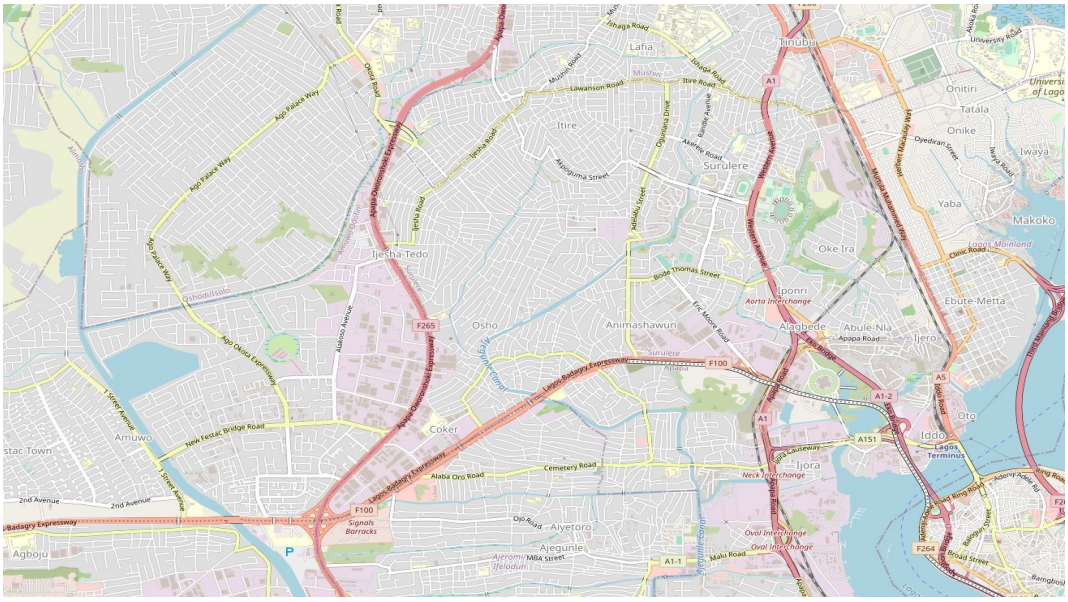
PROPOSED SOLUTION FOR MINI POWER GRID DISTRIBUTION IN SURULERE,LAGOS.

A. Introduction

A.1. Description & Discussion of the Background

Surulere is a residential and commercial Local Government Area located on the mainland of Lagos in Lagos State, Nigeria, with an area of 23 km². At the last census in the year 2006, there were 503,975 inhabitants, with a population density of 21,864 inhabitants per square kilometer.

The local government area is bordered by Yaba, Mushin and Ebute-Metta.1 Surulere is often touted as being the centre of Lagos .



What makes surulere lively is due to its incongruous mixture in many ramifications. It boasts a fine blend between commercial and residential activities, a motley of upscale neighborhoods as well as midrange and even lowscale localities.it is home to a mix of upscale cocktail bars, pulsing clubs, and laid-back beer parlors.

Like every city in Nigeria, Surulere is also plagued with epileptic power supply affecting small scale and big businesses alike , and is a major concern for both residential and commercial stakeholders in the city. Electricity shortages often mean residents resort to their petrol/diesel powered generator having to put up with the high blaring noise and it's detrimental effect on the environment especially at night when it is common to have as much as 100 generators within an 100m radius. companies spend up to a shocking 70% of the budget on diesel or petrol.

There seems to be some hope for residents with the proposed partnership of renewable energy companies with power distribution companies to provide alternative energy for consumers during power outage hours via an interconnected minigrid these mini-grid will leverage on existing distribution infrastructure to achieve lower system cost than isolated mini-grid while improving service reliability from the status quo.

A mini grid, also sometimes referred to as a "micro grid or isolated grid", can be defined as a set of electricity generators and possibly energy storage systems interconnected to a distribution network that supplies electricity to a localized group of customers."They involve small-scale electricity generation (10 kW to 10MW) which serves a limited number of consumers via a distribution grid that can operate in isolation from national electricity transmission networks."3

“These systems can help DisCos reduce losses to serve these communities (by N1–2 billion per DisCo per year) and create a mini-grid market with N400 billion in annual revenue, all while saving customers ₦60 billion per year compared to what they spend today,”4. Mini Grids provide an enhanced service where there are epileptic power supply in urban areas too especially within healthcare, higher education, government, businesses and the military base.

