Delineating a Beneficial Location for a Restaurant Opening a Vegetarian Restaurant in Frankfurt, Germany

Course Project

Applied Data Science Capstone

Karin Pietruska

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Introduction / Business Problem

Choosing the appropriate neighborhood in a city when deciding to open a new restaurant is critical for business success. In order to choose a beneficial location for a new restaurant it is important to know about the kind of restaurants and other venues that are already established in a neighborhood and the preferences of the community with regard to visiting these venues.
Frankfurt is a city in the midst of Germany of approximately 750.000 inhabitants internationally known for its major role in the financial and banking business. The city has several museums, an opera house, many fashion stores as well as an interesting multi-cultural restaurant scene. Recently, an increased interest in vegetarian and vegan food choices was observed in parts of the population in Germany. This might be due to media highlighting the importance to shift away from abundant meat consumption to vegetarian food choices as well as due to a general interest in the population to turn towards a vegetarian or vegan life style.
In this course project, I consult a person who wants to open a restaurant with a vegetarian and vegan cuisine in Frankfurt am Main, Germany. The person would like to have advice regarding a neighborhood that would be beneficial to open a vegan/vegetarian place. The question I am addressing in the following Capstone project is: which neighborhood in Frankfurt is best suitable to open a vegetarian/vegan restaurant? The target audience is a person or a business owner who wants to open a new vegetarian restaurant in Frankfurt am Main, Germany.

Data Section

Data Sources

In order to delineate a neighborhood that is best suited for opening a new vegetarian / vegan restaurant in the city of Frankfurt am Main, Germany, I needed to obtain data on

1) The neighborhoods and their location data in Frankfurt
2) Venues and restaurants in the neighborhoods
3) Vegetarian / Vegan Restaurants in Frankfurt and their User Ratings

1) Data on Neighborhoods in Frankfurt

First, I scraped data from the web to obtain information on the number, coordinates and postal codes of the neighborhoods in Frankfurt. I did a web search to look for web pages with information on neighborhoods of Frankfurt and I obtained this information on the following website:

https://www.suche-postleitzahl.org/frankfurt-plz-60306-65936.40d9

On this website, a table lists a total of 46 neighborhoods in Frankfurt with their postal codes. The first three rows of the table are displayed below and pasted directly in this document from the website.
The first column of the table displays the name of the neighborhood and the second column displays the postal codes of the neighborhood.

Stadtteil	Postleitzahl
Altstadt	60311, 60313
Bahnhofsviertel	60329
Bergen-Enkheim	60388, 60389

The html code of the website also contains the latitude and longitude coordinates for the respective neighborhoods in Frankfurt. Data from this website will be scraped and saved in a pandas dataframe with the columns: neighborhood name, postal codes, latitude and longitude coordinates.

2) Data on Venues and Restaurants

In order to delineate a beneficial location for a restaurant opening, I needed to acquire information about the number and categories of restaurants and venues that exist in each neighborhood. I used the Foursquare Venues API to extract information about the number and kind of venues in each neighborhood. Specifically, I ran search queries to extract up to 100 venues per neighborhood. For each venue extracted I saved the information shown below along with the name of the neighborhood in a dataframe:

Venue id: unique identification number for a specific venue

Venue name: Name of the venue

Venue category: Name of the venue category, e.g. Italian Restaurant, Vegetarian / Vegan Restaurant, Café)

Venue location: Latitude and Longitude coordinates of the location of the venue

Here is an example of a result of a Foursquare query to get venues in the neighborhood ‘Gallus’ within a radius of 500m and a limit of 100 venues. Note: This example only shows data for the

