Battle of the Neighborhoods

IDENTIFYING OPTIMAL LOCATIONS TO PLACE TIER 1 AUTOMOTIVE
SUPPLIER COMPANIES IN INDIA

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Introduction and Background

India is the 5th largest economy in the world and India's automotive industry is the fourth largest in the world. The automotive industry in India accounts for 4% of the country's gross domestic product.

With the onset of emerging automotive technologies, there is enormous scope for Tier 1 automotive suppliers to place themselves in India.

This capstone project explores the geographical locations of major automobile manufacturing plants and identifies major industrial areas in India.

Things to know before going ahead

It is important to understand the difference between a manufacturer and a tier 1 supplier in the automotive supply chain before going ahead, so here is a brief.

The following text has been taken from:

https://medium.com/self-driving-cars/the-automotive-supply-chain-explained-d4e74250106f

Manufacturers in the automotive industry

Automotive manufacturers are the brands that everyone knows — Ford and Toyota and BMW and their competitors. These firms are commonly referred to OEMs (original equipment manufacturers), which is an unfortunate misnomer. While these manufacturers produce some original equipment, their real strength is in designing cars, marketing cars, ordering the parts from suppliers, and assembling the final product.

Tier 1 Suppliers in the automotive industry

Companies that supply parts or systems directly to OEMs are called Tier 1 suppliers. Some of these brands are recognizable, like Bosch or Continental. Some of them are less so. Tier 1 suppliers specialize in making "automotive-grade" hardware. This means hardware that withstands the motion, temperature, and longevity demands of OEMs. These suppliers usually work with a variety of vehicle companies.

Business Problem

The problem for this capstone project is to identify the optimal locations for setting up Tier 1 automotive supplier companies in India. We'll find the optimal locations for placing companies that desire to cater to the needs of all types of manufacturing plants.

Depending upon the scope and financial strength of the tier 1 company, we'll answer three questions:

1. If a tier 1 company wants to cater products to all automotive manufacturing plants in India, where should it place itself?

2. If a tier 1 company wants to cater products to automotive manufacturing plants in a large part of India, where should it place itself?

3. If a tier 1 company wants to cater to the automotive manufacturing plants in a small part of India, where should it place itself?

Data and Approach

I will be using the following data-sets for the analysis:

1. List of Industrial centres in India

https://en.wikipedia.org/wiki/List_of_industrial_centres_in_India

2. List of vehicle plants in India

https://en.wikipedia.org/wiki/List_of_vehicle_plants_in_India

Both of these Wikipedia pages will be parsed using the BeautifulSoup library.

3. After parsing, cleaning and plotting this data, I'll cluster the data using K-means clustering algorithm and visualize the clusters.

4. The cluster with the greatest number of manufacturing plants in it will have the highest number of business opportunities, and that cluster's centre will be the most ideal location to start a tier 1 company geographically

5. Since operating a manufacturing company requires industrial resources, I'll use the data from point number 1 and locate the industrial area nearest to the coordinates obtained in point number 4 to come up with the final solution.

PARSING AND CLEANING DATA FOR INDUSTRIAL CENTERS IN INDIA

The parsed data for industrial center looks like this:

	Place	Significance
0	Raipur	Steel, Iron ore, plywood, containers logistics...
1	Rudrapur	Automobile, fmcg, chemical, pharmacuetical,Pre...
2	Bhilai	Iron and Steel, Power generation, cement, chem...
3	Raigarh	Coal, Iron and Steel, Power generation, cement...
4	Navi Mumbai	IT, Textiles, Logistics, MSME

Since quiet of few of the industries shown here won't have much to do with automobiles, I'll keep only those industrial centers in my data-set that contain the either of the words **'auto'**, **'electronic'** and **'electric'**. The following is the cleaned up data-set.

	Place	Significance
1	Rudrapur	AUTOMOBILE, FMCG, CHEMICAL, PHARMACUETICAL,PRE...
5	Vijayawada	AUTO PARTS
13	Jamshedpur	IRON AND STEEL, AUTO PARTS
19	Kharagpur	CHEMICALS, MACHINERY, HEAVY METALS, AUTOMOBILE...
22	Pithampur	AUTO CLUSTER, MEDICINE, COTTON YARN, AUTO TEST...
23	Belagavi	HYDRAULICS, HEAVY TOOLS, AUTOMOTIVE EXPORTS, A...
26	Noida	SOFTWARE, ELECTRONIC COMPONENTS,MOBILE PHONES,...
30	Kanpur	LEATHER, CHEMICAL, FERTILIZERS, IRON AND STEEL...
31	Rajkot	AUTO-COMPONENTS, CASTING AND FORGINGS, JEWELRY...
39	Ahmedabad	AUTOMOBILE, ENGINEERING, PHARMACEUTICAL, CHEMI...
44	Ludhiana	BICYCLE MANUFACTURING, BICYCLE PARTS, METAL FA...
45	Pimpri-Chinchwad	AUTOMOBILE, CARPLANTS, FACTORIES ETC.
46	Mumbai	PETROLEUM, AUTOMOBILES, ELECTRONICS, ENTERTAIN...
52	Sri City	AUTOMOTIVE, CHEMICALS, COSMETICS, PACKAGING ...
55	Nashik	AUTOMOBILE MANUFACTURING, GRAPES EXPORT, PHARM...
57	Hosur	AUTO MOBILES, PLASTICS, CHEMICALS
58	Haridwar	SUGAR MILL, CEMENT, AUTO MOBILES, PHARMACEUTIC...
59	Faridabad	AUTO COMPONENTS
61	Gurugram	AUTOMOBILES, IT, AUTO COMPONENTS
64	Pune	AUTOMOBILES, MANUFACTURING, PHARMACEUTICALS, I...
65	Aurangabad	AUTOMOBILES, MANUFACTURING, PHARMACEUTICALS, C...