The aim of this project is to develop a clustering model for the distribution of mini-grids around surulere .Based on the nature of mini grids to serve only a limited number of customers , it is important for stakeholders to have an idea of the size requirements of each mini-grids that should be deployed to each locale . Considering the incongruous mixture of commercial,industrial and residential venues within surulere we can create a map that categorises the needs of each locale into a few clusters as well as an information chart about the types of business found within each locale for easy visualization and better decision making.

B. Data Description

To consider the problem we can list the datas as below:

- The Open Street map (OSM) API was used to find the coordinates and street names for all streets in Surulere, this would be important to give a final breakdown of the streets that fall into each grid .
- Note : The OSM API failed to give street names for some locations given only latitude and longitude and the reverse being the case for some locations . we therefore rely on the Google API(find) to get this street names for locations without street names
  Data of the needed Columns from the OSM API is returned as seen below .

- The location data obtained was cleaned carefully to only include data from surulere .
- After splitting our data into contiguous 300metres grids . We use the Google API to obtain the location of our newly defined grid centers by passing the latitude and longitude of our new grids into the google Places API (Reverse Geocoding)
- The google maps Places API(nearbysearch) was used to get the name and business type of every contiguous grid/locale within the surulere. Our grids are defined as circular areas with a radius of 300 meters, so our grid centers will be 600 meters apart.. Google places API was also used to get the location and names of streets that we were not able to identify via the OSM API.

We create latitude & longitude coordinates for centroids of our candidate neighborhoods. We will create a grid of cells covering our area of interest. Next we find the latitude & longitude of our approximate center of surulere using Google Maps geocoding API

```
Coordinate of Fountain height school, surulere, Lagos: [6.4936877, 3.3487219]
```

Now we create a grid of area candidates, equally spaced, centered around the city centre(Fountain Heights School, surulere), and within ~3.5km from this center . Our neighborhoods will be defined as contiguous circular areas with a radius of 300 meters, so our neighborhood centers will be 600 meters apart. To accurately calculate distances we need to create our grid of locations in the Cartesian 2D coordinate system which allows us to calculate distances in meters (not in latitude/longitude degrees). Then we'll project those coordinates back to latitude/longitude degrees to be shown on the Folium map. So let's create functions to convert between WGS84 spherical coordinate system (latitude/longitude degrees) and UTM Cartesian coordinate system (X/Y coordinates in meters).

Below is a sample of what a coordinate transformation does at each location.

