Clustering the neighborhoods in the city of Almadinah using K-means

1- Introduction

Almadinah city in Saudi Arabia has the second holey mosque for Muslims around the world. Because of that it is visited during a whole year. Therefore, it is good for visitors to know the neighborhoods of the city and its characteristics. This will lead them to book their hotels and stay during their visits in their favorite neighborhoods. As a result, in this project I am aiming to cluster the neighborhoods in the city of Almadinah using k-means clustering technique.

2- Objective

The main goal of this project is to cluster the neighborhoods in the city of Almadinah in Saudi Arabia. For achieving that the neighborhoods of Almadinah city will be studied and analyzed first. Then, K-means is implemented. This will assist visitors of the city to know where to stay in the city during their visit.

3- Target Audience

The results of this project would be helpful for people who are interested in visiting Almadinah city and knowing its neighborhoods.

4- Data Description

4.1- Location Data of Saudi Arabia

This project on github (https://github.com/homaily/Saudi-Arabia-Regions-Cities-and-Districts/tree/master/json (https://github.com/homaily/Saudi-Arabia-Regions-Cities-and-Districts/tree/master/json)) has information about Regions, Cities and Districts in Saudi Arabia. The data is public and collected from https://maps.address.gov.sa/ (https://maps.address.gov.sa/) as ,all coordinates in (Lat, Lon) aka (Y, X) format and 8 decimal points. Data points include: Regions, Cities and Districts. All names are written in tow languages: Arabic and English. This data is divided into three parts:

- regions.json
- cities.json
- districts.json

However, the first step is to covert this data into a pandas data frame for further analysis.

4.2- Coordinate data for Saudi Cities

All the venues in each neighborhood in the KSA cities will be collected from Fousquare using Fousquare API. Because we are interested in neighborhoods of Almadinah city, therefore, its venues will be considered.

4.3- Sample from data and features

In [101]:

```
import warnings
warnings.filterwarnings("ignore")

import numpy as np # library to handle data in a vectorized manner


import pandas as pd # library for data analsysis
pd.set_option('display.max_columns', None)
pd.set_option('display.max_rows', None)

#!conda install -c conda-forge geopy --yes # uncomment this line if you haven'
t completed the Foursquare API lab
from geopy.geocoders import Nominatim # convert an address into latitude and l
ongitude values

import requests # library to handle requests
from pandas.io.json import json_normalize # tranform JSON file into a pandas d
ataframe

# Matplotlib and associated plotting modules
import matplotlib.cm as cm
import matplotlib.colors as colors

# import k-means from clustering stage
from sklearn.cluster import KMeans

#!conda install -c conda-forge folium=0.5.0 --yes # uncomment this line if you
haven't completed the Foursquare API lab
import folium # map rendering library

print('Libraries imported.')

import json # library to handle JSON files
```

```
Libraries imported.
```

Loading regions.json for extract KSA regions and explore it

In [ ]:

```
with open('/Users/malruily/week5/regions.json', encoding="utf-8") as json_data
:
    country_data = json.load(json_data)
print('No of regon:',len(country_data) )
country_data
```

Then convert json object of KSA regions to Pandas dataframe

In [104]:

```
# - Then convert json object of KSA districts to Pandas dataframe


country_regions= pd.DataFrame(columns= [ 'region_id', 'name_ar', 'name_en','po
pulation' , 'capital_city_id','Latitude', 'Longitude'] )

for i,data in enumerate (country_data):
    row=[]
    for c in country_regions.columns:
        if c == 'Latitude' :
            row.append(data['center'][0])
        elif c== 'Longitude':
            row.append(data['center'][1])
        else:
            row.append(data[c])
    country_regions.loc[len(country_regions)] = row

country_regions.head()
```

Out[104]:

	region_id	name_ar	name_en	population	capital_city_id	Latitude	Longitude
0	1	منطقة الرياض	Riyadh	6777146	3	24.70000	46.73333
1	2	منطقة مكة المكرمة	Makkah	6915006	6	21.42718	39.84349
2	3	منطقة المدينة المنورة	Madinah	1777933	14	24.47058	39.60781
3	4	منطقة القصيم	Qassim	1215858	11	26.33034	43.97436
4	5	المنطقة الشرقية	Eastern Province	4105780	13	26.44199	50.10920

Loading cities.json for extract KSA cities and explore it

In [105]:

```
with open('/Users/malruily/week5/cities.json', encoding="utf-8") as json_data:
    cities_data = json.load(json_data)
```

Then convert json object of KSA cities to Pandas dataframe

In [106]:

```
# - Then convert json object of KSA cities to Pandas dataframe


country_cities= pd.DataFrame(columns= ['city_id', 'region_id', 'name_ar', 'nam
e_en','Latitude', 'Longitude'] )


for data in cities_data:
    row=[]
    for c in country_cities.columns:
        if c == 'Latitude' :
            row.append(data['center'][0])

        elif c== 'Longitude':

            row.append(data['center'][1])
        else:
            row.append(data[c])
    #print(row)
    country_cities.loc[len(country_cities)] = row

country_cities.head()
```

Out[106]:

	city_id	region_id	name_ar	name_en	Latitude	Longitude
0	1	7	تبوك	Tabuk	28.41464	36.53387
1	2	7	نعمي	Na'mi	28.30508	35.74931
2	3	1	الرياض	Riyadh	24.70000	46.73333
3	4	7	حميط	Humayt	28.65152	35.38013
4	5	2	الطائف	At Taif	21.26848	40.41667

Loading cities.json for extract KSA districts and explore it

In [107]:

```
#with open('newyork_data.json') as json_data:
with open('/Users/malruily/week5/districts.json', encoding="utf-8") as json_da
ta:
    districts_data = json.load(json_data)
```

Then convert json object of KSA districts to Pandas dataframe

In [108]:

```
# - Then convert json object of KSA districts to Pandas dataframe

country_districts= pd.DataFrame(columns= ['district_id','city_id', 'region_id'
, 'name_ar', 'name_en','Latitude', 'Longitude', 'boundaries'] )

for data in districts_data:
    row=[]
    for c in country_districts.columns:
        if c == 'Latitude' :
            boundaries = np.array(data['boundaries'][0])
            center=boundaries.mean(axis=0 )
            #center=np.median(boundaries,axis=0 )
            row.append(center[0])
            row.append(center[1])

        elif c == 'Longitude' :
            None
        elif c == 'boundaries' :
            row.append(boundaries)

        else:
            row.append(data[c])
        #print(row)

    country_districts.loc[len(country_districts)] = row
#print(center) # last center point
#print(boundaries)    # last boundry

country_districts.rename(columns ={'name_en': 'Neighborhood'},inplace=True)
country_districts.head()
```