first venue retrieved. The data of interest are highlighted in yellow and will be saved to a dataframe.


```
[{'reasons': {'count': 0,
   'items': [{'summary': 'This spot is popular',
     'type': 'general',
     'reasonName': 'globalInteractionReason'}]},
  'venue': {'id': '530cffb7498e258c5e055b5e',
   'name': 'Elia Restaurant - Bar',
   'location': {'address': 'Frankenallee 111',
    'lat': 50.10458750676413,
    'lng': 8.641439899293005,
    'labeledLatLngs': [{'label': 'display',
      'lat': 50.10458750676413,
      'lng': 8.641439899293005}],
    'distance': 290,
    'postalCode': '60326',
    'cc': 'DE',
    'city': 'Frankfurt am Main',
    'state': 'Hessen',
    'country': 'Deutschland',
    'formattedAddress': ['Frankenallee 111',
     '60326 Frankfurt am Main',
     'Deutschland']},
   'categories': [{'id': '4bf58dd8d48988d10e941735',
     'name': 'Greek Restaurant',
     'pluralName': 'Greek Restaurants',
     'shortName': 'Greek',
     'icon': {'prefix': 'https://ss3.4sqi.net/img/categories_v2/food/greek_',
      'suffix': '.png'},
     'primary': True}],
   'photos': {'count': 0, 'groups': []}},
  'referralId': 'e-0-530cffb7498e258c5e055b5e-0'},
…
```


3) Vegetarian / Vegan Restaurants in Frankfurt

I will analyze the retrieved Vegetarian / Vegan Restaurants in Frankfurt in detail to delineate which of them are the best running ones in terms of customer preferences. I used the Foursquare Venue API and extracted the following information for each Vegetarian / Vegan Restaurant:

Likes: The total count of users who have indicated to like the venue

Price: the price tier from least pricy (1) to most pricy (4)

Rating: A numerical rating indicated by users from 0 (least possible score) to 10 (top score)

Note: Extracting the details of a venue is a premium call and is therefore restricted given my current free account to 500 calls / day.

The Foursquare query for information on the vegetarian restaurant 'Seven Swans & The Tiny Cup' with the id '54eb9315498e8927a1453286' returns the following Response. The data of interest are highlighted in yellow.

{'meta': {'code': 200, 'requestId': '5dd6f6eef7706a001b5b567d'},
 'response': {'venue': {'id': '54eb9315498e8927a1453286',
   'name': 'Seven Swans & The Tiny Cup',
   'contact': {'phone': '+491788539718',
    'formattedPhone': '+49 178 8539718',
    'facebook': '362524977100859',
    'facebookUsername': 'SEVENSWANSFRANKFURT',
    'facebookName': 'SEVEN SWANS'},
   'location': {'address': 'Mainkai 4',
    'lat': 50.10953369602869,
    'lng': 8.686896198682593,
    'labeledLatLngs': [{'label': 'display',
      'lat': 50.10953369602869,
      'lng': 8.686896198682593}],
    'postalCode': '60311',
    'cc': 'DE',
    'neighborhood': 'Altstadt',
    'city': 'Frankfurt am Main',
    'state': 'Hessen',
    'country': 'Deutschland',
    'formattedAddress': ['Mainkai 4',
     '60311 Frankfurt am Main',
     'Deutschland']},
   'canonicalUrl': 'https://foursquare.com/v/seven-swans--the-tiny-cup/54eb9315498e8927a1453286',
   'categories': [{'id': '4bf58dd8d48988d1d3941735',
     'name': 'Vegetarian / Vegan Restaurant',
     'pluralName': 'Vegetarian / Vegan Restaurants',
     'shortName': 'Vegetarian / Vegan',
     'icon': {'prefix': 'https://ss3.4sqi.net/img/categories_v2/food/vegetarian_',
      'suffix': '.png'},
     'primary': True},
    {'id': '4bf58dd8d48988d11e941735',
     'name': 'Cocktail Bar',
     'pluralName': 'Cocktail Bars',
     'shortName': 'Cocktail',
     'icon': {'prefix': 'https://ss3.4sqi.net/img/categories_v2/nightlife/cocktails_',
      'suffix': '.png'}}],
   'verified': False,
   'stats': {'tipCount': 11},
   'url': 'https://www.sevenswans.de',
   'price': {'tier': 2, 'message': 'Moderate', 'currency': '€'},
   'likes': {'count': 39,
    'groups': [{'type': 'others', 'count': 39, 'items': []}],
    'summary': '39 Likes'},
   'dislike': False,
   'ok': False,

