Culinary Venues Location Analysis in Singapore

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1. Introduction

1.1. Background

Singapore is a well developed city-state located in South East Asia. Well known as the main financial and logistic hub of the region, various businesses continue to develop here. This opportunity attracts various culinary businesess like food courts, restaurants, dessert stalls, and cafes to set up their shops here. However, the growing number and diversity of culinary businesses in Singapore is so overwhelming, so that a new culinary entrepreneur will need to perform serious initial feasibility study to carefully plan their growing business. Every new culinary entrepreneur will need to analyze potential customers to make sure that their business can grow. Apart from that, they also need to consider potential competitive businesses that may drive them out of the culinary business competition.

Figure 1. (a) Singapore location in South East Asia. (b) Singapore's financial centre as well as tourist attraction. (c) Popular food court centre. Various Singaporean food and beverages such as (d) chili crab, (e) Singaporean noodles and (f) Tangyuan dessert.

1.2 Problem Description

In summary, the target audience is:

- **culinary entrepreneurs (food courts, restaurants, fast food joint, cafes etc)**, who want to open a new business.

Problems to investigate:

- **Where to open their new business?**
- **How many is their potential customers?**
- **What kind of competitors they may face?**

Why would our target audience (culinary entrepreneurs) care:

- **They need to decide a place to start their business.**
- **Without selecting the correct place, they may fail to get customers.**
- **Without customers nobody buys their products.**
- **Also, they need to differentiate themselves from competitors.**

2. Data Description, Relevance, Acquisition, and Preparation

2.A Data Description

There are several main datasets I collected:

- **Zones and Coordinates Info for Each Location in Singapore**
- **Population Counts for Each Zones**
- **Venues Category and Counts for Each Zones**

2.B Data Relevance, How it Will Solve the Problem

Zones and Coordinate Info for Each Location in Singapore can be used to identify location of various neighborhood in this city. Subsequently, we want to collect population counts for each zones. Regions, with high population counts may provide our target audience (culinary entrepreneur) who want to leverage large number of customers. Subsequently, we want to collect data about various venues culinary or non-culinary using Foursquare API.

If it is non-culinary, it is of interest to our target audience since it is possible to pair our culinary product with those venues. For example healthy food stall may be a good pair around sport stadium and cafe may be a good pair with library.

If it is culinary, it is also important to decide whether they are in the same category or not. If we want to open a ramen shop, we must check not only the presence of other ramen shop, but also udon, noodles, pasta etc. On the other hand, it may be okay if the other venues are selling different kinds of food such as kebab or dessert such as

ice cream. Using data that we can obtain using Foursquare API, we can help to provide a dataset that can help our customer to investigate and decide where to open up their venue.

2.C Data Acquisition

2.C.1 Zones and Coordinates Info

For the case of Singapore venues analysis, I decide to use Development Guide Plans (DGP) zones or also known as planning areas to divide Singapore neighborhood. According to the government's document, DGP zones or planning areas are the main urban planning and census divisions of Singapore. The division is delineated by the Urban Redevelopment Authority to provide detailed planning guidelines for each plot of land throughout the city-state. There are a total of 55 of these DGP zones or planning areas.

Unlike the postal sectors division, a clear map that delineate the divisions between DGP zones is more readily understood, as can be inspected on Figure 2 below.

Figure 2. Development Guide Plans (DGP) Zones or Planning Areas in Singapore.
Reference: 'https://en.wikipedia.org/wiki/Planning_Areas_of_Singapore'

From now on, we will refer to Singapore neighborhoods according to this zones division. It needs to be noted that the coordinates value can not be obtained from the above mentioned wikipedia page, but most of the coordinates can be obtained from

the specific zone coordinate as displayed on the wikipedia subpage for each zone. First, we obtain the zones division by using Beautiful Soup 4 module to extract data from the main wikipedia page in form of wikitable class.

On the wikitable in the main Singapore zones page, there is a link that can lead to subsequent wikipedia page to describe in more detail, the description for each zone or neighborhood. From that page, we can collect information regarding the coordinates location for each zone. We then use the Beautiful Soup 4 module to parse this information from each zone wikipedia page. Some zone's page is incomplete, so we use geocoder to put the zones name to locate the coordinate. Overall process to acquire this information is succintly described in Figure 3.
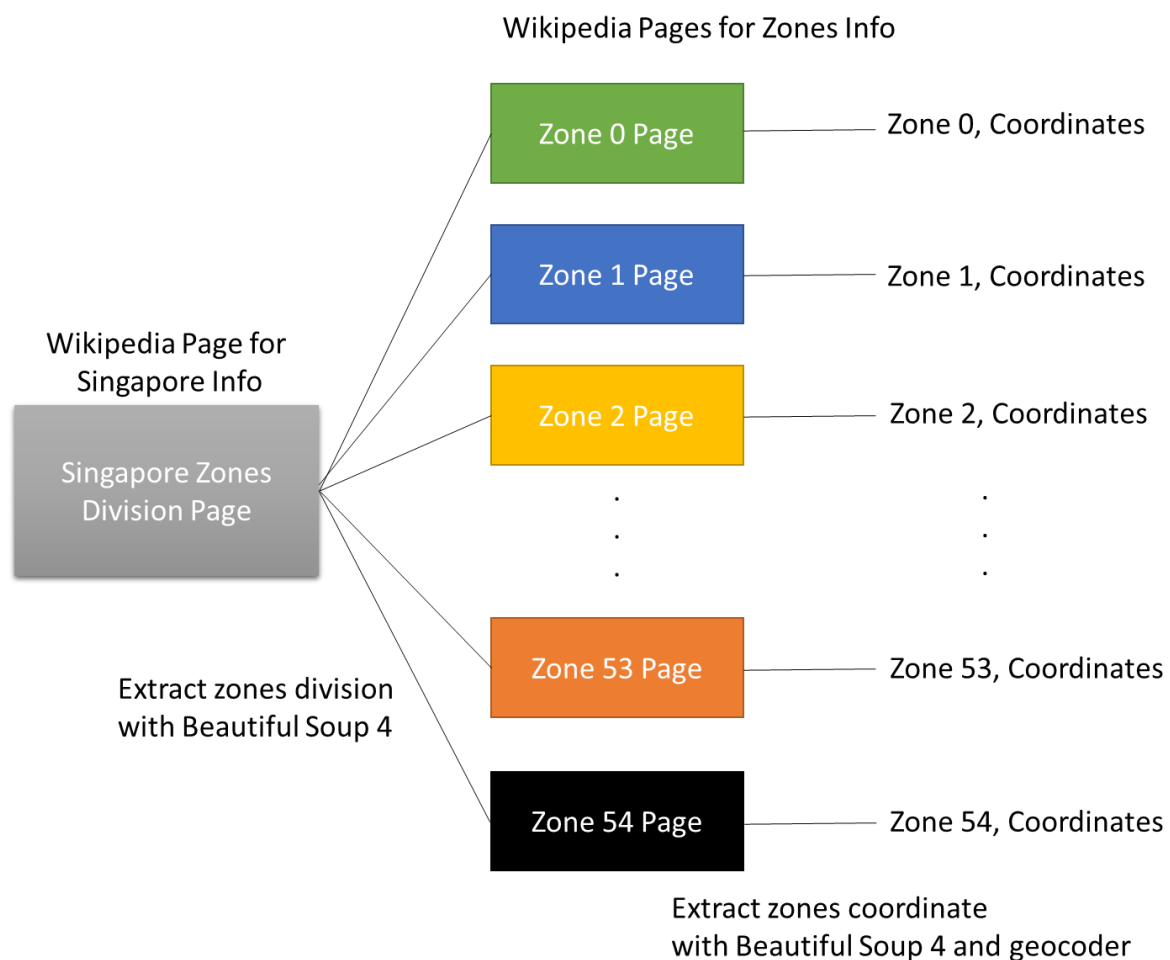

Figure 3. Scheme to Extract Zones Division and Coordinates for Singapore

2.C.2 Population Count for Each Zones

We can use similar scheme like in Figure 3 to collect population count for each zones. Fortunately, the data is already tabulated in the main Singapore wikipedia page, so I simply use the Beautiful Soup 4 to parse the data directly from the table. I also collect areas data in case it become handy. Based on the data, we collected so far, we can use pandas dataframe to describe it as shown in Figure 4. The dataframe describe zones division and zone_links which can be used to extract more information for each neighborhood. It also contains latitude and longitude coordinates we extracted for each zone. Data about population and areas is included as well.