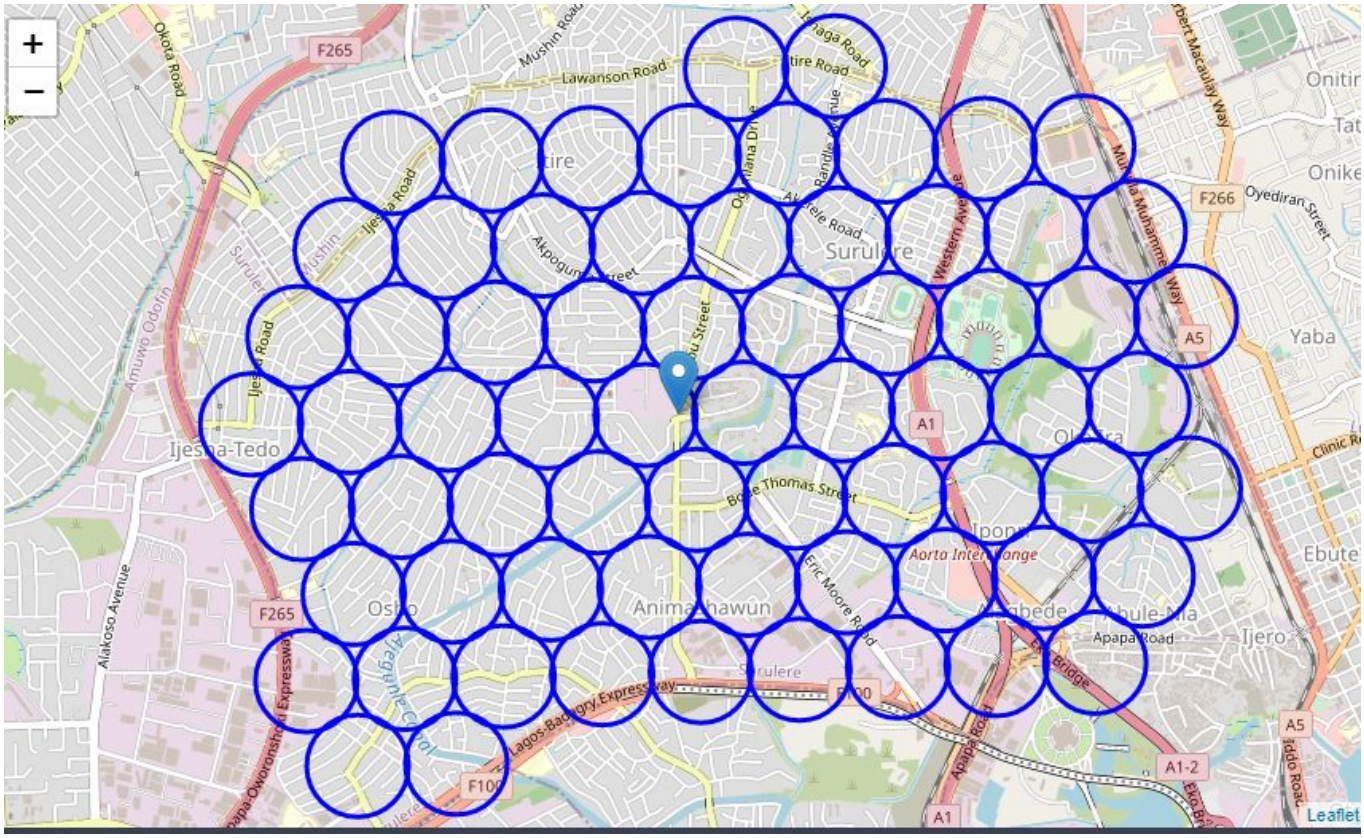
```
surulere center longitude=3.3487219, latitude=6.4936877

surulere center UTM X=-797030.4725273035, Y=732850.4270195634
surulere center longitude=3.3487218999999966, latitude=6.493687699999999
```

We create a hexagonal grid of cells: we offset every other row, and adjust vertical row spacing so that every cell center is equally distant from all its neighbors.

In the case our grids overlap several locations outside Surulere. it is important that we manually filter out some grids .