'rating': 8.0,
'ratingColor': '73CF42',
'ratingSignals': 54,
'allowMenuUrlEdit': True,
'beenHere': {'count': 0,
'unconfirmedCount': 0,
'marked': False,
'lastCheckinExpiredAt': 0},
'specials': {'count': 0, 'items': []},
'photos': {'count': 34,
'groups': [{'type': 'venue',
'name': 'Venue photos',
'count': 34,
'items': [{'id': '5bdf16ee8496ca002ce5e46a',
'createdAt': 1541347054,
'source': {'name': 'Swarm for iOS', 'url': 'https://www.swarmapp.com'},
'prefix': 'https://fastly.4sqi.net/img/general/',
'suffix': '/42733_C0esQ_JRwiAPUE_wkzrJIWfEZ_-ANoFLM2n3BVW_IGc.jpg',
'width': 1920,
'height': 1440,

Data Cleaning

1) Data on Neighborhoods in Frankfurt

I scraped the above stated website and saved the information on neighborhood names, postal codes and latitude as well as longitude coordinates in a dataframe. There were 46 neighborhoods in total. Table 1 below displays the top six rows of the dataframe. One can see in the column of the postal codes that the postal codes are not specific to certain neighborhoods. Postal code zones overlap with one to several neighborhood zones: E.g. the postal code 60437 is used in the neighborhood of ‘Bockenheim’ as well as in the neighborhood ‘Bonames’. Consequently, knowing the postal code of a venue or a location does not allow conclusions about the neighborhood the venue is located in.

Table 1. Displays the top 6 rows of the data frame containing information on the neighborhoods of Frankfurt, their postal codes and coordinates.

	neighbourhoods	postalcodes	latitude	longitude
0	Altstadt	60311, 60313	50.111579	8.684542
1	Bahnhofsviertel	60329	50.107940	8.670305
2	Bergen-Enkheim	60388, 60389	50.155105	8.752649
3	Berkersheim	60435	50.172748	8.697739
4	Bockenheim	60325, 60431, 60486, 60487	50.121240	8.641610
5	Bonames	60433, 60437	50.183384	8.664951
6	Bornheim	60385, 60386, 60389, 60435	50.130865	8.708913
7	Dornbusch	60320, 60322, 60431, 60433, 60435	50.145323	8.668009
8	Eckenheim	60320, 60435	50.149393	8.680750
9	Eschersheim	60431, 60433	50.157023	8.656325

2) Data on Venues and Restaurants

The location data extracted for each neighborhood via the foursquare API was saved in a data frame with the variables as described in the data section on source data. For each neighborhood a maximum of 100 venues were extracted within a radius of 500m centered around the coordinates of each neighborhood. Increasing the radius of extraction to 750m already resulted in redundant extractions of venues and thus an overlap of search fields. I therefore decided to retain a search radius of 500m although this has the disadvantage of missing out on venues in larger neighborhoods in the suburbs. For all neighborhoods in Frankfurt a total of 885 venues were extracted. For each venue information of its neighborhood name, latitude and longitude coordinate of the neighborhood, venue name, venue id, venue latitude, venue longitude and venue category were saved.

3) Vegetarian / Vegan Restaurants in Frankfurt

I used the data frame of the 885 extracted venues in total to delineate the number of venues that indicated to be a vegetarian / vegan restaurant in their first venue category field. This yielded a total of three vegetarian / vegan restaurants located in the neighborhoods ‘Altstadt’, ‘Bahnhofsviertel’ and ‘Rödelheim’. Results of the query on user ratings and likes are displayed in the Exploratory Analysis Section.