Out[108]:

	district_id	city_id	region_id	name_ar	Neighborhood	Latitude	Longitude	boun
0	10100003001	3	1	حي العمل	Al Amal Dist.	24.644966	46.723598	[[24.649 46.724 [24.647
1	10100003002	3	1	حي النموذجية	Al Namudhajiyah Dist.	24.655615	46.696523	[[24.650 46.702 [24.649
2	10100003003	3	1	حي الجرادية	Al Jarradiyah Dist.	24.618815	46.696110	[[24.617 46.706 [24.617
3	10100003004	3	1	حي الصناعية	Al Sinaiyah Dist.	24.646447	46.741675	[[24.640 46.759 [24.63
4	10100003005	3	1	حي منفوحة الجديدة	Manfuha Al Jadidah Dist.	24.613354	46.716463	[[24.613 46.727 [24.610

In [109]:

```
#Generic function to generate map using
# create map of both cities
def create_map( c_latitude, c_longitude, Latitude_list, Longitude_list,Neighbo
rhood_list,name, zoom=12):
    # create map of New York using latitude and longitude values
    city_map = folium.Map(location=[c_latitude, c_longitude], zoom_start=zoom)
    print(name)
    # add markers to map
    for lat, lng,  neighborhood in zip(Latitude_list, Longitude_list,Neighborh
ood_list):
        label = '{}'.format(neighborhood)
        label = folium.Popup(label, parse_html=True)
        folium.CircleMarker(
            [lat, lng],
            radius=5,
            popup=label,
            color='blue',
            fill=True,
            fill_color='#3186cc',
            fill_opacity=0.7,
            parse_html=False).add_to(city_map)

    folium.CircleMarker(
        [c_latitude, c_longitude],
        radius=5,
        popup=folium.Popup(name, parse_html=True),
        color='red',
        fill=True,
        fill_color='#3186cc',
        fill_opacity=0.7,
        parse_html=False).add_to(city_map)

    return city_map
```

In [110]:

```
#get one district to test center and boundaries on the map
country_districts[country_districts.district_id==10300014035] #10300014089
```

Out[110]:

	district_id	city_id	region_id	name_ar	Neighborhood	Latitude	Longitude	bou
868	10300014035	14	3	حي السكة الحديد	As Sikkah Al Hadid Dist.	24.449093	39.491466	[[24.46 39.50 [24.46

In [111]:

```
# Test create map for one district_id using  "center" and boundry points "boun
daries"

#get boundaries points of the district
boundaries= country_districts[country_districts.district_id==10300014035].boun
daries
boundaries = np.array(boundaries[868])

#convert boundaries to DataFrame
boundaries = pd.DataFrame( boundaries)
boundaries.columns=columns= ['Latitude','Longitude' ]
boundaries['Neighborhood']= 'points'

center_Lat= country_districts[country_districts.district_id==10300014035].Lati
tude.values[0]
center_Long= country_districts[country_districts.district_id==10300014035].Lon
gitude.values[0]
district_name =  country_districts[country_districts.district_id==10300014035]
.Neighborhood.values[0]
distrect_map=create_map( center_Lat,center_Long ,boundaries['Latitude'],bounda
ries['Longitude'],
                        boundaries['Neighborhood'] ,district_name,14)
distrect_map
```

As Sikkah Al Hadid Dist.

Out[111]:

In [112]:

```
city_id = 14   # Almadinah city_id
city_name=country_cities[country_cities.city_id==city_id].name_en.values[0]
print('Visited city: ', city_name)
```

```
Visited city:  Al Madinah Al Munawwarah
```

In [113]:

```
city_districts = country_districts[ country_districts.city_id==city_id ]
print(city_name,city_districts.shape[0],' districts')
```

```
Al Madinah Al Munawwarah 91  districts
```

In [114]:

```
# create a function to draw the vity  using generic create_map function
def create_city_map(city_districts,city_id,city_name,zoom=12):
    #get city latitude, longitude
    center_Lat,center_Long = country_cities[country_cities.city_id==city_id].L
atitude.values[0], \
                country_cities[country_cities.city_id==city_id].Longitude.valu
es[0]

    created_map=create_map( center_Lat,center_Long ,city_districts['Latitude']
,city_districts['Longitude'],
                        city_districts['Neighborhood'] ,city_name,zoom)
    return created_map
```

In [115]:

```
city_map=create_city_map(city_districts,city_id,city_name,10)
city_map
```

```
Al Madinah Al Munawwarah
```

Out[115]:

In [116]:

```
city_districts = pd.concat( [city_districts])

#as disvovered many Neighborhood with same name in two cities added city_id as
prefix to Neighborhood name
city_districts['Neighborhood'] =   city_districts.city_id.astype(str)  +'_' +
city_districts.Neighborhood
print(city_districts.shape)
city_districts.head()
```

```
(91, 8)
```

Out[116]:

	district_id	city_id	region_id	name_ar	Neighborhood	Latitude	Longitude	bou
834	10300014001	14	3	حي خاخ	14_Khakh Dist.	24.362240	39.537870	[[24.3 39.53 [24.3
835	10300014002	14	3	حي السكب	14_As Sakb Dist.	24.360363	39.582572	[[24.37 39.55 [24.37
836	10300014003	14	3	حي الجصة	14_Al Jassah Dist.	24.358140	39.610847	[[24.35 39.63 [24.35
837	10300014004	14	3	حي رهط	14_Raht Dist.	24.368233	39.631787	[[24.36 39.66 [24.36
838	10300014005	14	3	حي بني بياضة	14_Bani Bayadah Dist.	24.384755	39.592094	[[24.39 39.59 [24.3

Define Foursquare Credentials and Version

In [117]:

```
CLIENT_ID = 'TVSPG3MPILEHFZ5T0WUADCTYK0PU2UAHPB2XSRDQE2EFOGG4' # your Foursquare ID
CLIENT_SECRET = 'RXIMYAIACRTJX0QTI5MIDJYOF0BMHUFTQVFGPVLEHMSVA24A' # your Foursquare Secret
VERSION = '20180605'


print('Your credentails:')
print('CLIENT_ID: ' + CLIENT_ID)
print('CLIENT_SECRET:' + CLIENT_SECRET)
```

```
Your credentails:
CLIENT_ID: TVSPG3MPILEHFZ5T0WUADCTYK0PU2UAHPB2XSRDQE2EFOGG4
CLIENT_SECRET:RXIMYAIACRTJX0QTI5MIDJYOF0BMHUFTQVFGPVLEHMSVA24A
```