Out[5]:

	DGP zones	zone_links	latitude	longitude	population	areas
0	Ang Mo Kio	/wiki/Ang_Mo_Kio	1.370167	103.845619	165710	13.94
1	Bedok	/wiki/Bedok	1.323600	103.927339	281300	21.69
2	Bishan	/wiki/Bishan,_Singapore	1.350833	103.851389	88490	7.62
3	Boon Lay	/wiki/Boon_Lay_Planning_Area	1.347735	103.708826	30	8.23
4	Bukit Batok	/wiki/Bukit_Batok	1.359031	103.763681	144410	11.13
5	Bukit Merah	/wiki/Bukit_Merah	1.281906	103.823919	151870	14.34
6	Bukit Panjang	/wiki/Bukit_Panjang	1.380833	103.762500	140820	8.99
7	Bukit Timah	/wiki/Bukit_Timah	1.329411	103.802078	77280	17.53
8	Central Water Catchment	/wiki/Central_Water_Catchment	1.366667	103.800000	0	37.15
9	Changi	/wiki/Changi	1.345000	103.983194	2080	40.61
10	Changi Bay	/wiki/Changi_Bay	1.316850	104.020649	0	1.70
11	Choa Chu Kang	/wiki/Choa_Chu_Kang	1.383333	103.750000	187510	6.11
12	Clementi	/wiki/Clementi,_Singapore	1.316181	103.764939	93000	9.49
13	Downtown Core	/wiki/Downtown_Core	1.286667	103.853611	2510	4.34
14	Geylang	/wiki/Geylang	1.320556	103.886944	111610	9.64
15	Hougang	/wiki/Hougang	1.371778	103.893056	223010	13.93
16	Jurong East	/wiki/Jurong_East	1.328883	103.739947	81180	17.83
17	Jurong West	/wiki/Jurong_West	1.339722	103.704444	266720	14.69
18	Kallang	/wiki/Kallang	1.310833	103.865556	101420	9.17
19	Lim Chu Kang	/wiki/Lim_Chu_Kang	1.431844	103.719295	110	17.30
20	Mandai	/wiki/Mandai	1.411667	103.786389	2090	11.77
21	Marina East	/wiki/Marina_East	1.291158	103.872019	0	1.82

Figure 4. Pandas dataframe that describe Singapore zones location, population, and areas. Note that in total, there are 55 zones in Singapore.

2.C.3 Folium Map for All Zones Location

For visualization, I use Folium module to put a marker for each Singapore zones. Using python, we loop through all of the neighborhood, and then put the zones marker for each associated coordinates value. The result is shown in Figure 5. As we can see, the zone is distributed across the city-state. The highest concentration of neighborhoods is in the southern part of the Islands which is a busy marine port and the main financial center of the city. Neighborhood tends to be sparser in the West, East, and Northern part of the city. There are several zone located in or nearby natural reserve such as the two water catchments in the center and in the western region. Some zones are even located on the nearby islands, tends to be isolated from other parts of the city. South West region tends to be filled with industrial businesses. The East region is filled with one public airport and several other airbases. The rest is domestic or residential areas of Singapore.
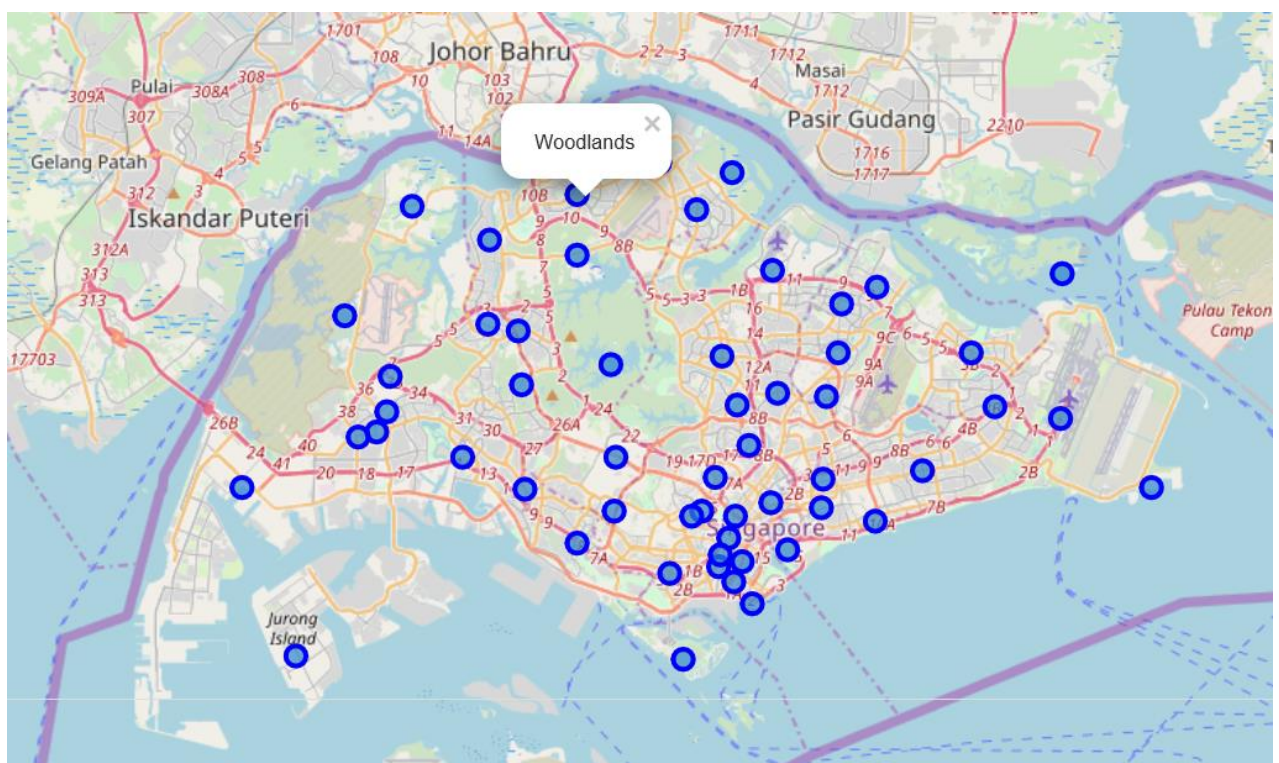

Figure 5. Folium map with markers, with each marker representing each zone or neighborhood in Singapore. As an example 'Woodlands' neighborhood is marked on the northern part of Singapore.

2.C.4 Venues Data Extracted with Foursquare API

Subsequently, we use Foursquare API to extract data for venues around a particular neighborhood. Figure 6 shows an example of venues data around Ang Mo Kio neighborhood. It can be seen that we manage to collect venues names, categories (park, Spa, supermarket, noodle house, seafood restaurant, etc). We also manage to collect the detailed coordinates or the latitude or longitude value for each venue. This later info will be used later to have more detailed understanding of venues location.

Out[53]:

	name	categories	lat	lng
0	Bishan - Ang Mo Kio Park	Park	1.362219	103.846250
1	Aramsa ~ The Garden Spa	Spa	1.362292	103.847602
2	FairPrice Xtra	Supermarket	1.369279	103.848886
3	Face Ban Mian 非板面 (Ang Mo Kio)	Noodle House	1.372031	103.847504
4	龍海鮮螃蟹王 Mellben Seafood	Seafood Restaurant	1.368324	103.836764
5	NTUC FairPrice	Supermarket	1.371507	103.847082
6	Pond Gardens	Park	1.366381	103.834190
7	Subway	Sandwich Place	1.369136	103.847612
8	Sin Ming Roti Prata (Faisal & Aziz Musli...	Indian Restaurant	1.355269	103.836719
9	MOS Burger	Burger Joint	1.369170	103.847831
10	Kam Jia Zhuang Restaurant	Asian Restaurant	1.368167	103.844118
11	Dog Run @ Bishan Park	Dog Run	1.365967	103.844024
12	Central Delights	College Cafeteria	1.377691	103.856590
13	Bangkok Street Mookata	BBQ Joint	1.365688	103.853186
14	Middle Rock Garden Bar	Bar	1.362181	103.847203
15	Boon Tong Kee 文東記	Chinese Restaurant	1.367917	103.836972
16	Prodigal Roasters	Coffee Shop	1.382212	103.841347
17	Chocolat N' Spice	Bakery	1.351867	103.837558
18	Lao San Kway Chap 老三楖汁·猪什汤	Chinese Restaurant	1.367916	103.837008
19	Tomyum Mama	Thai Restaurant	1.353415	103.834441
20	PLAYe	Hobby Shop	1.369109	103.848225
21	Double Scoops	Ice Cream Shop	1.367655	103.839277

Figure 6. Example of venues detail for Ang Mo Kio neighborhood.

Subsequently, we do the same thing for other neighborhoods in Singapore. It needs to be noted that some neighborhood have very few venues while other have a lot of them. Not only that, the categories for each venue can be significantly different. It is important to see which venues available in each particular zone.

3. Methodology

3.1 Exploratory Data Analysis and Inferential Statistical Testing

In terms of exploratory data analysis (EDA), we will try to categorize the venues category in more organized manner. We will tabulate all of culinary and non-culinary category in easily understandable terms.

We will use inferential statistical testing to investigate what kinds of culinary venues is more popular in particular neighborhood. However, it is also important to predict what kinds of potential venues is missing from particular neighborhod.

Results for EDA and inferential statistical testing is shown in detail in section 4.1.

3.2 Machine Learning for Neighborhood Clustering

We will uce K-Nearest Neighbor method to cluster the neighborhood in order to understand the overall segmentation shared by the neighborhoods. Neighborhoods sharing the same cluster will tends to share more similar characteristics than neighborhood outside of the cluster.

We will use the neighborhood clustering in two different ways:

1. Clustering based on overall population count, venues count, and planning areas type

We will cluster the neighborhood based on population count, venues count, and planning areas type. In terms of population count, a well populated neighborhood may provide significant number of residential customers. Culinary venues for such customers may be catered for family friendly restaurants with lower cost options. On the other hand, just because a neighborhood is not well populated doesn't always means that they are unviable. Some neighborhood is a financial centre (banking, insurance, etc) which have very few registered domestic residents but very full of office workers. Such neighborhood can have very high count of commercial venues but very low residential population. A culinary entrepreneus needs to consider what kind of venues that cater to this people.