Methodology

Overall Aims of the Analysis

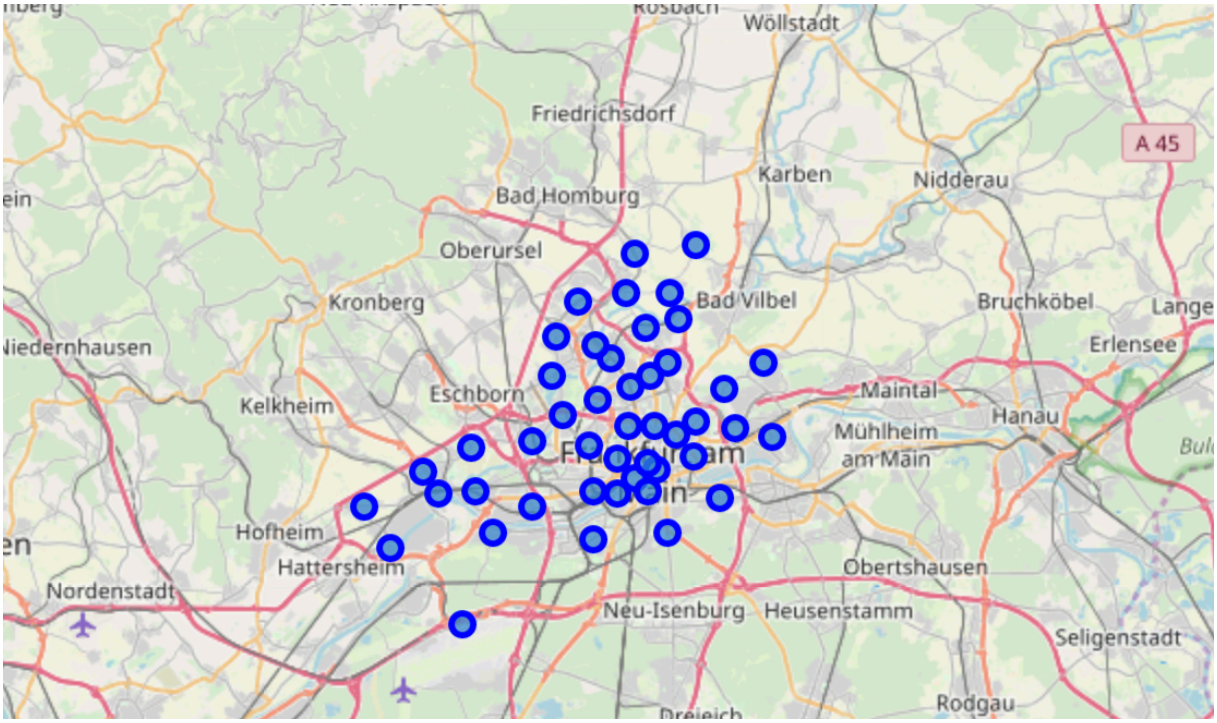
The overall aim of the following data analysis is to delineate a location in Frankfurt that is beneficial to open a new vegetarian restaurant. In order to achieve this aim, I will decompose the analysis in several steps: First, I will use the venue data to explore the top two well running vegetarian restaurants in Frankfurt and the characteristics of the neighborhood surrounding each of them. Second, I will explore venues that are indicative of health-oriented behavior or preferences such as health food stores. Third, I will conduct a cluster analysis two find neighborhoods that are similar to well running, already established vegetarian venues. To ensure that each analysis step is meaningful in terms of its data content and to get a better picture of the overall structure of neighborhoods and venues in Frankfurt, I conducted several exploratory analyses.

Exploratory Analysis

Neighborhoods of Frankfurt

To display the size and the distribution of the retrieved neighborhoods in Frankfurt I displayed the center coordinates of each neighborhood on a map using the folium library. Figure 1 displays the 46 neighborhoods as blue circles on top of a map.

Figure 1. Displays the 46 neighborhoods of Frankfurt as blue markers on a map.