In [118]:

```
####  A function to repeat the same process to all the neighborhoods in Almadinah city

def getNearbyVenues(city_districts, LIMIT = 100,radius = 500):

    names=city_districts['Neighborhood']
    latitudes=city_districts['Latitude']
    longitudes=city_districts['Longitude']
    city_id = city_districts['city_id']
    venues_list=[]
    print('explore the following Neighborhoods:' , end=' ')

    for name, lat, lng in zip(names, latitudes, longitudes):
        print(name, end=',')

        # create the API request URL
        url = 'https://api.foursquare.com/v2/venues/explore?&client_id={}&client_secret={}&v={}&ll={},{}&radius={}&limit={}'.format(
            CLIENT_ID,
            CLIENT_SECRET,
            VERSION,
            lat,
            lng,
            radius,
            LIMIT)

        # make the GET request
        results = requests.get(url).json()["response"]['groups'][0]['items']
        #print(results)

        # return only relevant information for each nearby venue
        venues_list.append([(
            name,
            lat,
```

```
            lng,
            city_id,  # adding city_id allows us seperate two cities later
            v['venue']['id'],
            v['venue']['name'],
            v['venue']['location']['lat'],
            v['venue']['location']['lng'],
            v['venue']['categories'][0]['name']) for v in results])


    nearby_venues = pd.DataFrame([item for venue_list in venues_list for item
in venue_list])
    nearby_venues.columns = ['Neighborhood',
                  'Neighborhood Latitude',
                  'Neighborhood Longitude',
                  'city_id',
                  'Venue_id',
                  'Venue',
                  'Latitude',  #Venue Latitude
                  'Longitude',  #Venue Longitude
                  'Category']  #Venue Category

    return(nearby_venues)
```

calling the foursquare API for each neighborhood to get all nearby venues

In [119]:

```
city_districts_venues= getNearbyVenues(city_districts)
from openpyxl import load_workbook
city_districts_venues.to_excel('combined_city_'+city_name+'_'+'_districts_venu
es.xlsx',index=False)
```

```
explore the following Neighborhoods: 14_Khakh Dist.,14_As Sakb Dis
t.,14_Al Jassah Dist.,14_Raht Dist.,14_Bani Bayadah Dist.,14_Nubal
a Dist.,14_Ash Shahba Dist.,14_Ar Rumanah Dist.,14_Abu Kabir Dist.
,14_Al Gharra Dist.,14_As Sad Dist.,14_Al Jabirah Dist.,14_Ar Ranu
na Dist.,14_Al Hadiqah Dist.,14_Abu Burayqa Dist.,14_Ar Rawabi Dis
t.,14_Al Qaswa Dist.,14_Al Usbah Dist.,14_Al Khatim Dist.,14_Al Az
iziyah Dist.,14_Al Ihn Dist.,14_Dhu Al Hulayfah Dist.,14_Mahzur Di
st.,14_Ad Duwaimah Dist.,14_Mudhainib Dist.,14_Ayn Al Khif Dist.,1
4_Urwah Dist.,14_Az Zahirah Dist.,14_Ash Shuraybat Dist.,14_Umm Kh
alid Dist.,14_Al Jumah Dist.,14_Al Mughaisilah Dist.,14_Qurban Dis
t.,14_Ad Difa Dist.,14_As Sikkah Al Hadid Dist.,14_Al Wabra Dist.,
14_Al Usayfirin Dist.,14_An Naqa Dist.,14_Bani Zafar Dist.,14_Al I
skan Dist.,14_Al Khalidiyah Dist.,14_Al Jamawat Dist.,14_Al Manakh
ah Dist.,14_Badaah Dist.,14_Josham Dist.,14_Al Hadra Dist.,14_As S
ih Dist.,14_Al Masani Dist.,14_Al Qiblatayn Dist.,14_As Salam Dist
.,14_Al Mabuth Dist.,14_Al Jamiah Dist.,14_Bani Harithah Dist.,14_
Bir Uthman Dist.,14_Shizat Dist.,14_Taibah Dist.,14_Al Qalah Dist.
,14_King Fahd Dist.,14_Al Barakah Dist.,14_Al Uyun Dist.,14_Ad Dar
Dist.,14_Al Nakhil Dist.,14_Az Zahrah Dist.,14_Al Hafya Dist.,14_A
l Balqa Dist.,14_Kittanah Dist.,14_As Sadiqiyah Dist.,14_Al Ghabah
Dist.,14_An Naqs Dist.,14_Wairah Dist.,14_Al Matar Dist.,14_Al Ari
yd Dist.,14_Al Anabis Dist.,14_Al Fath Dist.,14_Ar Rayah Dist.,14_
Masjid Ad Dar Dist.,14_As Suqya Dist.,14_Qalat Makhit Dist.,14_Ash
Shafiyah Dist.,14_Sayed Ash Shuhada Dist.,14_Jabal Uhud Dist.,14_B
ani Khidrah Dist.,14_Bani Abdul Ashhal Dist.,14_Bani Muawiyah Dist
.,14_Al Haram Dist.,14_Warqan Dist.,14_Shuran Dist.,14_Industrial
Area,14_Ad Duwaikhilah Dist.,14_Al Aqoul Dist.,14_Wadi Al Battan D
ist.,
```

In [120]:

```
#### Start from here we can reload  Almadinah districts venues

city_districts_venues= pd.read_excel('combined_city_'+city_name+'_'+'_district
s_venues.xlsx')
```

dropping null and explore data

In [121]:

```
print(city_districts_venues.shape)
city_districts_venues.dropna(inplace = True)
print(city_districts_venues.shape)
city_districts_venues.head()
```

```
(532, 9)
(532, 9)
```

Out[121]:

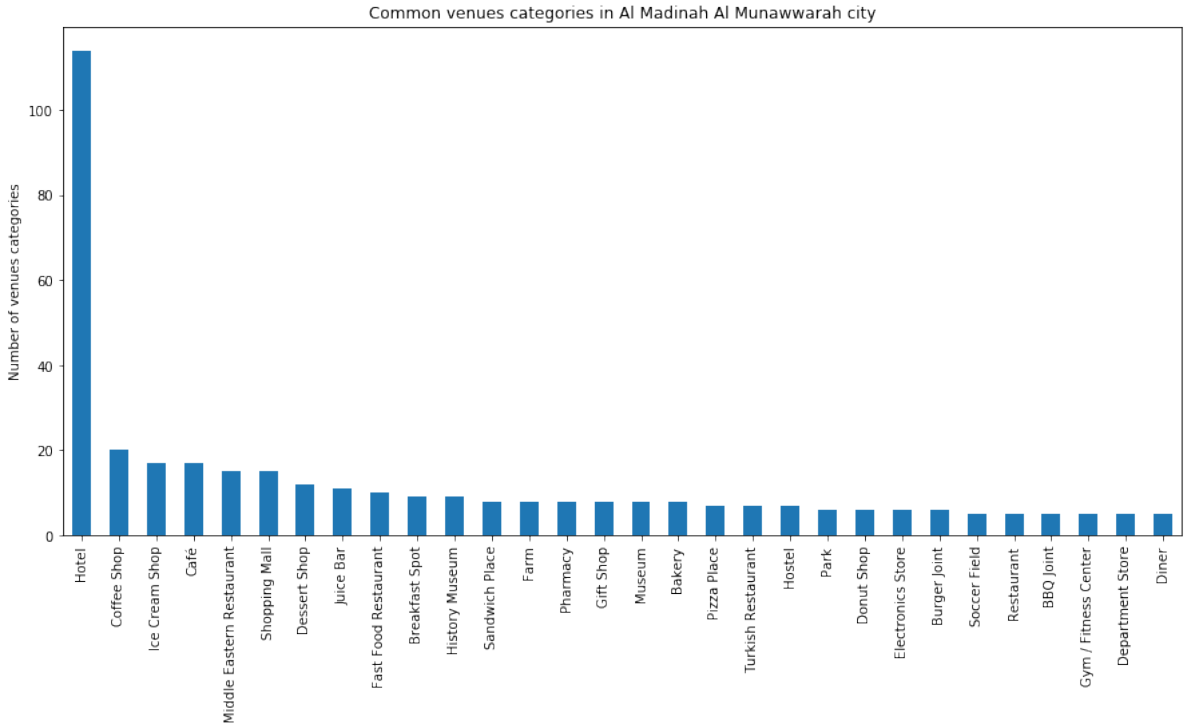
	Neighborhood	Neighborhood Latitude	Neighborhood Longitude	city_id	Venue_id	Ve
0	14_Bani Bayadah Dist.	24.384755	39.592094	834 14\n835 14\n836 14\n837 14\n83...	5b0d6768f427de002c0c6053	U(FITN
1	14_Bani Bayadah Dist.	24.384755	39.592094	834 14\n835 14\n836 14\n837 14\n83...	59c45362628c830948d582de	و سنابل
2	14_As Sad Dist.	24.408279	39.633194	834 14\n835 14\n836 14\n837 14\n83...	55635026498e5eb4e3e11112	غوفر ية
3	14_Al Jabirah Dist.	24.404695	39.586949	834 14\n835 14\n836 14\n837 14\n83...	5536a1be498e27b0a26f1fd2	بابلاش رة
4	14_Al Jabirah Dist.	24.404695	39.586949	834 14\n835 14\n836 14\n837 14\n83...	58341411110d0369b2e8d671	اجواد موت

- Data Analysis

- Common categories in Almadinah city

In [122]:

```
import matplotlib.pyplot as plt
plt.figure(figsize=(15,7))
city_districts_venues.Category.value_counts()[:30].plot.bar()
plt.title('Common venues categories in ' + city_name + ' city' )
plt.ylabel('Number of venues categories')
plt.show()
```



It can be seen most common categories in the city are:

- Hotels
- Coffee shops
- Ice cream shops
- Café
- Shopping mall

In [123]:

```
city_districts_venues.dtypes
```

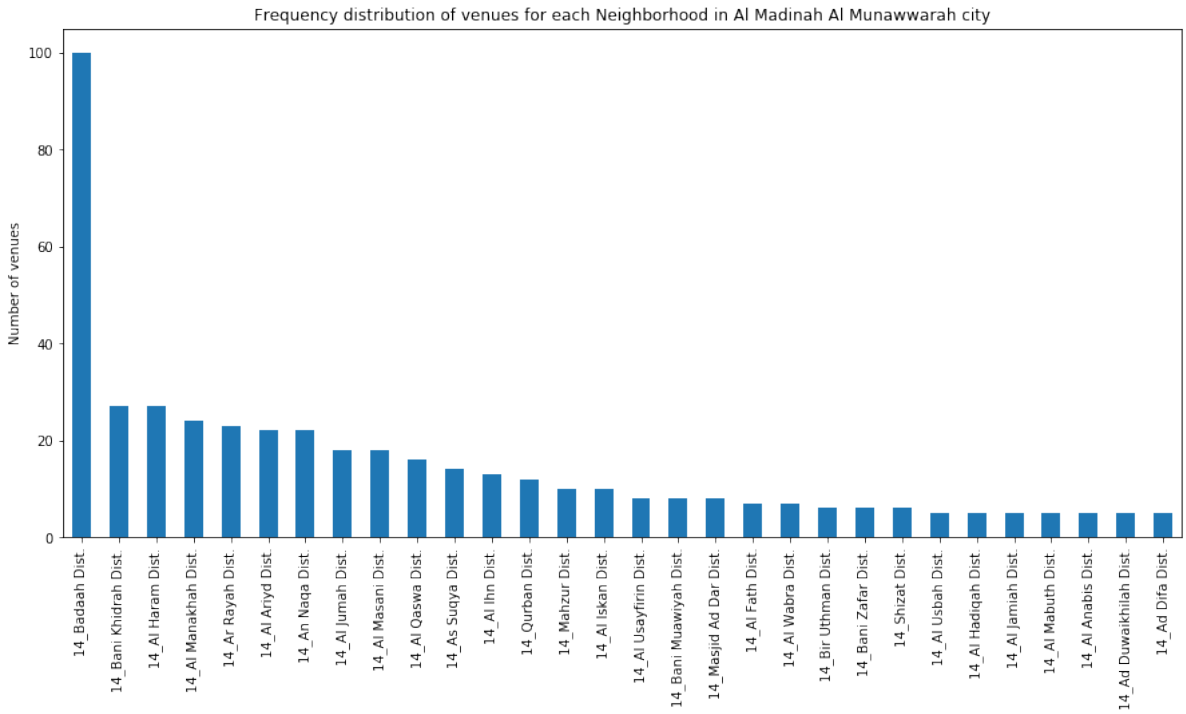
Out[123]:

```
Neighborhood               object
Neighborhood Latitude     float64
Neighborhood Longitude    float64
city_id                    object
Venue_id                   object
Venue                      object
Latitude                  float64
Longitude                 float64
Category                   object
dtype: object
```

- displaying number of venues per Neighborhood

In [124]:

```
import matplotlib.pyplot as plt
plt.figure(figsize=(15,7))
city_districts_venues.Neighborhood.value_counts()[:30].plot.bar()
plt.title('Frequency distribution of venues for each Neighborhood in '+city_na
me + ' city')
plt.ylabel('Number of venues')
plt.show()
```



The above Figure shows that most of Neighborhood with more than 30 venues are downtone Neighborhoods

3-Methodology

Steps 1,2 already performed in Data Description & Preperatio phase

Generate one-hot encoding for venues categories

We use One Hot Encoding for venues categories, and then find out the top ten venues categories present in each neighborhood.