Some other regions are designated into a different type of planning areas type. A natural reserve region tends to have very small population and venues count, but the culinary venues can be high end restaurants since they also cater to wealthy tourist. Expensive and extraordinary menus will be profitable in such location. Some region is reserved for industrial and logistic centre such as petroleum refinery and shipyards. It is important to offer low cost and fast food options in such places. Other regions designated for airports/airbases also need special consideration.

2. Clustering based on culinary venues

Apart from the above considerations, we can further clusters the neighborhood also based on the culinary venues that they already have. This way we can offer our target audience, the culinary entrepreneurs, with data that can help them to check their competitors and their potential customers.

By having two kinds of clustering, we will help our target audience to compare neighborhood in various ways. For example, let say we identify that ramen restaurants is popular for some residential neighborhoods. However, we identify that there are other residential neighborhoods that does not have any ramen restaurant. We can identify this fact to culinary entrepreneurs to consider opening ramen shop in that location.

Results for neighborhood clustering is shown in detail in section 4.2.

4. Results

4.1 Results of Exploratory Data Analysis

Figure 7 shows the statistic of population count for all neighborhood in Singapore. In average, there are 72624 person for each neighborhood. The most populous neighborhood, Bedok, has 281300 domestic residents in this zone. The third quartile is in 130650 which is around the population of Toa Payoh and Bukit Panjang. The median population is in 20030 which is in Outram. The first quartile is in 180 persons which is around the population of Lim Chu Kang and Seletar. There are some zones that has zero person since they are in reserved regions. Some of those zones are reserved for shipping industry (Marina South, Marina East, Straits View), airport and naval base (Changi Bay), and natural reserves (Simpang, Central Water Catchment). The histogram in Figure 8 shows that in general, the population count varies greatly across the various neighborhoods.

```
In [118]: df_final['population'].describe()

Out[118]: count         55.000000
          mean       72624.000000
          std        88304.424485
          min            0.000000
          25%          180.000000
          50%        20030.000000
          75%       130650.000000
          max       281300.000000
          Name: population, dtype: float64
```

Figure 7. Statistic of population count for all neighborhoods in Singapore.

```
In [132]: plt.hist(df_final['population'], bins=10)

Out[132]: (array([29.,  2.,  2.,  6.,  2.,  6.,  1.,  2.,  2.,  3.]),
           array([     0.,  28130.,  56260.,  84390., 112520., 140650., 168780.,
                   196910., 225040., 253170., 281300.]),
           <a list of 10 Patch objects>)
```
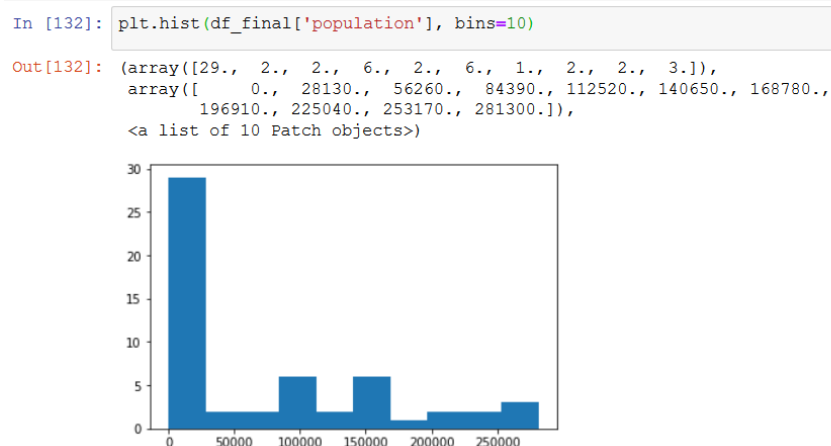

Figure 8. Histogram of population count for all neighborhoods in Singapore.

Figure 9 shows the statistic of venues count for all of the neighborhood. In general, it can be seen that across the 55 neighborhoods, the number of venues in average is 29.7 venues for each neighborhood. The median count of venues is 19, which indicate that the distribution is dominated by some neighborhood that has significantly higher counts of venues than the other. There is at least one venues for each neighborhood. The first and third quartiles of venues count is in 7 and 46 respectively. Histogram in Figure 10 shows the distribution of venues count across the entire neighborhood.

```
In [133]: df_final['venues_count'].describe()

Out[133]: count       55.000000
          mean        29.727273
          std         28.610704
          min          1.000000
          25%          7.000000
          50%         19.000000
          75%         46.000000
          max        100.000000
          Name: venues_count, dtype: float64
```

Figure 9. Statistic of venues count for all neighborhoods in Singapore.

```
In [137]: plt.hist(df_final['venues_count'], bins=10)

Out[137]: (array([18., 12.,  4.,  4.,  4.,  5.,  2.,  2.,  0.,  4.]),
           array([  1. ,  10.9,  20.8,  30.7,  40.6,  50.5,  60.4,  70.3,  80.2,
                   90.1, 100. ]),
           <a list of 10 Patch objects>)
```
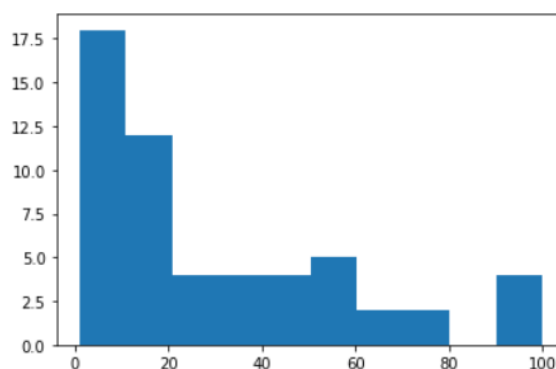

Figure 10. Histogram of venues count for all neighborhoods in Singapore.

Table 1 shows the classification of culinary venues in Singapore neighborhoods. The category information is collected from Foursquare API. Since, there are so many categories, this will not be useful for general understanding of the culinary map in Singapore. We further classify this category into major category which will further help us to recommends potential venues for various culinary business in Singapore.

Table 1. Culinary Venues in Singapore Neighborhoods

Major Category	Category (some category may belong to more than one major category)	Explanation
Food Court and Cafeteria	'Food Court', 'Breakfast Spot', 'Bistro', 'Deli / Bodega', 'Food Stand', 'Bed & Breakfast', 'Cafeteria', 'Food & Drink Shop', 'Street Food Gathering', 'Comfort Food Restaurant'	General food court and cafeteria, not food or culinary culture specific.
Fastfood	'Burger Joint', 'Sandwich Place', 'Fast Food Restaurant', 'Fried Chicken Joint', 'Steakhouse', 'Burrito Place', 'Wings Joint', 'BBQ Joint', 'Fish & Chips Shop', 'Diner', 'Buffet', 'Pizza Place'	Fastfood (burger, sandwich, fried chicken etc)
Dessert, Beverages, and Cafe	'Dessert Shop', 'Snack Place', 'Coffee Shop', 'Bubble Tea Shop', 'Frozen Yogurt Shop', 'Café', 'Ice Cream Shop', 'Cha Chaan Teng', 'Juice Bar', 'Tea Room', 'Chocolate Shop'	Places that provide dessert without heavy meal, dessert and beverages focused
Pub, Bar, Alcoholic Beverages	'Gastropub', 'Beer Garden', 'Beer Bar', 'Bar', 'Cocktail Bar', 'Club House', 'Nightclub', 'Hotel Bar', 'Whisky Bar', 'Pub', 'Wine Bar', 'Brewery', 'Wine Shop', 'Sake Bar', 'Sports Bar', 'Rock Club'	Focused on alcoholic beverages
Bakery, Doughnut and Bagel	'Bakery', 'Bagel Shop', 'Donut Shop', 'Pastry Shop', 'Creperie', 'Cupcake Shop'	Bakery and similar establishments
East Asian Restaurant	'Asian Restaurant', 'Chinese Restaurant', 'Japanese Restaurant', 'Hong Kong Restaurant', 'Shaanxi Restaurant', 'Cantonese Restaurant', 'Chinese Breakfast Place', 'Korean Restaurant', 'Japanese Curry Restaurant', 'Taiwanese Restaurant', 'Hainan Restaurant', 'Dongbei Restaurant', 'Szechuan Restaurant', 'Peking Duck Restaurant', 'Seafood Restaurant', 'Sushi Restaurant', 'Hotpot Restaurant', 'Noodle House', 'Ramen	Chinese, Japanase, Korean, and other East Asian Restaurant

	Restaurant', 'Udon Restaurant', 'Dumpling Restaurant', 'Dim Sum Restaurant'	
South East Asian Restaurant	'Thai Restaurant', 'Malay Restaurant', 'Indonesian Restaurant', 'Filipino Restaurant', 'Vietnamese Restaurant', 'Halal Restaurant'	South East Asian Restaurant
Indian and Middle Eastern Restaurant	'Indian Restaurant', 'Middle Eastern Restaurant', 'Kebab Restaurant', 'North Indian Restaurant', 'South Indian Restaurant', 'Halal Restaurant', 'Vegetarian / Vegan Restaurant'	Indian and Middle Eastern Restaurant
Western Restaurant	'Modern European Restaurant', 'American Restaurant', 'French Restaurant', 'Italian Restaurant', 'Mexican Restaurant', 'Spanish Restaurant', 'German Restaurant', 'Mediterranean Restaurant', 'Greek Restaurant', 'English Restaurant', 'Cuban Restaurant', 'New American Restaurant', 'Southern / Soul Food Restaurant', 'Australian Restaurant'	Western (Europe, American, and Australian) Restaurant
Seafood and Sushi	'Seafood Restaurant', 'Sushi Restaurant', 'Hotpot Restaurant'	May overlap with Japanase and Chinese restaurant.
Udon, Noodle, Ramen	'Noodle House', 'Ramen Restaurant', 'Udon Restaurant'	Noodle like cuisine. Most East Asian and South East Asian Restaurant may provide this kind of food as well.
Dumpling and Dimsum	'Dumpling Restaurant', 'Dim Sum Restaurant'	May overlap with Chinese Restaurant.
Health, Vegetarian, Salad	'Health Food Store', 'Salad Place', 'Soup Place', 'Vegetarian / Vegan Restaurant',	Vegetable and health focused food.