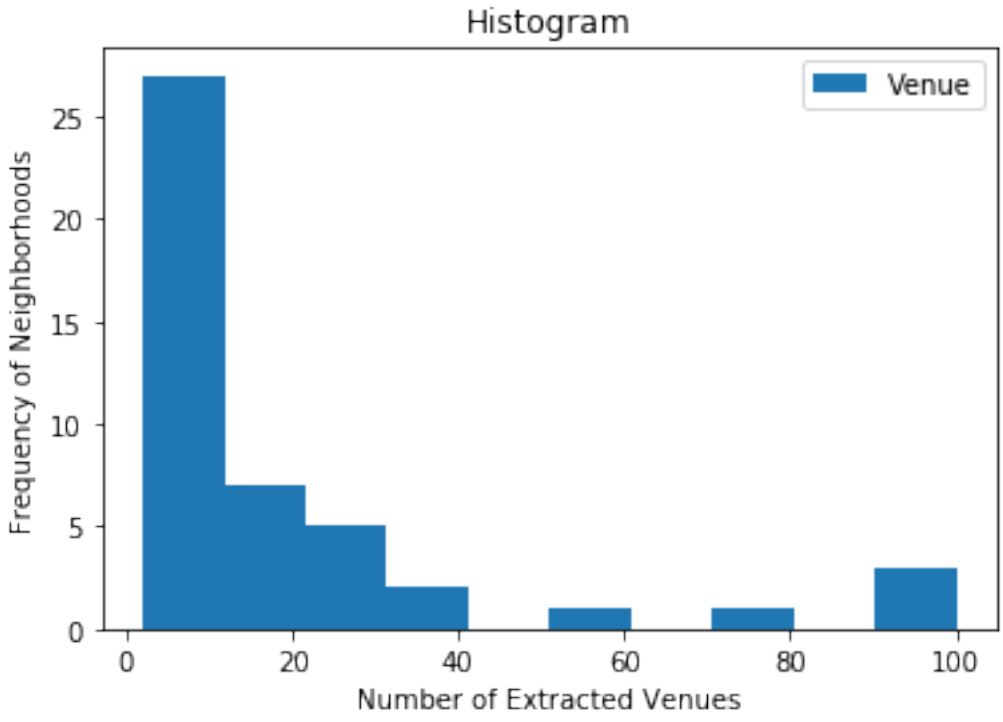


Venues in Frankfurt am Main

For each neighborhood I extracted up to a maximum of 100 venues. For all neighborhoods there were a total of 885 venues extracted with 172 unique venue categories. A venue category is for instance 'Italian restaurant', 'Parc' or 'Greek restaurant'. I continued to group the venues by neighborhood and displayed the total count of extracted venues for each neighborhood. I also displayed the frequency distribution thereof in a histogram. In three neighborhoods located in the city center the maximum number of 100 venues was extracted. These neighborhoods comprise: Altstadt, Bahnhofsviertel and Innenstadt. In contrast and as displayed by the histogram in Figure 2, for most neighborhoods 10 or less venues were extracted.

In order to ensure that the cluster analysis will be based on a meaningful list of venue categories with at least 4 categories per neighborhood, I decided to exclude neighborhoods with a total venue return of less than 4 venues from further analysis. This resulted in the exclusion of the neighborhood 'Fechenheim'. In the neighborhood Fechenheim only two venues could be retrieved.

Figure 2. The histogram depicts the number of extracted venues on the x-axis and the frequency of neighborhoods in which the respective number of venues was extracted on the y-axis.



Vegetarian / Vegan Restaurants in Frankfurt am Main

I continued to search the data frame with 885 venues in Frankfurt for restaurants of the category vegetarian / vegan restaurant. This resulted in a total of three vegetarian restaurants in Frankfurt. Subsequently, for each them, I used foursquare to extract information on the count of user likes, the user rating as well as the price category of the venues. The results are displayed in table 2.

Table 2. Displays the vegetarian / vegan restaurants in the neighborhoods of Frankfurt with their user ratings.

Neighborhood	*Vegan Restaurant*	*Likes*	*Rating*	*Price Tier*
Altstadt	Seven Swans & …	39	7.9	Moderate
Bahnhofsviertel	Vevay	43	7.4	Moderate
Rödelheim	Savory	33	8.1	Moderate

I defined the top two vegetarian restaurants in Frankfurt as following: The top two restaurants were defined as those with a user rating larger or equal to 7.5 and the largest count of user likes. According to these criteria, the Seven Swans & The Tiny Cup in the neighborhood of 'Altstadt' as well as the Savory in 'Rödelheim' are the top scoring vegetarian restaurants, see Table 3.

Table 3. Displays the top two ranking vegetarian restaurants in Frankfurt.