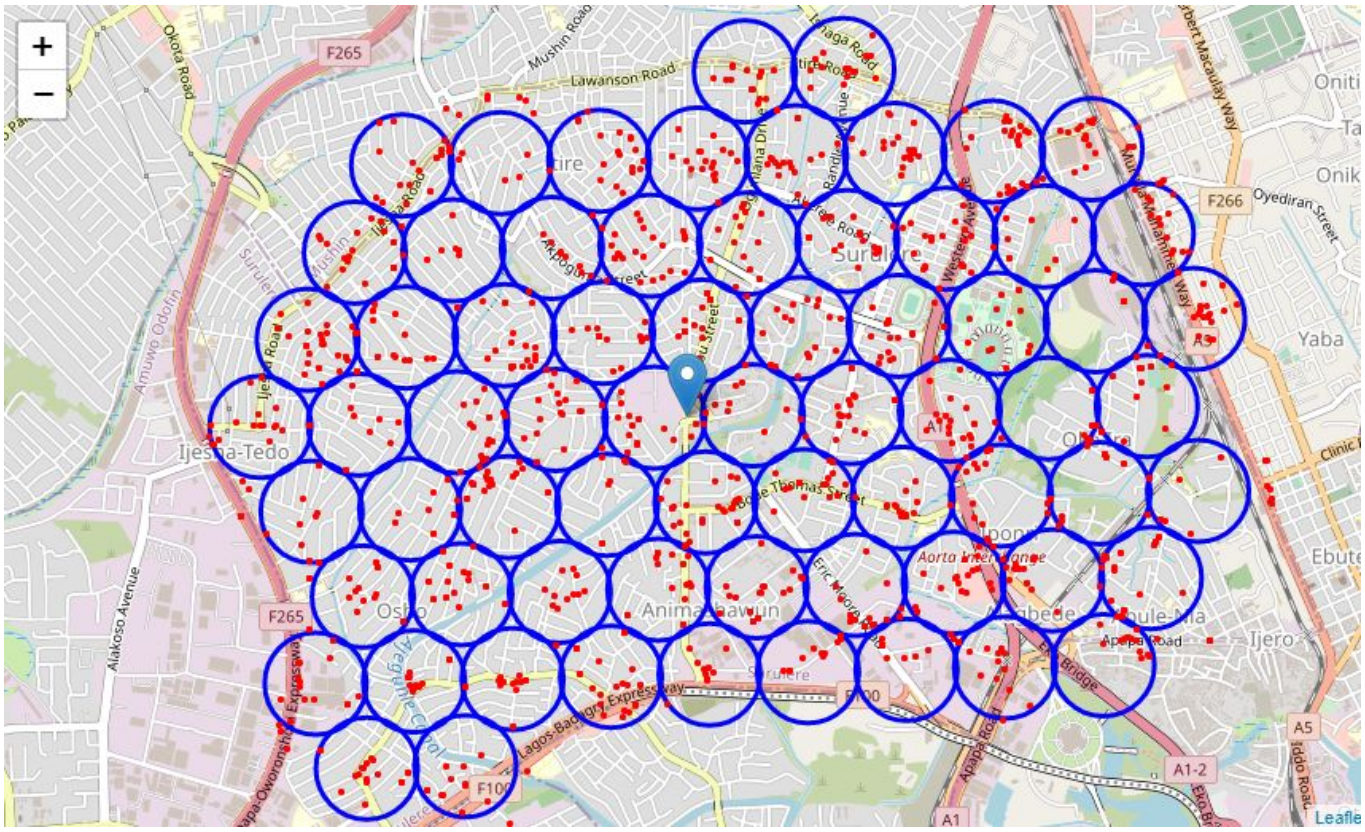
Now our grids show a more accurate representation of Surulere. OK, we now have the coordinates of centers of neighborhoods/areas to be evaluated, equally spaced (distance from every point to its neighbors is exactly the same) carefully fitted within surulere.



Using Google Maps API to get approximate addresses of those locations. We get a table of locations and their respective latitude and longitude as shown below ,

	Addresses	Latitude	Longitude
0	95 Coker Rd, Coker, Nigeria	6.474863	3.331438
1	2 Ecwa Rd, Coker, Nigeria	6.474987	3.336752
2	11 Abo-Aba Cl, Coker, Nigeria	6.479404	3.328674
3	26 Coker Rd, Surulere, Nigeria	6.479528	3.333988
4	88 Baale St, Orile Iganmu, Nigeria	6.479652	3.339302
5	19 Savage St, Orile Iganmu, Nigeria	6.479776	3.344615
6	31 Jimoh Odutola St, Iganmu, Nigeria	6.479899	3.349929
7	KM2 Lagos - Badagry Expy, Surulere 100242, Nig...	6.480023	3.355243
8	64 Eric Moore Rd, Abulenla, Nigeria	6.480147	3.360557
9	Brewery, Abulenla, Nigeria	6.480270	3.365872

Next , We use the Google Maps Places API to obtain data on nearby venues. We are interested in the names of this location and type for venues that are businesses . The google API refers to business in general as establishments and gives a more detailed (type) for few locations .



The map above gives us a clue of what our analysis will be predicated upon.We hope to be able to reach a conclusion on the most suitable grid location for our mini grid solutions . based on the venues within each grid as well as venues just outside the grid for a more accurate result. So far, We have been able to gather data of 1380 venues , from 69 grids within Surulere, Next is to prepare our data for Processing .