Apart from the culinary venues, we also collect and classify various venues in Singapore neighborhoods as shown in Table 2. This will help our target audience to understand better the surrounding environment in which they will setup their business. Using information about other venues, we can help them to identify and pair their offering to the particular business scene. For example, business offering healthy food may provide better values around sports and medical centre. On the other hand, quick and convenient food may be useful around office and industrial regions.

Table 2. Non-Culinary Venues in Singapore Neighborhoods

Major Category	Category	Explanation
Shopping	'Supermarket', 'Shopping Mall', 'Electronics Store', 'Convenience Store', 'Department Store', 'Clothing Store', 'Bookstore', 'Plaza', 'Cosmetics Shop', 'Kids Store', 'Grocery Store', 'Video Store', 'Sporting Goods Shop', "Men's Store",'Smoke Shop', 'Shoe Store', 'Pet Store', 'Kitchen Supply Store', 'Other Repair Shop', 'Mobile Phone Shop','Optical Shop', 'Miscellaneous Shop', 'Jewelry Store', 'Stationery Store', 'Paper / Office Supplies Store', 'Flea Market', 'Gift Shop', 'Bike Rental / Bike Share', 'Fruit & Vegetable Store', 'Flower Shop', 'Auto Garage', 'Bike Shop', 'Shopping Plaza', 'Market', 'Print Shop', 'Night Market', 'Furniture / Home Store', 'Shop & Service', 'Video Game Store'	Shopping places
Finance	'Bank', 'Business Service'	Finance Centres
Entertainment	'Multiplex', 'Karaoke Bar', 'Movie Theater', 'Theater', 'Concert Hall', 'General Entertainment', 'Music Venue', 'Theme Park Ride / Attraction', 'Indie Theater', 'Arts & Entertainment', 'Museum', 'Art Gallery', 'Recreation Center', 'Casino', 'Arcade'	Entertainment Places
Park, Garden, Waterbody, Outdoor	'Trail', 'Garden', 'Garden Center', 'Dog Run', 'Skate Park', 'Park', 'Waterfront', 'Outdoor Sculpture', 'Bridge', 'Bay', 'Sculpture Garden', 'Canal', 'Scenic Lookout', 'Playground', 'Other Great Outdoors', 'Harbor / Marina', 'Beach', 'Pier', 'Cruise', 'River', 'Lighthouse'	Park, Garden, Waterbody, Outdoor Locations
Transport	'Bus Station', 'Train Station', 'Bus Line', 'Light Rail Station', 'Tunnel', 'Platform', 'Airport Service', 'Airport', 'Boat or Ferry', 'Bus Stop', 'Airport Terminal', 'Metro Station'	Transport Hub
Sports and Health	'Gym', 'Gym / Fitness Center', 'Pool Hall', 'Pharmacy', 'Pool', 'Soccer Stadium', 'Martial Arts Dojo', 'Basketball Court', 'Gym Pool', 'Golf Course', 'Medical Center', "Doctor's Office", 'Golf Driving Range', 'Stadium', 'Field', 'Soccer Field', 'Racetrack'	Sports and Health Places
Beauty Care	'Salon / Barbershop', 'Spa', 'Massage Studio', 'Yoga Studio', 'Dance Studio', 'Boutique'	Beauty Care Places
Hotel and Inn	'Hotel', 'Motel', 'Hostel', 'Rest Area'	Hotel and Inn Places

Education	'General College & University', 'Student Center', 'Speakeasy', 'High School'	Education Places
Other	'Hobby Shop', 'Gaming Cafe', 'Performing Arts Venue', 'History Museum', , 'Arts & Crafts Store', , 'Monument / Landmark', 'Lounge', 'Event Space', 'Office', 'Government Building', 'Housing Development', 'Post Office', 'Farm'	Other

4.2 Results of Machine Learning for Neighborhood Clustering

a. Neighborhood Clustering

We classify various neighborhood to 7 different clusters in term of the general neighborhood situations using machine learning. For each neighborhood, we consider population count, venues count, and whether they are industrial region, natural reserve, or airport. For the industrial region, natural reserve or airport they are indicated using one hot encoding. For the population and venues count, they are normalized using scikit-learn min max scaler module.
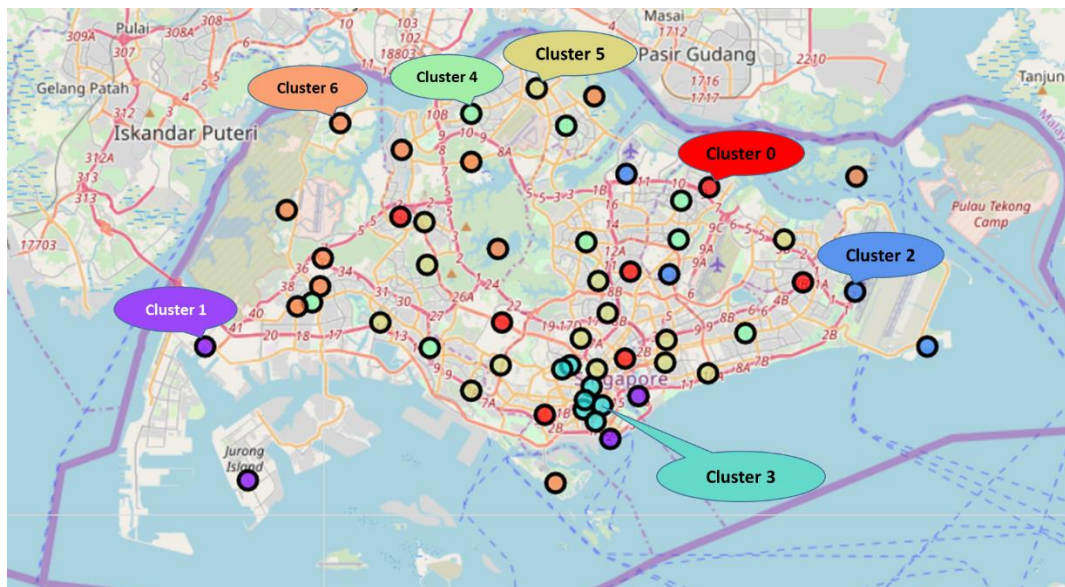
Figure 11. General clustering of Singapore Neighborhood.

Subsequently, we put the normalized dataframe into scikit-learn KMeans clustering algorithm. Based on that, we get 7 different clusters with various characteristics. We plot those clusters using Folium map as shown in Figure 11.

We tabulate the general classification in the Table 3 as shown below.

Cluster	Population Count /neighborhood	Venues Count/ neighborhood	Neighborhoods and General Description
Cluster 0	77280 - 257110	4 to 12	Bukit Merah, Bukit Timah, Choa Chu Kang, Kallang, Punggol, Serangoon, Tampines (heavily populated residential area with few venues)
Cluster 1	0 - 70	1 to 13	Marina East, Marina South, Tuas, Western Islands (industrial area)
Cluster 2	0 - 2080	6 to 20	Changi, Changi Bay, Paya Lebar, Seletar (airport, airbase area)
Cluster 3	0 - 20030	61 to 100	Downtown Core, Museum, Newton, Outram, Singapore River, Straits View, Orchard (financial area)
Cluster 4	93000 - 281300	32 to 63	Ang Mo Kio, Bedok, Clementi, Hougang, Jurong West, Sengkang, Woodlands, Yishun (heavily populated residential area with lots of venues)
Cluster 5	9930 - 146920	17 to 58	Bishan, Bukit Batok, Bukit Panjang, Geylang, Jurong East, Marine Parade, Novena, Pasir Ris, Queenstown, River Valley, Rochor, Sembawang, Tanglin, Toa Payoh (moderately populated

			residential area with moderate amount of venues)
Cluster 6	0 to 2090	1 to 18	Central Water Catchment, Western Water Catchment, Lim Chu Kang, Mandai, North Eastern Islands, Boon Lay, Pioneer, Simpang, Southern Island, Sungai Kadut, Tengah (Sparsely populated areas. Some is in or nearby natural reserved areas. Far from urban centre)