Neighborhood	*Vegan Restaurant*	*Likes*	*Rating*	*Price Tier*
Altstadt	Seven Swans & …	39	7.9	Moderate
Rödelheim	Savory	33	8.1	Moderate

Exploration of health food stores

I used the dataframe with all 885 venues retrieved for the neighborhoods in Frankfurt and extracted all health food stores. There were two health food stores retrieved. Both are located in the neighborhood of 'Westend-Nord' and are displayed in Table 4.

Table 4. Displays the Health Food Stores that could be retrieved in the neighborhoods of Frankfurt.

	Neighborhood	*Venue Name*	*Category*
	Westend-Nord	Basic	Health Food Store
	Westend-Nord	Reformhaus Achim Andersch	Health Food Store

Exploration of Neighborhoods in Frankfurt

I continued to extract the four most common venues of each neighborhood in Frankfurt. This serves to analyze the characteristics of the neighborhoods, in which the top two vegetarian restaurants are located as. In addition, this information is also necessary for the cluster analysis that aims at delineating neighborhoods that are similar in terms of venues and infrastructure to the vegetarian restaurants.

Table 5 below display the most common venues located in the neighborhoods of the top two ranking vegetarian restaurants:

Table 5. Displays the top 10 most common venue categories for the neighborhood Altstadt and Rödelheim.

	Neighborhood			
	Altstadt	Count	Rödelheim	Count
1st Most Common Venue	Café	10	Supermarket	6
2nd Most Common Venue	Bar	5	Bakery	1
3rd Most Common Venue	Restaurant	5	Bank	1
4th Most Common Venue	Italian Restaurant	5	Bus Stop	1
5th Most Common Venue	Plaza	4	Chinese Restaurant	1
6th Most Common Venue	German Restaurant	4	Doner Restaurant	1
7th Most Common Venue	Art Museum	3	Grocery Store	1
8th Most Common Venue	Wine Bar	3	Ice Cream Store	1
9th Most Common Venue	Burger Joint	3	Italian Restaurant	1
10th Most Common Venue	Clothing Store	2	Light Rail Station	1

Cluster Analysis of neighborhoods in Frankfurt

I continued to explore the characteristics of neighborhoods that are similar to the neighborhoods of the top two running vegetarian restaurants in Frankfurt. To do so, I did a k-means cluster analysis with k=5 means based on the top 4 most common venues in each neighborhood. The analysis was constrained to the top 4 most common venues because the Foursquare query for venues did not return more than 4 venues for many neighborhoods (see histogram Figure 2).

Results

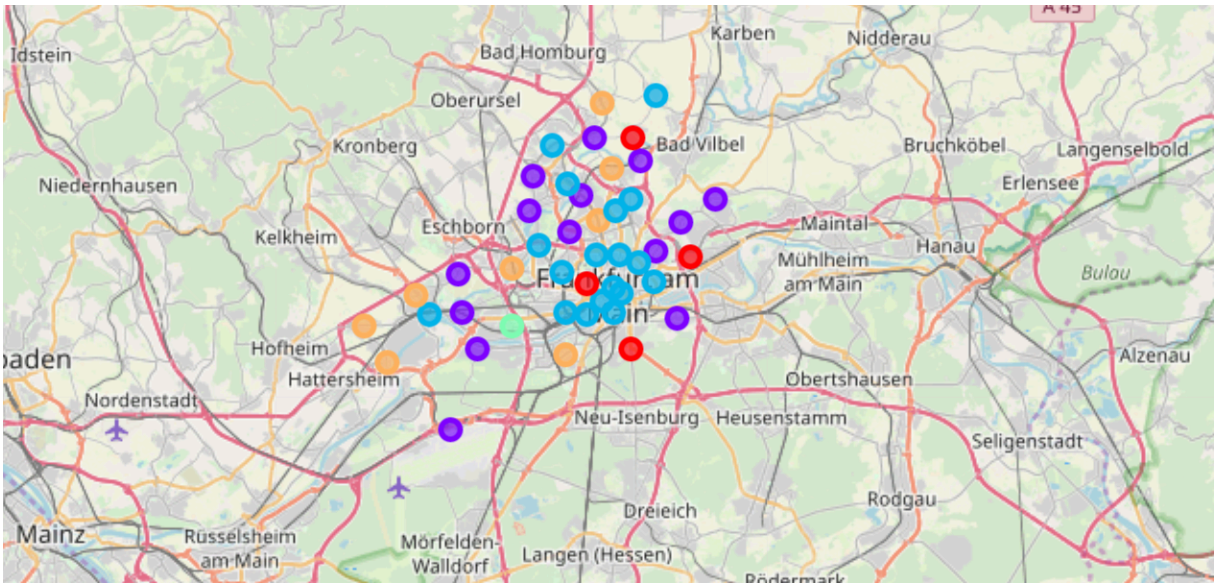
The top two running vegetarian restaurants were identified in the neighborhoods of Altstadt and Rödelheim. The cluster analysis with k= 5 means allows to identify neighborhoods that are similar to Altstadt and Rödelheim in terms of the venue infrastructure of the neighborhood.