In [125]:

```
# one hot encoding
city_onehot = pd.get_dummies(city_districts_venues[['Category']], prefix="", p
refix_sep="")
city_onehot.head(100)
# add neighborhood column back to dataframe
city_onehot['Neighborhood'] =  city_districts_venues['Neighborhood']
city_onehot['city_id'] =  city_districts_venues['city_id']

# move neighborhood & city_id columns to the first column
fixed_columns=list( city_onehot.columns)
fixed_columns.remove('Neighborhood')
fixed_columns.remove('city_id')

fixed_columns =  ['Neighborhood','city_id'] + fixed_columns

city_onehot = city_onehot[fixed_columns]

print('shape after onehot:',   city_onehot.shape)

city_onehot.head()
```

```
shape after onehot: (532, 127)
```

Out[125]:

	Neighborhood	city_id	ATM	Accessories Store	Afghan Restaurant	African Restaurant	Airport	Airport Terminal	F
0	14_Bani Bayadah Dist.	834 14\n835 14\n836 14\n837 14\n83...	0	0	0	0	0	0	
1	14_Bani Bayadah Dist.	834 14\n835 14\n836 14\n837 14\n83...	0	0	0	0	0	0	
2	14_As Sad Dist.	834 14\n835 14\n836 14\n837 14\n83...	0	0	0	0	0	0	
3	14_Al Jabirah Dist.	834 14\n835 14\n836 14\n837 14\n83...	0	0	0	0	0	0	
4	14_Al Jabirah Dist.	834 14\n835 14\n836 14\n837 14\n83...	0	0	0	0	0	0	

b) Group by neighborhoods and sum all venues categories

as shown in above one-hot encodong tabel, there are number of recoreds for each Neighborhood (venues), now we will group data by Neighborhood to have one value between Neighborhood and catagory as shown below:

In [126]:

```
city_grouped = city_onehot.groupby('Neighborhood').sum().reset_index()

#this second grouping allow keep keeping city_id

city_grouped = city_onehot.groupby('Neighborhood').mean().values


#print('shape after group:',   combined_city_grouped.shape)
city_grouped
```

Out[126]:

```
array([[0. , 0. , 0. , ..., 0.2, 0. , 0. ],
       [0. , 0. , 0. , ..., 0. , 0. , 0. ],
       [0. , 0. , 0. , ..., 0. , 0. , 0. ],
       ...,
       [0. , 0. , 0. , ..., 0. , 0. , 0. ],
       [0. , 0. , 0. , ..., 0. , 0. , 0. ],
       [0. , 0. , 0. , ..., 0. , 0. , 0. ]])
```

In [127]:

```
almadinah_grouped = city_onehot.groupby('Neighborhood').mean().reset_index()
almadinah_grouped.head()
```

Out[127]:

	Neighborhood	ATM	Accessories Store	Afghan Restaurant	African Restaurant	Airport	Airport Terminal	American Restaurant
0	14_Ad Difa Dist.	0.0	0.0	0.0	0.0	0.0	0.0	0.000000
1	14_Ad Duwaikhilah Dist.	0.0	0.0	0.0	0.0	0.0	0.0	0.000000
2	14_Ad Duwaimah Dist.	0.0	0.0	0.0	0.0	0.0	0.0	0.000000
3	14_Al Anabis Dist.	0.0	0.0	0.0	0.0	0.0	0.0	0.000000
4	14_Al Ariyd Dist.	0.0	0.0	0.0	0.0	0.0	0.0	0.045455

Let's confirm the new size

In [128]:

```
almadinah_grouped.shape
```

Out[128]:

```
(62, 126)
```

Let's print each neighborhood along with the top 5 most common venues

In [ ]:

```
num_top_venues = 5

for hood in almadinah_grouped['Neighborhood']:
    print("----"+hood+"----")
    temp = almadinah_grouped[almadinah_grouped['Neighborhood'] == hood].T.rese
t_index()
    temp.columns = ['venue','freq']
    temp = temp.iloc[1:]
    temp['freq'] = temp['freq'].astype(float)
    temp = temp.round({'freq': 2})
    print(temp.sort_values('freq', ascending=False).reset_index(drop=True).hea
d(num_top_venues))
    print('\n')
```

Let's put that into a *pandas* dataframe

First, let's write a function to sort the venues in descending order.

In [130]:

```
def return_most_common_venues(row, num_top_venues):
    row_categories = row.iloc[1:]
    row_categories_sorted = row_categories.sort_values(ascending=False)

    return row_categories_sorted.index.values[0:num_top_venues]
```

- Displaying the top 10 most common venues catagories for each Neighborhood

In [131]:

```
#creating the new dataframe and display the top 10 venues for each neighborhoo
d.
num_top_venues = 10

indicators = ['st', 'nd', 'rd']

# create columns according to number of top venues
columns = ['Neighborhood']
for ind in np.arange(num_top_venues):
    try:
        columns.append('{}{} Most Common Venue'.format(ind+1, indicators[ind])
)
    except:
        columns.append('{}th Most Common Venue'.format(ind+1))

# create a new dataframe
neighborhoods_venues_sorted = pd.DataFrame(columns=columns)
neighborhoods_venues_sorted['Neighborhood'] = almadinah_grouped['Neighborhood'
]

for ind in np.arange(almadinah_grouped.shape[0]):
    neighborhoods_venues_sorted.iloc[ind, 1:] = return_most_common_venues(alma
dinah_grouped.iloc[ind, :], num_top_venues)
print(neighborhoods_venues_sorted.shape)
neighborhoods_venues_sorted.head()
```

```
(62, 11)
```

Out[131]:

	Neighborhood	1st Most Common Venue	2nd Most Common Venue	3rd Most Common Venue	4th Most Common Venue	5th Most Common Venue	6th Most Common Venue	7th Con V
0	14_Ad Difa Dist.	Park	Video Game Store	Comic Shop	Farm	Plaza	Dog Run	F Resta
1	14_Ad Duwaikhilah Dist.	Bus Stop	Soccer Field	Farm	Hookah Bar	Rest Area	Doner Restaurant	F Resta
2	14_Ad Duwaimah Dist.	Turkish Restaurant	Flower Shop	Garden	Yemeni Restaurant	Doner Restaurant	Farmers Market	
3	14_Al Anabis Dist.	Coffee Shop	Electronics Store	Juice Bar	Bakery	Middle Eastern Restaurant	Farmers Market	
4	14_Al Ariyd Dist.	Fast Food Restaurant	Pizza Place	Burger Joint	Juice Bar	Dessert Shop	Donut Shop	Ame Resta

C) Cluster Neighborhoods

Run *k*-means to cluster the neighborhood into 5 clusters.

