simple. Or you can have t raditional Italian. But why would you? T he staff are brilliant, just the right amou nt of upbeat buzz.”
Mayfair	C London	8.1	103	"All the dishes we've tried were soooo g ood and the portions are more than eno ugh👌I recommend the gnocchi as a mai n dish and the parmigiana as an appetiz er"
Greenwich	Franco Manca	8.3	0	
Greenwich	Zizzi	6.5	11	“The table by the river is best. Suggest C alzone di pollo and tiramisu! Nice place and good food for the price”

5. DISCUSSION

The aim of the project was to aid stakeholder's decision in opening a restaurant though a comparison of 10 London neighbourhoods. It was clear from figure 7 that the most common type of restaurant in 7 out of the 10 neighbourhoods was an Italian restaurant. It was deduced that Italian restaurants are a popular type of restaurant and so it was decided that the type of restaurant that would be most profitable would be an Italian restaurant. As a result, further filtering was completed to determine the number of Italian restaurants within a 500m radius of each neighbourhood. Figure 9 displaces a folium map of all the Italian restaurants surrounding each neighbourhood, providing an effective means of passing information to the stakeholders. Figure 10 clearly shows that Shoreditch, Southwark and Soho each have 4 Italian restaurants within 500m and so these three neighbourhoods are not a good option for opening an Italian restaurant. On the other hand, Mayfair and Greenwich only have 2 Italian restaurants surrounding their neighbourhood. Thus, further analysis was performed on Mayfair and Greenwich to decide which of the two would be a better option to open up a restaurant in.

Foursquare API was used to find the ratings of each of the two restaurants in Mayfair and Greenwich. This is because the lower the ratings of the restaurants results in a better prospect of opening a successful restaurant there. Table 1 shows the results obtained from Foursquare API where Mayfair's two restaurants have high ratings and one of Greenwich's restaurants have a low rating. I was then decided to look at the reviews on the restaurants to see if that could give us a better idea of the quality of the restaurants. Three of the restaurants that had tips were complementary. Despite the fact that one of Greenwich's restaurants had a low rating, it had a positive review and so the deciding factor between these two neighbourhood's will be the distance from city central. Greenwich is the furthest neighbourhood from London center with a distance of 8.9km whereas Mayfair is 1.4km. It is therefore determined that Mayfair is the most ideal London neighbourhood to open an Italian restaurant out of the 10 neighbourhood's that were compared.

In order to improve this analysis, a radius of more than 500m could have been used when obtaining venue data from Foursquare. I wouldn't recommend using a radius of longer than 1km as we don't want to encroach on another nearby neighbourhood and skew the results. In addition, more than 10 neighbourhoods could have been analyzed in order to get a broader sample of data and thus able to make a more informed decision.

6. CONCLUSION

The goal of this assignment was to analyze different neighbourhood's in London in order to aid stakeholder's search for an optimum area to open a restaurant as well as the type of restaurant that would be most lucrative.

Foursquare API data was used to find restaurant venue information surrounding each of the 10 neighbourhoods within a specified radius. After which it was determined that an Italian restaurant was the most common amongst the neighbourhoods and thus an ideal restaurant type to open due to its popularity. Once the search was narrowed down to 2 neighbourhoods, further analysis, using Foursquare API, was completed to obtain data on the ratings and tips of these neighbourhood's. Finally, it was determined that Mayfair was the best option to open an Italian restaurant due to its proximity to London center as well as the minimum number of Italian restaurants within 500m of its coordinates.

This study could be improved by expanding the number of neighbourhoods compared as well as by increasing the radius of the venues surrounding each neighbourhood. Multiple additional factors

including noise levels, crime rate and vicinity to public transportation could be used in future analysis to help the stakeholders make their final decision.

7. REFERENCES

[1] Ferne Arfin. 2019. Top 20 Most Popular UK Cities for International Visitors. 06 December 2019. <https://www.tripsavvy.com/popular-uk-cities-for-international-visitors-1661845>

[2] Rachel Erdos. 2019. The 10 Best Neighbourhoods to Explore in London. 06 December 2019. <https://www.tripsavvy.com/best-neighbourhoods-to-explore-in-london-4129386>

[3] Spk578. 2017. Distance on a sphere: The Haversine Formula. 06 December 2019. <https://community.esri.com/groups/coordinate-reference-systems/blog/2017/10/05/haversine-formula>