C. Methodology

In this project we will direct our efforts on categorising locations based on the type of venues obtainable in each locale .

In the first step we have collected the required data: location and type (category) of every venue within Surulere as well as the type of venue in each case.

We will present a map of all such locations by creating clusters (using k-means clustering) of those locations to identify the type of neighborhood each falls into.

We will make an attempt to analyse our clusters to understand what is going on within each cluster and more especially why these locations have been grouped together by our unsupervised learning algorithm.

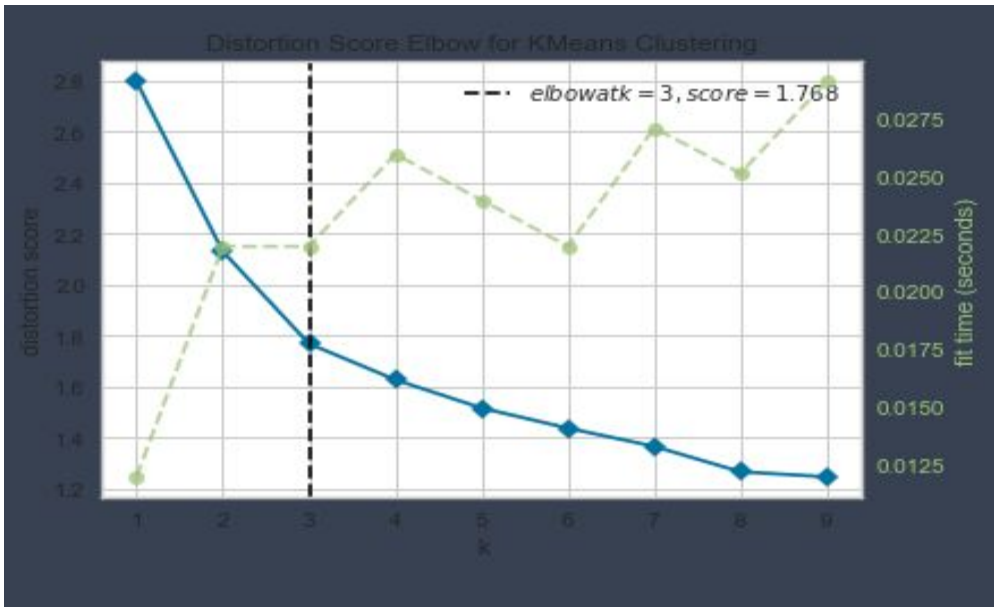
These classification would Therefore make it easier for stakeholders to decide the size and requirements that would be optimal for each location.

C.1 Feature Engineering

We extract the venue type data from our data for processing . It is obvious that we are dealing with categorical variables, this makes it difficult to process, in such case we make use of One_hot_encoding using the pd.get_dummies() function.

We use an unsupervised learning K-means algorithm to cluster the venue types. K-Means algorithm is one of the most common cluster methods of unsupervised learning.

First, we employ the yellow brick module to run an elbow visualizer to determine the optimal number of clusters (k) that best suits the data.