In [132]:

```
# set number of clusters
kclusters = 5

almadinah_grouped_clustering = almadinah_grouped.drop('Neighborhood', 1)

# run k-means clustering
kmeans = KMeans(n_clusters=kclusters, random_state=0).fit(almadinah_grouped_cl
ustering)

# check cluster labels generated for each row in the dataframe
kmeans.labels_[0:10]
```

Out[132]:

```
array([3, 3, 3, 3, 3, 3, 3, 3, 3, 3], dtype=int32)
```

Let's create a new dataframe that includes the cluster as well as the top 10 venues for each neighborhood.

In [133]:

```
# add clustering labels
#neighborhoods_venues_sorted.insert(0, 'Cluster Labels', kmeans.labels_)
neighborhoods_venues_sorted['Cluster Labels']=kmeans.labels_
almadinah_merged = city_districts

# merge toronto_grouped with toronto_data to add latitude/longitude for each n
eighborhood
almadinah_merged = almadinah_merged.join(neighborhoods_venues_sorted.set_index
('Neighborhood'), on='Neighborhood')
almadinah_merged.head() # check the last columns!
```

Out[133]:

	district_id	city_id	region_id	name_ar	Neighborhood	Latitude	Longitude	bou
834	10300014001	14	3	حي خاخ	14_Khakh Dist.	24.362240	39.537870	[[24.3 39.53 [24.3
835	10300014002	14	3	حي السكب	14_As Sakb Dist.	24.360363	39.582572	[[24.37 39.55 [24.37
836	10300014003	14	3	حي الجصة	14_Al Jassah Dist.	24.358140	39.610847	[[24.35 39.63 [24.35
837	10300014004	14	3	حي رهط	14_Raht Dist.	24.368233	39.631787	[[24.36 39.66 [24.36
838	10300014005	14	3	حي بني بياضة	14_Bani Bayadah Dist.	24.384755	39.592094	[[24.39 39.59 [24.3

In [134]:

```
almadinah_merged['Cluster Labels'].isnull().sum()
print(almadinah_merged.shape)
# dropping rows with  null values
almadinah_merged.dropna(axis = 0, inplace = True)
print(almadinah_merged.shape)
almadinah_merged.head()
```

```
(91, 19)
(62, 19)
```

Out[134]:

	district_id	city_id	region_id	name_ar	Neighborhood	Latitude	Longitude	bou
838	10300014005	14	3	حي بني بياضة	14_Bani Bayadah Dist.	24.384755	39.592094	[[24.39 39.59 [24.3
844	10300014011	14	3	حي السد	14_As Sad Dist.	24.408279	39.633194	[[24.41 39.62 [24.41
845	10300014012	14	3	حي الجابرة	14_Al Jabirah Dist.	24.404695	39.586949	[[24.40 39.59 [24.40
846	10300014013	14	3	حي الرانوناء	14_Ar Ranuna Dist.	24.399049	39.597323	[[24.41 39.60 [24.41
847	10300014014	14	3	حي الحديقة	14_Al Hadiqah Dist.	24.417218	39.609482	[[24.42 39.62 [24.42

Finally, let's visualize the resulting clusters

In [135]:

```
x = np.arange(kclusters)
print(x)
ys = [i + x + (i*x)**2 for i in range(kclusters)]
colors_array = cm.rainbow(np.linspace(0, 1, len(ys)))
rainbow = [colors.rgb2hex(i) for i in colors_array]
rainbow
```

```
[0 1 2 3 4]
```

Out[135]:

```
['#8000ff', '#00b5eb', '#80ffb4', '#ffb360', '#ff0000']
```

In [136]:

```
# create map
latitude = 24.47058
longitude = 39.60781
map_clusters = folium.Map(location=[latitude , longitude], zoom_start=11)

# set color scheme for the clusters
x = np.arange(kclusters)
ys = [i + x + (i*x)**2 for i in range(kclusters)]
colors_array = cm.rainbow(np.linspace(0, 1, len(ys)))
rainbow = [colors.rgb2hex(i) for i in colors_array]

# add markers to the map
markers_colors = []
for lat, lon, poi, cluster in zip(almadinah_merged['Latitude'], almadinah_merg
ed['Longitude'], almadinah_merged['Neighborhood'], almadinah_merged['Cluster L
abels']):
    label = folium.Popup(str(poi) + ' Cluster ' + str(cluster), parse_html=Tru
e)
    #print(cluster)
    cluster = int(cluster)
    folium.CircleMarker(
        [lat, lon],
        radius=5,
        popup=label,
        color=rainbow[cluster-1],
        fill=True,
        fill_color=rainbow[cluster-1],
        fill_opacity=0.7).add_to(map_clusters)

map_clusters
```

Out[136]:

D) Examine Clusters

Now, you can examine each cluster and determine the discriminating venue categories that distinguish each cluster. Based on the defining categories, you can then assign a name to each cluster.

In [137]:

```
almadinah_merged.set_index("Neighborhood", inplace= True)
```

Cluster 1

In [138]:

```
almadinah_merged.loc[almadinah_merged['Cluster Labels'] == 0 , almadinah_merge
d.columns[[1] + list(range(5, almadinah_merged.shape[1]))]]
```

Out[138]:

Neighborhood	city_id	Longitude	boundaries	1st Most Common Venue	2nd Most Common Venue	3rd Most Common Venue	4th M Comm Ven
14_Ar Ranuna Dist.	14	39.597323	[[24.41683728, 39.60076966], [24.41679279, 39....	Hookah Bar	Café	Yemeni Restaurant	Flov Sh
14_Bani Harithah Dist.	14	39.627848	[[24.48564547, 39.61575111], [24.48662775, 39....	Persian Restaurant	Café	Diner	Ind Restaur
14_Shuran Dist.	14	39.622276	[[24.4122708, 39.62312234], [24.412227, 39.623...	Café	Yemeni Restaurant	Flower Shop	Cric Grou

Cluster 2

In [139]:

```
almadinah_merged.loc[almadinah_merged['Cluster Labels'] == 1, almadinah_merged
.columns[[1] + list(range(5, almadinah_merged.shape[1]))]]
```

Out[139]:

Neighborhood	city_id	Longitude	boundaries	1st Most Common Venue	2nd Most Common Venue	3rd Most Common Venue	4th Mos Commor Venue
14_An Naqa Dist.	14	39.604915	[[24.46682528, 39.604814], [24.46570653, 39.60...	Hotel	History Museum	Ice Cream Shop	Middl Eastern Restauran
14_Al Manakhah Dist.	14	39.604343	[[24.46738333, 39.60481675], [24.46739629, 39....	Hotel	Museum	Gift Shop	Shoppin Mal
14_Badaah Dist.	14	39.610184	[[24.47095138, 39.60610706], [24.47155078, 39....	Hotel	Shopping Mall	Coffee Shop	Donu Shop
14_Al Masani Dist.	14	39.608860	[[24.48560351, 39.61340205], [24.48564547, 39....	Hotel	Turkish Restaurant	Breakfast Spot	Middl Eastern Restauran
14_As Suqya Dist.	14	39.600247	[[24.46112392, 39.60106684], [24.46060103, 39....	Hotel	History Museum	Breakfast Spot	Restauran
14_Bani Khidrah Dist.	14	39.612655	[[24.46411419, 39.60707874], [24.46413448, 39....	Hotel	History Museum	Museum	Hoste
14_Al Haram Dist.	14	39.612750	[[24.46411419, 39.60707874], [24.46410303, 39....	Hotel	History Museum	Hostel	Museum

Cluster 3

In [140]:

```
almadinah_merged.loc[almadinah_merged['Cluster Labels'] == 2, almadinah_merged
.columns[[1] + list(range(5, almadinah_merged.shape[1]))]]
```

Out[140]:

Neighborhood	city_id	Longitude	boundaries	1st Most Common Venue	2nd Most Common Venue	3rd Most Common Venue	4th Most Common Venue
14_Az Zahrah Dist.	14	39.565242	[[24.54368047, 39.58184065], [24.54356982, 39....	Bus Stop	Yemeni Restaurant	Flower Shop	Cricket Ground

Cluster 4

In [141]:

```
almadinah_merged.loc[almadinah_merged['Cluster Labels'] == 3, almadinah_merged
.columns[[1] + list(range(5, almadinah_merged.shape[1]))]]
```

Out[141]:

Neighborhood	city_id	Longitude	boundaries	1st Most Common Venue	2nd Most Common Venue	3rd Most Common Venue	4t Co
14_Bani Bayadah Dist.	14	39.592094	[[24.39186456, 39.59318685], [24.3918323, 39.5...	Gym / Fitness Center	Supermarket	Yemeni Restaurant	Res
14_As Sad Dist.	14	39.633194	[[24.41268509, 39.62274948], [24.41362301, 39....	Dessert Shop	Yemeni Restaurant	Flower Shop	Cos
14_Al Jabirah Dist.	14	39.586949	[[24.40354893, 39.59112981], [24.40349162, 39....	Halal Restaurant	Home Service	African Restaurant	I Res
14_Al Hadiqah Dist.	14	39.609482	[[24.42064373, 39.62051688], [24.42060326, 39....	Park	Stadium	Art Gallery	N
14_Al Qaswa Dist.	14	39.589593	[[24.42825848, 39.60601986], [24.42818653, 39....	Bakery	Yemeni Restaurant	Restaurant	

14_Al Usbah Dist.	14	39.615441	[[24.4263577, 39.61942727], [24.42633661, 39.6...	Big Box Store	Pharmacy	Hotel Pool	
14_Al Khatim Dist.	14	39.622014	[[24.4263577, 39.61942727], [24.42731026, 39.6...	Motel	Arts & Crafts Store	Farm	Hot
14_Al Aziziyah Dist.	14	39.500703	[[24.43370571, 39.4987144], [24.43364971, 39.4...	Burger Joint	Kebab Restaurant	Yemeni Restaurant	
14_Al Ihn Dist.	14	39.632616	[[24.43889318, 39.63641157], [24.4388112, 39.6...	Coffee Shop	Garden	Café	Bu
14_Dhu Al Hulayfah Dist.	14	39.566301	[[24.44614158, 39.57515071], [24.44606644, 39....	Water Park	Pier	Coffee Shop	Cos
14_Mahzur Dist.	14	39.644385	[[24.44883791, 39.65930088], [24.44889644, 39....	Coffee Shop	Mobile Phone Shop	Gift Shop	I
14_Ad Duwaimah Dist.	14	39.608016	[[24.44831202, 39.61321648], [24.44747527, 39....	Turkish Restaurant	Flower Shop	Garden	Res
14_Mudhainib Dist.	14	39.679036	[[24.43705615, 39.68414148], [24.43676414, 39....	Movie Theater	Sports Club	Yemeni Restaurant	Fas Res
14_Urwah Dist.	14	39.580830	[[24.45339731, 39.58983451], [24.45362883, 39....	Historic Site	Castle	Electronics Store	Ju
14_Az Zahirah Dist.	14	39.602992	[[24.45362883, 39.59038624], [24.45384355, 39....	Flower Shop	Turkish Restaurant	Castle	Res
14_Ash Shuraybat Dist.	14	39.639293	[[24.44498252, 39.6422244], [24.44487692, 39.6...	Diner	Campground	Ice Cream Shop	BB
14_Al Jumah Dist.	14	39.613739	[[24.4631909, 39.6071965], [24.4631909, 39.607...	Ice Cream Shop	Juice Bar	BBQ Joint	C
14_Al Mughaisilah Dist.	14	39.604167	[[24.4631909, 39.6071965], [24.46305078, 39.60...	Shopping Mall	Afghan Restaurant	Gift Shop	Cos
14_Qurban			[[24.46316053, 39.60925763],		Dessert	Coffee	

Dist.	14	39.620865	[24.46315252, 39....	Pizza Place	Shop	Shop	
14_Ad Difa Dist.	14	39.516584	[[24.46000887, 39.54580277], [24.45963763, 39....	Park	Video Game Store	Comic Shop	
14_Al Wabra Dist.	14	39.582102	[[24.46715319, 39.58267582], [24.46641206, 39....	Shopping Mall	Department Store	Café	
14_Al Usayfirin Dist.	14	39.590773	[[24.45424973, 39.59000635], [24.45626305, 39....	Ice Cream Shop	Café	Falafel Restaurant	I
14_Bani Zafar Dist.	14	39.627798	[[24.46433614, 39.61763963], [24.46435845, 39....	Shopping Mall	Ice Cream Shop	Farm	BB
14_Al Iskan Dist.	14	39.646484	[[24.46984883, 39.63467375], [24.46984883, 39....	Sandwich Place	Coffee Shop	Pizza Place	Ice
14_Al Khalidiyah Dist.	14	39.659641	[[24.4719152, 39.66063394], [24.472002, 39.661...	Coffee Shop	Market	Ice Cream Shop	
14_Al Jamawat Dist.	14	39.556041	[[24.46716052, 39.57731981], [24.46622783, 39....	Cricket Ground	Yemeni Restaurant	Flower Shop	Cos
14_Josham Dist.	14	39.678039	[[24.472002, 39.66155766], [24.47209198, 39.66...	Accessories Store	Yemeni Restaurant	Food & Drink Shop	(
14_As Sih Dist.	14	39.596576	[[24.47025967, 39.59839914], [24.47031879, 39....	Electronics Store	Middle Eastern Restaurant	Breakfast Spot	
14_Al Qiblatayn Dist.	14	39.577275	[[24.48120444, 39.58376432], [24.48073026, 39....	Coffee Shop	Gym / Fitness Center	Salon / Barbershop	Res
14_Al Mabuth Dist.	14	39.678744	[[24.49116876, 39.69189169], [24.49069487, 39....	Café	Breakfast Spot	Grocery Store	Ice
14_Al Jamiah Dist.	14	39.562047	[[24.48921555, 39.57175947], [24.48692009, 39....	Soccer Field	Bus Station	Bookstore	Br
14_Bir Uthman Dist.	14	39.583768	[[24.50793031, 39.58322433], [24.50787057, 39....	Bookstore	Turkish Restaurant	Gym	