Table 4. Details About Cluster 0: Heavily Populated Areas with Few Venues

	zone_links	areas	population	venues_count	Cluster Labels	1st Most Common Venue	2nd Most Common Venue	3rd Most Common Venue	4th Most Common Venue	5th Most Common Venue
5	/wiki/Bukit_Merah	14.34	151870	12	0	Chinese Restaurant	Residential Building (Apartment / Condo)	Coffee Shop	Seafood Restaurant	Bus Line
7	/wiki/Bukit_Timah	17.53	77280	3	0	Pool	Bus Station	Coffee Shop	Yoga Studio	Fast Food Restaurant
11	/wiki/Choa_Chu_Kang	6.11	187510	10	0	Department Store	Coffee Shop	Bus Station	Bus Stop	Shop & Service
18	/wiki/Kallang	9.17	101420	12	0	Restaurant	Coffee Shop	Supermarket	Fast Food Restaurant	Hostel
33	/wiki/Punggol	9.34	161570	4	0	Casino	Chinese Restaurant	Bus Station	High School	Flower Shop
40	/wiki/Serangoon	10.10	117310	11	0	Asian Restaurant	Indian Restaurant	Fast Food Restaurant	Bike Shop	Park
46	/wiki/Tampines	20.89	257110	7	0	Indian Restaurant	Sandwich Place	Fast Food Restaurant	Grocery Store	South Indian Restaurant

Table 5. Details about Cluster 1: Industrial Areas.

	zone_links	areas	population	venues_count	Cluster Labels	1st Most Common Venue	2nd Most Common Venue	3rd Most Common Venue	4th Most Common Venue	5th Most Common Venue
21	/wiki/Marina_East	1.82	0	4	1	Golf Course	Golf Driving Range	Park	Yoga Studio	Fast Food Restaurant
22	/wiki/Marina_South	1.62	0	13	1	Cruise	Pier	Boat or Ferry	Road	Buffet
50	/wiki/Tuas	30.04	70	7	1	Asian Restaurant	Seafood Restaurant	Food Court	Harbor / Marina	Boat or Ferry
51	/wiki/Western_Islands,_Singapore	39.47	10	1	1	Boat or Ferry	Yoga Studio	Fast Food Restaurant	Frozen Yogurt Shop	Fried Chicken Joint

Table 6. Details about Cluster 2. Airport and Airbase Area.

	zone_links	areas	population	venues_count	Cluster Labels	1st Most Common Venue	2nd Most Common Venue	3rd Most Common Venue	4th Most Common Venue	5th Most Common Venue
9	/wiki/Changi	40.61	2080	13	2	Bus Station	Airport Terminal	Airport	Tunnel	Sporting Goods Shop
10	/wiki/Changi_Bay	1.70	0	6	2	Boat or Ferry	Gym Pool	Smoke Shop	Pizza Place	History Museum
31	/wiki/Paya_Lebar	11.69	40	20	2	Bakery	Coffee Shop	Noodle House	Bus Station	Breakfast Spot
37	/wiki/Seletar	10.25	250	7	2	Other Repair Shop	Modern European Restaurant	Playground	Café	English Restaurant

Table 6. Details about Cluster 3: Financial Area

	zone_links	areas	population	venues_count	Cluster Labels	1st Most Common Venue	2nd Most Common Venue	3rd Most Common Venue	4th Most Common Venue	5th Most Common Venue
13	/wiki/Downtown_Core	4.34	2510	71	3	Italian Restaurant	Cocktail Bar	Concert Hall	Japanese Restaurant	Asian Restaurant
24	/wiki/Museum_Planning_Area	0.83	420	61	3	Hotel	Café	Japanese Restaurant	Karaoke Bar	Movie Theater
25	/wiki/Newton,_Singapore	2.07	7640	71	3	Hotel	Japanese Restaurant	Chinese Restaurant	Café	Asian Restaurant
28	mw-redirect	0.96	990	100	3	Boutique	Japanese Restaurant	Sushi Restaurant	Hotel	Chinese Restaurant
29	/wiki/Outram,_Singapore	1.37	20030	100	3	Chinese Restaurant	Hostel	Vegetarian / Vegan Restaurant	Food Court	Seafood Restaurant
42	/wiki/Singapore_River	0.96	2980	100	3	Japanese Restaurant	Hotel	Nightclub	Food Court	Seafood Restaurant
44	/wiki/Straits_View	0.77	0	97	3	Café	Coffee Shop	Korean Restaurant	Cocktail Bar	Restaurant

Table 7. Details about Cluster 4: Heavily populated residential area with lots of venues

	zone_links	areas	population	venues_count	Cluster Labels	1st Most Common Venue	2nd Most Common Venue	3rd Most Common Venue	4th Most Common Venue	5th Most Common Venue
0	/wiki/Ang_Mo_Kio	13.94	165710	60	4	Food Court	Coffee Shop	Fast Food Restaurant	Dessert Shop	Seafood Restaurant
1	/wiki/Bedok	21.69	281300	60	4	Coffee Shop	Chinese Restaurant	Sushi Restaurant	Food Court	Supermarket
12	/wiki/Clementi,_Singapore	9.49	93000	63	4	Coffee Shop	Food Court	Asian Restaurant	Dessert Shop	Chinese Restaurant
15	/wiki/Hougang	13.93	223010	32	4	Fast Food Restaurant	Café	Food Court	Coffee Shop	Supermarket
17	/wiki/Jurong_West	14.69	266720	58	4	Asian Restaurant	Fast Food Restaurant	Japanese Restaurant	Chinese Restaurant	Dessert Shop
39	/wiki/Sengkang	10.59	240640	30	4	Food Court	Fast Food Restaurant	Bus Station	Chinese Restaurant	Asian Restaurant
53	/wiki/Woodlands,_Singapore	13.59	252530	54	4	Japanese Restaurant	Café	Coffee Shop	Bus Station	Frozen Yogurt Shop
54	/wiki/Yishun	21.24	214940	47	4	Chinese Restaurant	Hainan Restaurant	Dessert Shop	Food Court	Coffee Shop

Table 8. Details about Cluster 5: moderately populated residential area with moderate amount of venues

	zone_links	areas	population	venues_count	Cluster Labels	1st Most Common Venue	2nd Most Common Venue	3rd Most Common Venue	4th Most Common Venue	5th Most Common Venue
2	/wiki/Bishan,_Singapore	7.62	88490	45	5	Food Court	Coffee Shop	Café	Bubble Tea Shop	Chinese Restaurant
4	/wiki/Bukit_Batok	11.13	144410	30	5	Italian Restaurant	Coffee Shop	Café	Supermarket	Shopping Mall
6	/wiki/Bukit_Panjang	8.99	140820	45	5	Sushi Restaurant	Coffee Shop	Fast Food Restaurant	Noodle House	Shopping Mall
4	/wiki/Geylang	9.64	111610	17	5	Food Court	Asian Restaurant	Grocery Store	Chinese Restaurant	Pool
6	/wiki/Jurong_East	17.83	81180	19	5	Bus Station	Hotel	Café	Steakhouse	Sushi Restaurant
3	/wiki/Marine_Parade	6.12	47250	36	5	Hotel	Massage Studio	Multiplex	Chinese Restaurant	Salad Place
7	/wiki/Novena,_Singapore	8.98	48950	58	5	Café	Coffee Shop	Japanese Restaurant	Chinese Restaurant	Hotel
0	/wiki/Pasir_Ris	15.02	146920	31	5	Coffee Shop	Sushi Restaurant	Bus Station	Sandwich Place	Fast Food Restaurant
4	/wiki/Queenstown,_Singapore	20.43	97870	31	5	Coffee Shop	Food Court	Bus Station	Noodle House	Beer Bar
5	/wiki/River_Valley,_Singapore	1.48	9930	24	5	Noodle House	Chinese Restaurant	Asian Restaurant	Food Court	Seafood Restaurant
6	/wiki/Rochor	1.62	13450	41	5	Indian Restaurant	Vegetarian / Vegan Restaurant	Chinese Restaurant	Hotel	Hostel
8	/wiki/Sembawang	12.34	87380	15	5	Fast Food Restaurant	Coffee Shop	Chinese Restaurant	Government Building	Supermarket
7	/wiki/Tanglin	7.63	20960	20	5	Food Court	Chinese Restaurant	Bus Station	Gym	Japanese Restaurant
9	/wiki/Toa_Payoh	8.17	120480	29	5	Chinese Restaurant	Coffee Shop	Fast Food Restaurant	Noodle House	Asian Restaurant

Table 9. Details about Cluster 6: Sparsely populated areas. Some is in or nearby natural reserved areas. Far from urban centre.

	zone_links	areas	population	venues_count	Cluster Labels	1st Most Common Venue	2nd Most Common Venue	3rd Most Common Venue	4th Most Common Venue	5th Most Common Venue
3	/wiki/Boon_Lay_Planning_Area	8.23	30	9	6	Grocery Store	Residential Building (Apartment / Condo)	Café	Shopping Mall	Performing Arts Venue
8	/wiki/Central_Water_Catchment	37.15	0	1	6	Business Service	Yoga Studio	Fast Food Restaurant	Frozen Yogurt Shop	Fried Chicken Joint
19	/wiki/Lim_Chu_Kang	17.30	110	4	6	Farm	Theme Park Ride / Attraction	Cosmetics Shop	Yoga Studio	Flower Shop
20	/wiki/Mandai	11.77	2090	3	6	Scenic Lookout	Garden	Trail	Event Space	French Restaurant
26	/wiki/North-Eastern_Islands	42.88	50	3	6	Scenic Lookout	Rest Area	Moving Target	Department Store	Dessert Shop
32	/wiki/Pioneer,_Singapore	12.10	90	18	6	Gym	Convenience Store	Bus Station	Dance Studio	Dumpling Restaurant
41	/wiki/Simpang	5.13	0	1	6	Platform	Yoga Studio	Farm	Frozen Yogurt Shop	Fried Chicken Joint
43	/wiki/Southern_Islands	6.07	1800	13	6	Golf Course	Hotel	Spa	Light Rail Station	Cocktail Bar
45	/wiki/Sungei_Kadut	15.99	780	4	6	Breakfast Spot	Food Court	Bus Station	Office	Yoga Studio
48	/wiki/Tengah,_Singapore	7.40	10	3	6	Moving Target	Department Store	Bus Station	Field	Fruit & Vegetable Store
52	/wiki/Western_Water_Catchment	69.46	720	1	6	Fruit & Vegetable Store	Furniture / Home Store	Frozen Yogurt Shop	Fried Chicken Joint	French Restaurant

5. Discussion

Since, there are so many possibilities for culinary category in Singapore, we decide to showcase three kinds example for case studies.