The neighborhood Rödelheim was attributed to cluster 4 with a total number of 8 neighborhoods in the cluster. Common to the neighborhoods in that cluster is presence of supermarkets and public transport stations among the top most common venues, followed by categories as Pharmacy, Grocery Store, Bakery, Italian Restaurants and Ice Cream Shops. Altogether the venue infrastructure of this cluster hints towards a rather suburban neighborhood with a focus on residential areas with public transport and supermarkets.

The neighborhood Altstadt was attributed to cluster 2 with a total number of 18 neighborhoods. Overall the venue infrastructure of this cluster is dominated by Cafés, Hotels, Restaurants and Parcs. Notably, the neighborhood Westend-Nord with its Health Food Stores was also allocated within this cluster.

Figure 3 displays the results of the cluster analysis. Neighborhoods belonging to Cluster 2 in which also the neighborhood Altsadt is located are depicted as blue circles. Neighborhoods belonging to the cluster of Rödelheim (Cluster 4) are depicted as orange circles.

Figure 3. Results of the Cluster Analysis. The neighborhood Altstadt belongs to cluster 2 (blue circle markers) and the neighborhood Rödelheim belongs to cluster 4 (orange circle markers)



Given the allocation of the neighborhood 'Westend-Nord' to the same cluster as 'Altstadt' and the presence of Health Food Stores in 'Westend-Nord', I decided to explore this neighborhood further as a possible candidate for the opening of a new vegetarian / vegan restaurant. Table 6 displays the 10 most common venue categories in Westend-Nord.

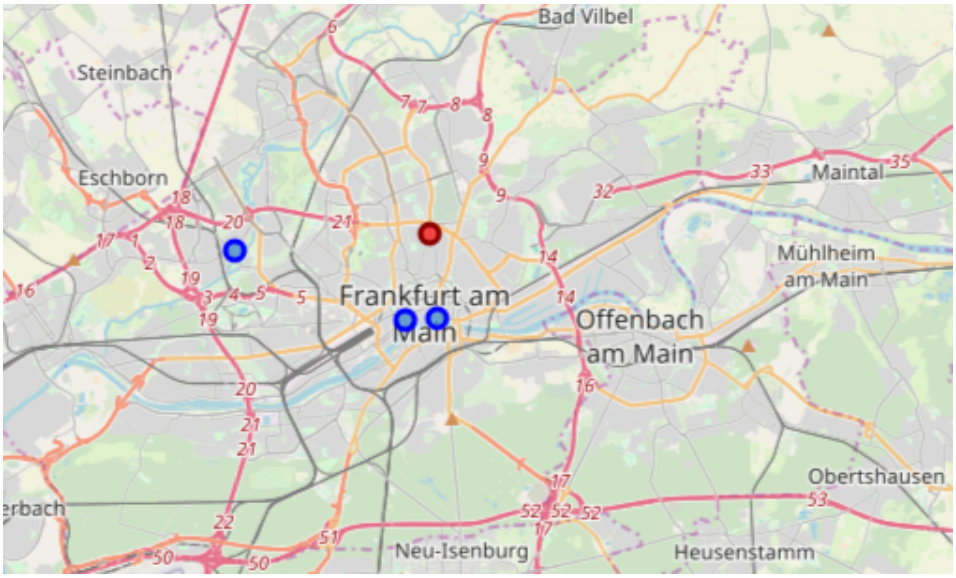
Table 6. Displays the 10 most common venue categories for the neighborhood of Westend-Nord