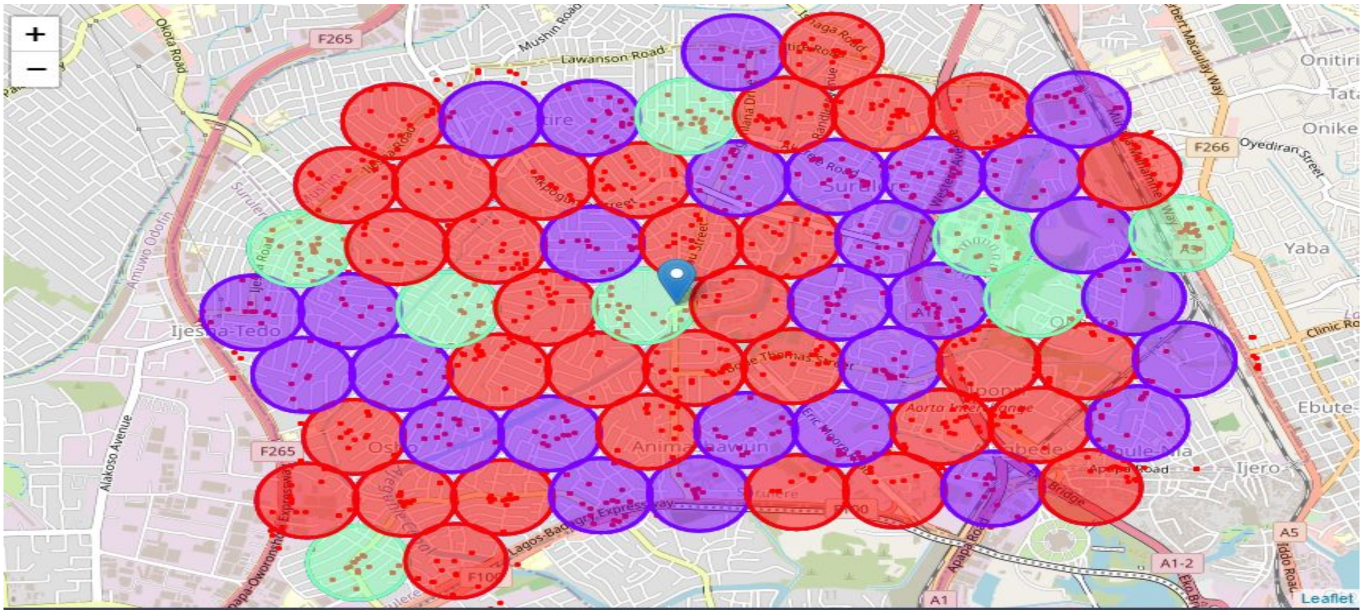


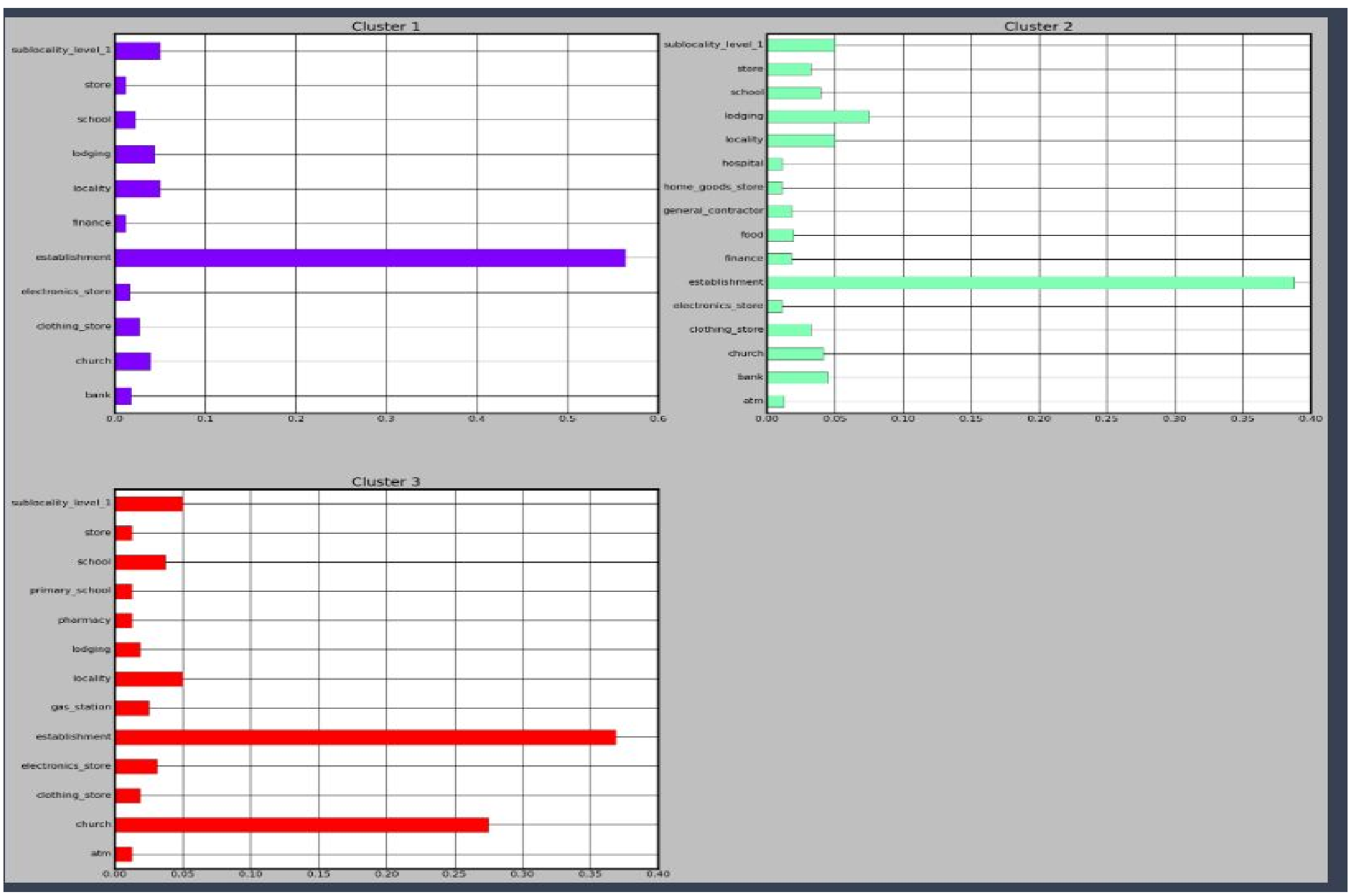
We can see that the optimal number of clusters(k) that would suit the data is three(3)