Case studies:

1. Opening Healthy Food Near Health and Sport Centre

2. Opening Ramen Noodles Shop in Populated Residential Areas

3. Opening Bubble Tea Stall at Outdoor Parks and Beaches

Case Study 1: Opening Healthy Food Venues Near Health and Sport Centres

We want to study whether we can find location of health and sport centre that require healthy food options. This will be useful for culinary entrepreneur who have plans on this specific category.

As shown in Table 10, there are many places that have more health foods option available than health centres available. However, there are also places in which they has fewer health foods option than health centres available. This kind of places may possess high potential for healthy food business. Details for individual venues are shown in Table 11.

Table 10. Statistic of Health Foods Venues Count and Health Centres Count.

```
In [266]: df_case1[['health_foods', 'health_centres']].describe()
```

Out[266]:

	health_foods	health_centres
count	31.000000	31.000000
mean	1.000000	2.129032
std	1.591645	1.586231
min	0.000000	0.000000
25%	0.000000	1.000000
50%	0.000000	2.000000
75%	1.000000	3.000000
max	7.000000	6.000000

Table 11. Health Foods and Health Centres Count for Each Neighborhood

Neighborhood	health_foods	health_centres
Ang Mo Kio	1	4
Bedok	2	0
Bishan	0	5
Boon Lay	0	1
Bukit Batok	1	2
Bukit Panjang	0	3
Bukit Timah	0	1
Changi Bay	0	1
Clementi	1	2
Downtown Core	2	2
Geylang	1	2
Hougang	1	1
Jurong East	0	3
Marina East	0	3
Marine Parade	2	0
Museum	0	1
Newton	1	1
Novena	1	2
Outram	7	2
Pasir Ris	1	0
Pioneer	0	6
Queenstown	0	2
Rochor	3	0
Sengkang	0	2
Singapore River	5	3
Southern Islands	0	4
Straits View	2	6
Tanglin	0	2
Toa Payoh	0	2
Woodlands	0	1
Yishun	0	2

Example of Neighborhood: Outram

Table 12 shows that health foods option are quite numerous in Outram neighborhood. There are two gym/fitness centres in Outram. However, they are already close to numerous health foods option as shown in Figure 12.

Table 12. Health Foods and Health Centres in Outram Neighborhood

Check for Outram Neighborhood

```
df_case1_a = singapore_venues_case1[singapore_venues_case1['Neighborhood'] == 'Outram']
df_case1_a = df_case1_a[(df_case1_a['health_foods']==1)|(df_case1_a['health_centres']==1)]
df_case1_a
```

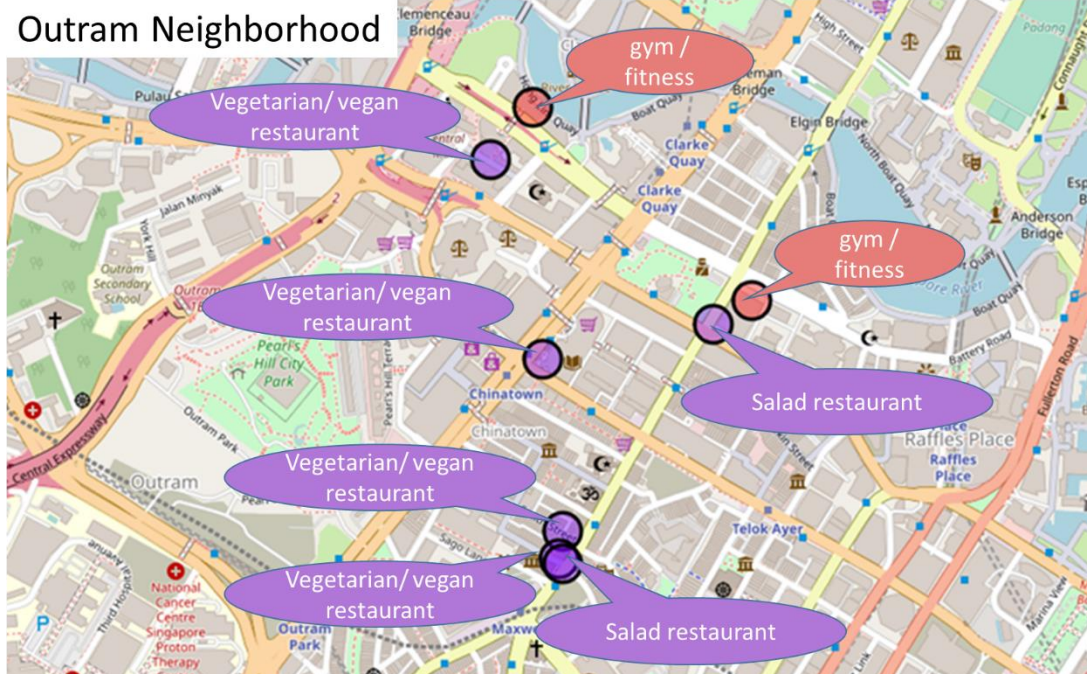|	Neighborhood	Neighborhood Latitude	Neighborhood Longitude	Venue	Venue Latitude	Venue Longitude	Venue Category	health_foods	health_centres
949	Outram	1.284889	103.843889	Lotus Kitchen	1.284966	103.844385	Vegetarian / Vegan Restaurant	1	0
964	Outram	1.284889	103.843889	Annalakshmi	1.288414	103.843472	Vegetarian / Vegan Restaurant	1	0
995	Outram	1.284889	103.843889	Fitness First Platinum	1.285972	103.847977	Gym / Fitness Center	0	1
999	Outram	1.284889	103.843889	Ci Yan Organic Vegetarian Restaurant	1.282014	103.844734	Vegetarian / Vegan Restaurant	1	0
1003	Outram	1.284889	103.843889	Eight Treasures Vegetarian 八宝素食馆	1.281538	103.844667	Vegetarian / Vegan Restaurant	1	0
1004	Outram	1.284889	103.843889	Energia Fitness Club	1.289307	103.844210	Gym	0	1
1012	Outram	1.284889	103.843889	SaladStop!	1.285575	103.847320	Salad Place	1	0
1014	Outram	1.284889	103.843889	Well Dressed Salad Bar & Café	1.281462	103.844736	Vegetarian / Vegan Restaurant	1	0

Figure 12. Map of Health Foods and Health Centres in Outram Neighborhood

Example of Neighborhood: Ang Mo Kio

Table 13 shows that health foods option are quite limited in Ang Mo Kio neighborhood. There are two gym/fitness centres and one pool hall. However, there is only onea health foods option as shown in Figure 13.

Table 13. Health Foods and Health Centres in Ang Mo Kio Neighborhood

Check for Ang Mo Kio

```
df_case1_b = singapore_venues_case1[singapore_venues_case1['Neighborhood'] == 'Ang Mo Kio']
df_case1_b = df_case1_b[(df_case1_b['health_foods']==1)|(df_case1_b['health_centres']==1)]
df_case1_b
```