Neighborhood: Westend-Nord	
Venue Category	Frequency
Café	6
Italian Restaurant	3
Asian Restaurant	2
Greek Restaurant	2
Health Food Store	2
Supermarket	2
Apple Wine Pub	1
Bakery	1
Beer Garden	1
Fast Food Restaurant	1

The comparably large number of cafés as well as the surrounding restaurants in Westend-Nord hint towards a life style as is typically found in densely populated inner-city neighborhoods. In addition, the presence of two health food stores signals that at least part of the population in the neighborhood displays food shopping behavior that is health oriented. These shopping preferences are often observed in persons that display vegetarian or vegan food preferences. Notably, health food stores could not be retrieved in the neighborhoods of the top two already running vegetarian restaurants in Frankfurt, rendering the neighborhood of Westend-Nord particularly promising for the opening of a new vegetarian restaurant.

Since Westend-Nord appeared as a favorable spot for the opening of a new restaurant, I plotted the already existing vegetarian restaurants on a map as blue circles and added a new hypothetical spot for the opening of a new vegetarian restaurant in Westend-Nord. Figure 4 gives a graphical representation on a map and shows that a new spot in Westend-Nord would be spatially well separated from already existing vegetarian restaurants.

Figure 4. Displays already existing vegetarian restaurants as blue circle markers and adds a red marker as a potential new opening spot in the neighborhood of Westend-Nord.



Discussion

This project aimed at delineating a beneficial location for the opening of a new vegetarian / vegan restaurant in Frankfurt am Main, Germany by using the Foursquare venue data.

In total only three vegetarian / vegan restaurants could be retrieved within the neighborhoods of Frankfurt. Among these, the top two in terms of user ratings and user likes were analyzed in more detail regarding their respective neighborhood and surrounding venues. One of them was located in the neighborhood 'Altstadt' in the inner city with a dense café and restaurant scene whereas the other restaurant was located in a more suburban, residential neighborhood named 'Rödelheim' dominated by supermarkets, pharmacies and public transport stations.

Subsequently, a cluster analysis was performed to delineate neighborhoods that were similar to these in terms of venue infrastructure and surroundings. In general, the number of venues that could be retrieved per neighborhood in Frankfurt was very little. Most frequently 10 or less venues could be retrieved per neighborhood. In contrast to large cities in Northern America such as New York or Toronto, the number of active Foursquare users appears to be relatively small in comparison. In the cluster analysis the neighborhood 'Westend-Nord' was within the same cluster as the 'Altstadt' neighborhood. Remarkably, there was a relatively large number of cafes in the Westend-Nord neighborhood. Combined with the restaurant and hotel scene it appears likely that there will be a substantial amount pedestrians and potential walk-in customers. Furthermore, Westend-Nord was the only neighborhood in Frankfurt in which two health food stores could be retrieved indicating that at least part of the population in the neighborhood shows a health oriented food preferences.

Limitations

A limitation is that for many neighborhoods in Frankfurt only very few venues (below 10) could be extracted with the Foursquare venue API. In addition, I extracted venues for each neighborhood that were located within a radius of 500m around the center coordinates of the respective neighborhood. This radius-based extraction of venues for each neighborhood did very likely miss a considerable number of venues in larger neighborhoods. Therefore, I consider the analysis as a very crude approximation and more definite conclusions about the vegetarian restaurant scene in Frankfurt will need a more precise method for venue extraction in the neighborhoods.

Conclusion

Based on the above discussed results, Westend-Nord appears like a good spot for opening a new vegetarian restaurant. Given the health food stores, the café and restaurant infrastructure of this inner-city neighborhood, it might even have the potential to outrank already existing vegetarian venues in Frankfurt.