D. Results

The next step is to indicate each locality's cluster on the map . To give a clear idea of where each locality belongs in one view.

Let's view the distribution of venues within each cluster


F265
Mushin Road
Lawanson Road
Okota Road
Onitiri
Onike
F266
Oyediran Street
Yaba
Ijesha-Tedo
Alakoso Avenue
Ebute-
Ijero
A5
A1-2
A1
Leaflet


Cluster 1
sublocality_level_1
store
school
lodging
locality
finance
establishment
electronics_store
clothing_store
church
bank
0.0 0.1 0.2 0.3 0.4 0.5 0.6
Cluster 2
sublocality_level_1
store
school
lodging
locality
hospital
home_goods_store
general_contractor
food
finance
establishment
electronics_store
clothing_store
church
bank
atm
0.00 0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40
Cluster 3
sublocality_level_1
store
school
primary_school
pharmacy
lodging
locality
gas_station
establishment
electronics_store
clothing_store
church
atm
0.00 0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40

E. Discussions

We have been able to create different category of predicted power consumption per locality using the K-means algorithm to cluster each locality based on the type of venues within and immediately nearby .We are able to achieve this by creating a contiguous circle of radius 300m around surulere , and collecting types of nearby locations within and around each grid to determine the expected power requirements of each locality . This project is definitely important to any stakeholder involved in the distribution of mini grids as a first point of insights into what can be expected on site and therefore plays a large role in decision making of mini grids allocation.

F. Conclusions¶

We are able to reach some conclusions about our clusters from the bar chart and map we have created . Firstly we see that every portion of our clusters have a considerable amount of economical activities with a significant amount of establishments in every cluster.

- Cluster 1 (Purple) - We can see that cluster represents localities with a few establishments . locations within this cluster have the least amount of business and economic activities . Hence localities within this cluster would require the least amount of power.

- Cluster 2(Red) - Localities within this cluster make up most of surulere , having a large amount of Small and Medium scale businesses. as well as the more residential parts of the city . We observe the high amount of churches present

within these clusters , almost rivalling the amount of businesses present .The presence of gas stations and schools also tells us everything we need to know about this region . we can therefore conclude that localities within this cluster would require a more balanced power grid and would likely be more profitable since there seem to be a perfect mix of daytime and nighttime needs.

- Cluster 2(Arctic) - We observe that this cluster represents localities with a high Amount of Large Scale businesses as well as a good proportion of other structures like schools ,hospitals and pharmacies . we can conclude that these regions make up the highbrow part of surulere and would therefore have the highest power requirements.

G. REFERENCES

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