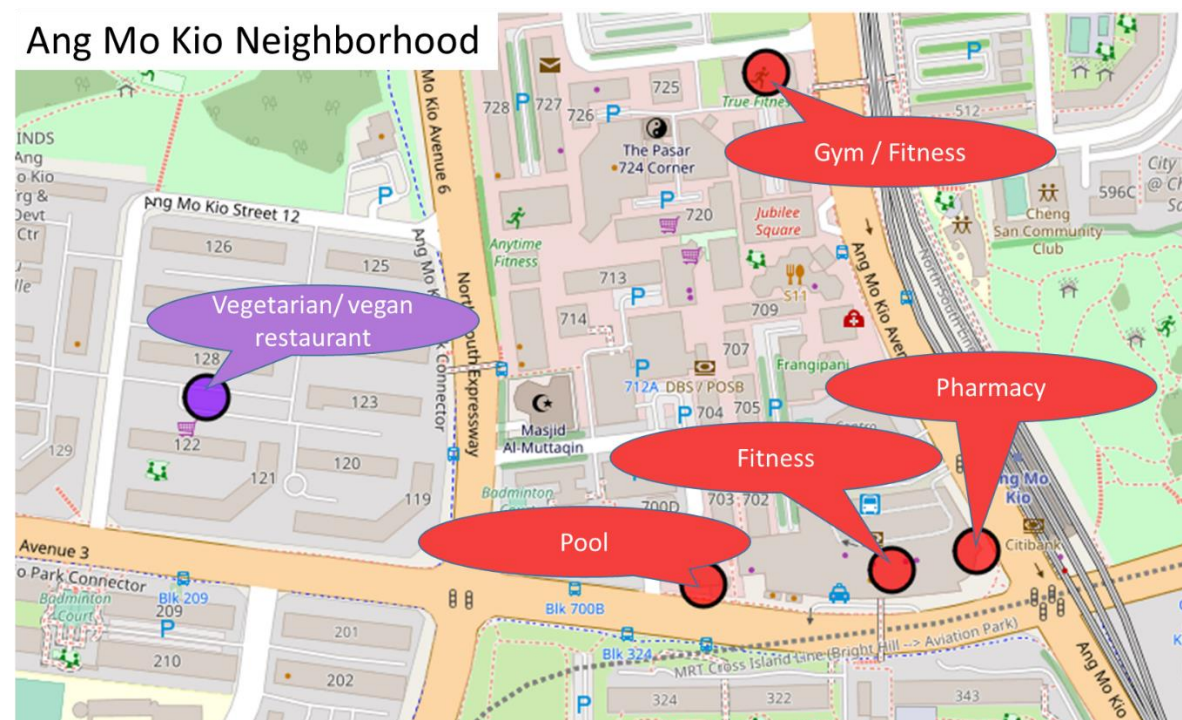|	Neighborhood	Neighborhood Latitude	Neighborhood Longitude	Venue	Venue Latitude	Venue Longitude	Venue Category	health_foods	health_centres
16	Ang Mo Kio	1.370167	103.845619	True Fitness	1.372891	103.847661	Gym	0	1
26	Ang Mo Kio	1.370167	103.845619	Fitness First	1.369249	103.848584	Gym / Fitness Center	0	1
38	Ang Mo Kio	1.370167	103.845619	The King's Pool	1.369141	103.847205	Pool Hall	0	1
45	Ang Mo Kio	1.370167	103.845619	Watsons	1.369382	103.849214	Pharmacy	0	1
46	Ang Mo Kio	1.370167	103.845619	真一素食坊 Zhenyi Veggie Place	1.370514	103.843556	Vegetarian / Vegan Restaurant	1	0

Figure 13. Map of Health Foods and Health Centres in Ang Mo Kio Neighborhood

Example of Neighborhood: Bishan

Table 14 shows that health centres are available in Bishan neighborhood. There are sports hall, footbal stadium, swimming complex and gym. However, there is not healthy food options at all around this neighborhood as shown in Figure 14. It means that there is some niche in this specific culinary option that can leveraged by entrepreneurs.

Table 14. Health Foods and Health Centres in Bishan

Check for Bishan

```
df_case1_c = singapore_venues_case1[singapore_venues_case1['Neighborhood'] == 'Bishan']
df_case1_c = df_case1_c[(df_case1_c['health_foods']==1)|(df_case1_c['health_centres']==1)]
df_case1_c
```

	Neighborhood	Neighborhood Latitude	Neighborhood Longitude	Venue	Venue Latitude	Venue Longitude	Venue Category	health_foods	health_centres
124	Bishan	1.350833	103.851389	Gymm Boxx XL	1.349909	103.850689	Gym	0	1
130	Bishan	1.350833	103.851389	Bishan Swimming Complex	1.354225	103.850448	Pool	0	1
140	Bishan	1.350833	103.851389	Watsons	1.350810	103.848542	Pharmacy	0	1
163	Bishan	1.350833	103.851389	Home United FC	1.354946	103.851242	Soccer Stadium	0	1
164	Bishan	1.350833	103.851389	Bishan Sports Hall - Dance Studio	1.355157	103.851305	Gym / Fitness Center	0	1

Figure 14. Map of Health Foods and Health Centres in Bishan Neighborhood

Case Study 2: Opening Ramen Noodles Shop in Populated Residential Areas

Table 15 shows the number of noodles based shops (Noodle, Ramen, Udon) in Singapore Neighborhood. Most neighborhood have at least one noodles based shop but may have up to 5 of them. If someone want to open a new family friendly ramen shop in residential areas, the best bet is to find a Neighborhood with the most population while have the fewer number of noodle venues. The last columns of the Table 15 shows the number of population / noodle_venues in each neighborhood. Top three neighborhood to open such venues are in Jurong West, Bedok, and Geylang since they have the fewer amount of noodle venues per given population. The most competitive neighborhood will be Straits View (financial centre region), Paya Lebar, Museum, and Orchard.

Table 15. Noodles Based Shop in Singapore Neighborhood

```
df_case2['noodle_cluster'] =  df_case2['population/noodle_venues'].apply(population_per_noodle_venues_encoder)
df_case2 = df_case2.sort_values('population/noodle_venues', ascending=False)
df_case2
```

	Neighborhood	noodle_foods	population	longitude	latitude	population/noodle_venues	noodle_cluster
5	Jurong West	1	266720	103.704444	1.339722	266720.000000	0
1	Bedok	2	281300	103.927339	1.323600	140650.000000	0
4	Geylang	1	111610	103.886944	1.320556	111610.000000	0
17	Yishun	2	214940	103.835364	1.430367	107470.000000	0
2	Bukit Panjang	2	140820	103.762500	1.380833	70410.000000	1
16	Toa Payoh	2	120480	103.856328	1.334303	60240.000000	1
0	Ang Mo Kio	3	165710	103.845619	1.370167	55236.666667	1
12	Queenstown	2	97870	103.786128	1.294167	48935.000000	2
6	Marine Parade	1	47250	103.907778	1.303056	47250.000000	2
3	Clementi	2	93000	103.764939	1.316181	46500.000000	2
8	Novena	2	48950	103.842431	1.320858	24475.000000	2
10	Outram	3	20030	103.843889	1.284889	6676.666667	3
13	River Valley	4	9930	103.886149	1.308398	2482.500000	3
14	Singapore River	5	2980	103.845154	1.289178	596.000000	4
9	Orchard	2	990	103.832876	1.305272	495.000000	4
7	Museum	1	420	103.848500	1.296611	420.000000	4
11	Paya Lebar	2	40	103.887821	1.353899	20.000000	4
15	Straits View	2	0	103.850553	1.278552	0.000000	4

Figure 15 shows the Singapore neighborhood classified in terms of population count / noodle venues count. Cluster 4 indicate population/noodle venues count less than 1000. Cluster 3 indicate population/noodle venues count between 1000 and 10000 persons. Cluster 2 indicate population/noodle venues count between 10000 and 50000. Similarly, Cluster 1 indicate population/noodle venues count between 100000 and 30000. Ultimately, for neighborhoods with population/noodle venues count that exceed 30000 can be classified as Cluster 0.
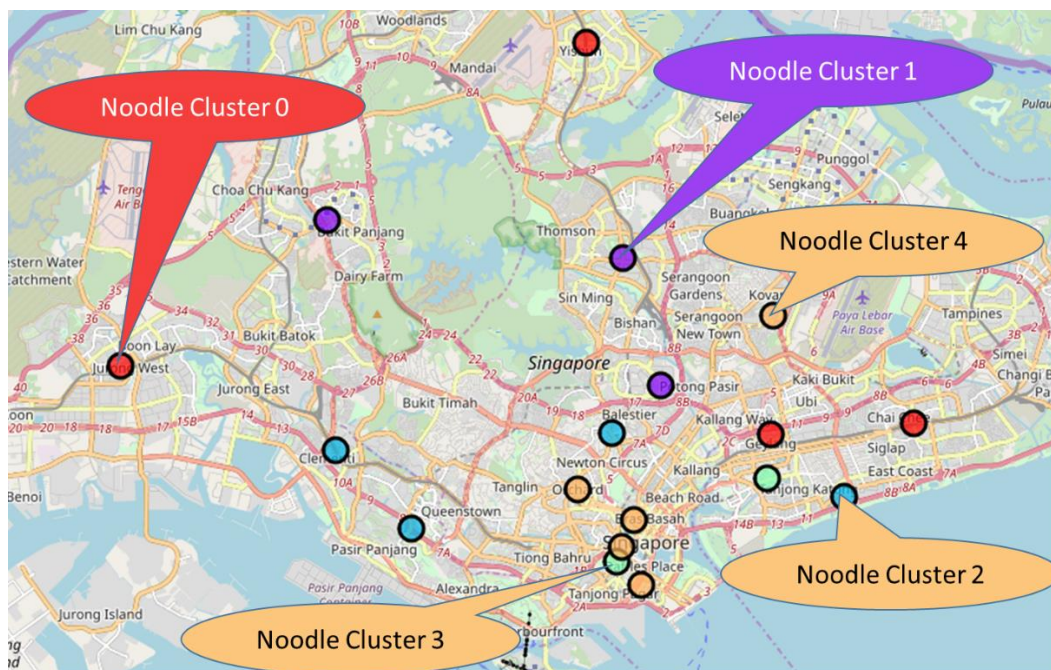

Figure 15. Map of Noodle Based Restaurants and Population Centre in Singapore

Case Study 3: Opening Bubble Tea Stall at Outdoor Parks and Beaches

Table 16 shows the number of refreshments stalls in Singapore Neighborhood. Most neighborhood have at least one refreshment stalls but may have up to 11 of them. If we want to open a refreshment stall, for example selling bubble tea, it may be a good idea to sell them at outdoor parks and beachers. In the hot and humid tropical island climate of Singapore, in such places, sweet and cold beverages may sell very well. So we also locate the number of outdoor parks and beaches venues at each neighborhood. Some neighborhood has a lots of outdoor venues such as Marina South with very few refreshment stalls. Other neighborhood like Downtown Core also has a lots of outdoor venues but they also have significant numbers of refreshment stalls. It is important to pinpoint locations and exact categories of such stalls to see whether it is still possible to compete with other refreshment stalls.