14_Shizat Dist.	14	39.655275	[[24.49972868, 39.6636641], [24.49652792, 39.6...	Coffee Shop	Department Store	Dessert Shop	C
14_Al Qalah Dist.	14	39.649136	[[24.49429948, 39.64115822], [24.49500818, 39....	Furniture / Home Store	Mattress Store	Auto Garage	Res
14_King Fahd Dist.	14	39.689393	[[24.52880763, 39.68719192], [24.52769714, 39....	Gym / Fitness Center	Park	Pool	
14_Al Barakah Dist.	14	39.573432	[[24.50811908, 39.58048411], [24.50797032, 39....	Restaurant	Pharmacy	Pie Shop	
14_Al Uyun Dist.	14	39.589876	[[24.53606454, 39.59407164], [24.53544205, 39....	Garden	Soccer Field	Doner Restaurant	F
14_Kittanah Dist.	14	39.561311	[[24.56015359, 39.56791643], [24.56006208, 39....	Dog Run	Bar	Yemeni Restaurant	
14_Al Ghabah Dist.	14	39.606644	[[24.55234228, 39.61988362], [24.55219599, 39....	Motel	Yemeni Restaurant	Flower Shop	
14_Al Ariyd Dist.	14	39.642785	[[24.48066021, 39.62866732], [24.48134299, 39....	Fast Food Restaurant	Pizza Place	Burger Joint	Ju
14_Al Anabis Dist.	14	39.587701	[[24.48006995, 39.58377648], [24.48073026, 39....	Coffee Shop	Electronics Store	Juice Bar	
14_Al Fath Dist.	14	39.596228	[[24.48073026, 39.58412918], [24.48125606, 39....	Coffee Shop	Café	Electronics Store	M
14_Ar Rayah Dist.	14	39.599733	[[24.48580952, 39.60297271], [24.48535178, 39....	Dessert Shop	Grocery Store	Middle Eastern Restaurant	T
14_Masjid Ad Dar Dist.	14	39.610432	[[24.48560351, 39.61340205], [24.48573552, 39....	Bookstore	Hotel	Breakfast Spot	Ph
14_Sayed Ash Shuhada Dist.	14	39.614863	[[24.50533627, 39.60726483], [24.50537078, 39....	Mountain	Yemeni Restaurant	Flower Shop	

14_Bani Abdul Ashhal Dist.	14	39.621279	[[24.47366126, 39.61392552], [24.47595401, 39....	Park	Pharmacy	Middle Eastern Restaurant	Ju
14_Bani Muawiyah Dist.	14	39.621609	[[24.47334726, 39.61759528], [24.47345821, 39....	African Restaurant	Middle Eastern Restaurant	Juice Bar	Res
14_Ad Duwaikhilah Dist.	14	39.675751	[[24.49116876, 39.69189169], [24.49091389, 39....	Bus Stop	Soccer Field	Farm	I
14_Wadi Al Battan Dist.	14	39.788515	[[24.53848798, 39.86997305], [24.53188387, 39....	Fast Food Restaurant	Yemeni Restaurant	Flower Shop	Cos

Cluster 5

In [142]:

```
almadinah_merged.loc[almadinah_merged['Cluster Labels'] == 4, almadinah_merged
.columns[[1] + list(range(5, almadinah_merged.shape[1]))]]
```

Out[142]:

Neighborhood	city_id	Longitude	boundaries	1st Most Common Venue	2nd Most Common Venue	3rd Most Common Venue	4th Mos Commo Venu
14_Ar Rawabi Dist.	14	39.662602	[[24.41867641, 39.67161693], [24.41753367, 39....	Farm	Park	Yemeni Restaurant	Flowe Sho
14_As Sadiqiyah Dist.	14	39.579453	[[24.55818679, 39.59347244], [24.55806418, 39....	Farm	Yemeni Restaurant	Flower Shop	Cosmetic Sho

Name each cluster based on most common venues in this cluster

In [159]:

```
#this function will count Most Common Venues 1--> 10
def cluster_name(data):
    ven = []
    for i in range(7,17): # from 1st Most Common Venue to 10th  Most Common Ve
nue
        ven= ven+ list(data[data.columns[i]]) # add all Venues in one list
    ven = pd.DataFrame({'Venue':ven})
    return ven.Venue.value_counts().head() # return most 5 Venues
```

In [160]:

```
#dislay
for i in range(0,5):
    # return most common Venue
    print('Cluster_No:',i)
    print(cluster_name(almadinah_merged.loc[almadinah_merged['Cluster Labels']
== i ] ) )
    print()
```

```
Cluster_No: 0
Diner                3
Department Store     3
Dog Run              3
Yemeni Restaurant    3
Dessert Shop         3
Name: Venue, dtype: int64

Cluster_No: 1
Hotel                        7
History Museum               4
Hostel                       4
Middle Eastern Restaurant    4
Farmers Market               3
Name: Venue, dtype: int64

Cluster_No: 2
Diner               1
Cricket Ground      1
Department Store    1
Donut Shop          1
Flower Shop         1
Name: Venue, dtype: int64

Cluster_No: 3
Dessert Shop          29
Yemeni Restaurant     27
Diner                 24
Doner Restaurant      23
Falafel Restaurant    23
Name: Venue, dtype: int64

Cluster_No: 4
Dessert Shop        2
Cosmetics Shop      2
Department Store    2
Flower Shop         2
Diner               2
Name: Venue, dtype: int64
```

4- Conclusion

We can name cluster from most two/three Venues as followig:

- Cluster_0: Cricket Ground area,
- Cluster_1: Hotel
- Cluster_2: Diner
- Cluster_3: Yemeni Restaurant
- Cluster_4: Cosmetics Shop, Flower Shop