Table 16. Refreshment Stalls at Outdoor Parks and Beaches Venues

```
In [370]: df_case3['population'] = df_case3['Neighborhood'].apply(neighborhood_population_dictionary_function)
          df_case3a = df_case3.sort_values('refreshment per venues')[['Neighborhood', 'refreshing_desserts_beverages_venues','outdoor_p
          df_case3a.head(20)
```

Out[370]:

	Neighborhood	refreshing_desserts_beverages_venues	outdoor_park_venues	refreshment per venues	population
16	Mandai	0	2	0.000000	2090
18	Marina South	0	9	0.000000	0
17	Marina East	0	1	0.000000	0
22	North-Eastern Islands	0	1	0.000000	50
11	Downtown Core	7	9	0.777778	2510
41	Tuas	1	1	1.000000	70
37	Southern Islands	1	1	1.000000	1800
32	Seletar	1	1	1.000000	250
36	Singapore River	5	4	1.250000	2980
40	Toa Payoh	2	1	2.000000	120480
35	Serangoon	2	1	2.000000	117310
31	Rochor	3	1	3.000000	13450
34	Sengkang	3	1	3.000000	240640
43	Yishun	7	2	3.500000	214940
19	Marine Parade	4	1	4.000000	47250
14	Jurong West	11	2	5.500000	266720
6	Bukit Panjang	6	1	6.000000	140820
20	Museum	9	1	9.000000	420
25	Outram	9	1	9.000000	20030
1	Bedok	10	1	10.000000	281300

Example of Neighborhood: Marina East

Table 17 shows the outdoor venues available in Marina South. Mostly, the place is for cruise or beach viewing. No venues registered for refreshment and beverages stalls in this location as shown in Figure 16. So this may be a potential location to open bubble ice tea stalls for tourist refreshments.
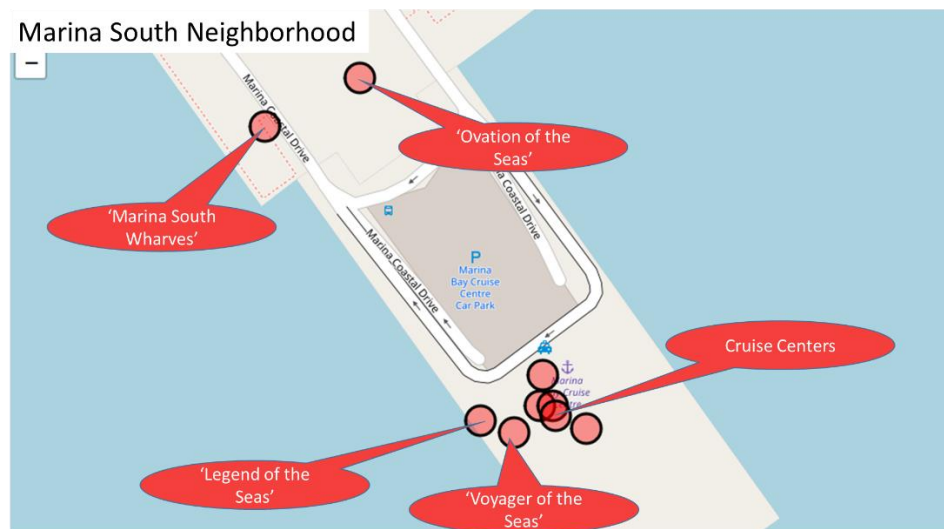
Table 17. Marina South Neighborhood Outdoor Venues

Check for Marina South Neighborhood

```
df_case3_a = singapore_venues_case3[singapore_venues_case1['Neighborhood'] == 'Marina South']
df_case3_a = df_case3_a[(df_case3_a['refreshing_desserts_beverages_venues']>0)|(df_case3_a['outdoor_park_venues']>0)]
df_case3_a
```

	Neighborhood	Neighborhood Latitude	Neighborhood Longitude	Venue	Venue Latitude	Venue Longitude	Venue Category	refreshing_desserts_beverages_venues	outdoor_park_venues
578	Marina South	1.2692	103.8579	Marina South Wharves	1.267472	103.858920	Pier	0	1
579	Marina South	1.2692	103.8579	Ovation of the Seas	1.267734	103.859438	Cruise	0	1
582	Marina South	1.2692	103.8579	RCI Legend of The Seas	1.265878	103.860090	Cruise	0	1
583	Marina South	1.2692	103.8579	East Berth | Marina Bay Cruise Centre	1.266124	103.860428	Pier	0	1
584	Marina South	1.2692	103.8579	Marina Bay Cruise Centre	1.265961	103.860409	Pier	0	1
586	Marina South	1.2692	103.8579	RCI Voyager of the Seas	1.265814	103.860273	Cruise	0	1
587	Marina South	1.2692	103.8579	RCI Mariner Of The Seas	1.265956	103.860479	Cruise	0	1
588	Marina South	1.2692	103.8579	MBCC Arrival Hall	1.265903	103.860497	Pier	0	1
589	Marina South	1.2692	103.8579	Celebrity Millennium	1.265837	103.860664	Cruise	0	1

Figure 16. Marina South Neighborhood Map

Example Neighborhood: Downtown Core

Table 18 shows the outdoor venues available in Downtown Core Neighborhood. Mostly, the place is for recreation and entertainment. Most refreshment shops or stalls here are café, although some also sell ice cream and snacks. Figure 17 shows that although there are many venues, none of them sell bubble ice tea beverages. So this may be a potential location to open bubble ice tea stalls for tourist refreshments.

Table 18. Downtown Core Neighborhood Outdoor Venues

Check for Downtown Core Neighborhood

```
singapore_venues_case3[singapore_venues_case1['Neighborhood'] == 'Downtown Core']
df_case3_b[(df_case3_b['refreshing_desserts_beverages_venues']>0)|(df_case3_b['outdoor_park_venues']>0)]
'Neighborhood', 'Venue', 'Venue Category', 'refreshing_desserts_beverages_venues', 'outdoor_park_venues']]
```

|	Neighborhood	Venue	Venue Category	refreshing_desserts_beverages_venues	outdoor_park_venues
359	Downtown Core	The Merlion	Outdoor Sculpture	0	1
360	Downtown Core	Cavenagh Bridge	Bridge	0	1
361	Downtown Core	Fullerton WaterFront	Waterfront	0	1
362	Downtown Core	Starbucks Reserve Store (Starbucks Reserve)	Coffee Shop	1	0
364	Downtown Core	Esplanade Park	Park	0	1
366	Downtown Core	Merlion Park	Sculpture Garden	0	1
367	Downtown Core	Starbucks	Coffee Shop	1	0
371	Downtown Core	Esplanade Riverside	Waterfront	0	1
373	Downtown Core	J-Cone Jipangyi	Snack Place	1	0
378	Downtown Core	Marina Bay	Bay	0	1
396	Downtown Core	La Brasserie	Café	1	0
406	Downtown Core	Ohara Farm Hokkaido Ice Cream	Ice Cream Shop	1	0
418	Downtown Core	Boat Quay	Canal	0	1
419	Downtown Core	Boost Juice	Juice Bar	1	0
426	Downtown Core	Esplanade Roof Terrace	Scenic Lookout	0	1
427	Downtown Core	Suzette	Café	1	0
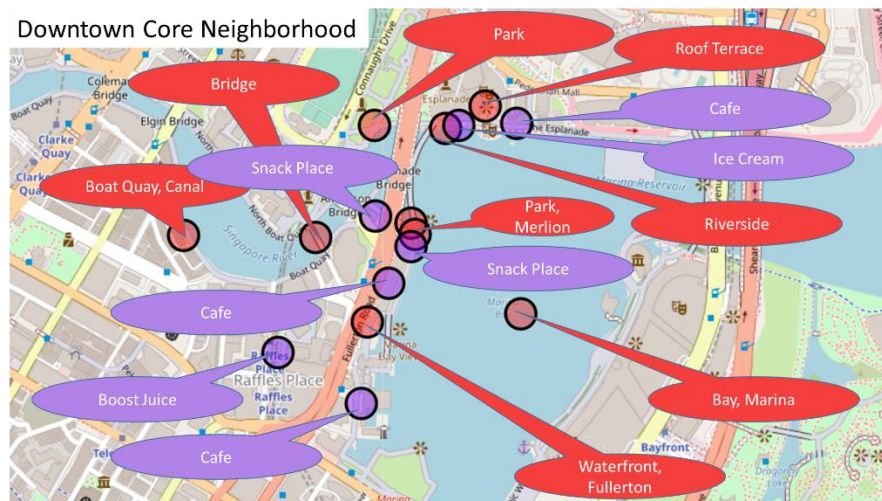
Figure 17. Map of Downtown Core Neighborhood

6. Conclusion

In this report, I studied the clustering of Singapore's neighborhoods based on their population and venues count. Using Foursquare API, I collected detailed information about local venues to study culinary and non-culinary venues on each particular neighborhood. Subsequently, I used this information to study locations for new culinary venues that can serve the particular locale needs and requirements. These model can be useful to help culinary entrepreneurs to decide locations that offer numerous customers and with fewer number of competitors.