PARSING AND CLEANING DATA OF AUTOMOTIVE MANUFACTURING PLANTS IN INDIA

The parsed data from the list of automotive manufacturing plants in India looks like this:

	Location	Manufacturer	Class
0	Sri City	Isuzu Motors India	Passenger & Commercial vehicles
1	Satyavedu	Hero MotoCorp	Two wheelers
2	Vijayawada[1]	Ashok Leyland Limited	Commercial vehicles
3	Sri City	kobelco[2]	Cranes, Excavators & back hoe loaders
4	Penukonda	Kia Motors	Sportage , Picanto, Rio
5	Vijayawada[3]	AVERA New & Renewable Energy	Electric Two Wheelers
6	Kodakachani, Medak District[4]	Deccan Auto	Bus Manufacturing Plant
7	Zahirabad	Mahindra & Mahindra	Commercial vehicles
8	Dharuhera	Hero MotoCorp	Two wheelers
9	Gurgaon	Harley-Davidson India	Two wheelers

As seen, there are undesired brackets which need to be removed. Also there are a variety of classes of manufacturing plants.

Since we are solving the problem for Tier 1 supplier companies that will serve all manufacturing facilities, it really doesn't matter what class the manufacturing plant belongs to. However, just to have a better look, I have classified the plants into four different classes.

The cleaned data-set looks like the following:

	Location	Manufacturer	Class
1	SATYAVEDU	HERO MOTOCORP	TWO WHEELERS
8	DHARUHERA	HERO MOTOCORP	TWO WHEELERS
9	GURGAON	HARLEY-DAVIDSON INDIA	TWO WHEELERS
10	GURGAON	HERO MOTOCORP	TWO WHEELERS
11	FARIDABAD	INDIA YAMAHA MOTOR	TWO WHEELERS
...	...	...	...
115	CHAKAN	FORCE MOTORS	COMMERCIAL VEHICLES
128	NAVI MUMBAI	LIEBHERR	COMMERCIAL VEHICLES
131	CHAKAN	BEIQI FOTON	COMMERCIAL VEHICLES
133	THANE	EICHER MOTORS	COMMERCIAL VEHICLES
3	SRI CITY	KOBELCO	MISC

GEOCODING

The foursquare API does not work very well with locations in rural India. Thus, I have used google maps API for the purpose of geocoding.

The geocoded data looks like this:

	Place	Significance	Latitude	Longitude
1	Rudrapur	AUTOMOBILE, FMCG, CHEMICAL, PHARMACUETICAL,PRE…	28.987508	79.414121
5	Vijayawada	AUTO PARTS	16.506174	80.648015
13	Jamshedpur	IRON AND STEEL, AUTO PARTS	22.804566	86.202875
19	Kharagpur	CHEMICALS, MACHINERY, HEAVY METALS, AUTOMOBILE…	22.346010	87.231975
22	Pithampur	AUTO CLUSTER, MEDICINE, COTTON YARN, AUTO TEST…	22.611121	75.677269
23	Belagavi	HYDRAULICS, HEAVY TOOLS, AUTOMOTIVE EXPORTS, A…	15.849695	74.497674
26	Noida	SOFTWARE, ELECTRONIC COMPONENTS,MOBILE PHONES,…	28.535516	77.391026
30	Kanpur	LEATHER, CHEMICAL, FERTILIZERS, IRON AND STEEL…	26.449923	80.331874

Industrial areas in India

	Location	Manufacturer	Class	Latitude	Longitude
1	SATYAVEDU	HERO MOTOCORP	TWO WHEELERS	13.5244	79.9697
8	DHARUHERA	HERO MOTOCORP	TWO WHEELERS	28.2058	76.7956
9	GURGAON	HARLEY-DAVIDSON INDIA	TWO WHEELERS	28.4323	77.0127
10	GURGAON	HERO MOTOCORP	TWO WHEELERS	28.4656	77.0396
11	FARIDABAD	INDIA YAMAHA MOTOR	TWO WHEELERS	28.3712	77.3132
…	…	…	…	…	…
115	CHAKAN	FORCE MOTORS	COMMERCIAL VEHICLES	18.7422	73.8472
128	NAVI MUMBAI	LIEBHERR	COMMERCIAL VEHICLES	19.0527	73.0079
131	CHAKAN	BEIQI FOTON	COMMERCIAL VEHICLES	18.7632	73.8613
133	THANE	EICHER MOTORS	COMMERCIAL VEHICLES	19.2308	72.9741
3	SRI CITY	KOBELCO	MISC	13.5534	80.0127

100 rows × 5 columns

Automobile Manufacturing Plants in India

EXTRACTING INDUSTRIAL AREA POLYGONS

To obtain industrial area polygons, I have used OpenSteetMap data to manually downloaded the polygon shapes from the following links:

https://nominatim.openstreetmap.org/ and http://polygons.openstreetmap.fr/index.py

Data Visualization

- Two wheeler manufacturing plants
- Passenger vehicle manufacturing plants
- Commercial vehicle manufacturing plants
- Miscellaneous automotive manufacturing plants
- Semi-transparent regions are the identified industrial areas

There are multiple clusters of automotive manufacturing plants near various identified industrial areas.

Methodology

To answer the three questions mentioned in the 'Business problem' section, I have run the K-means clustering algorithm twice.

Let's go through the problems one by one:

1. If a tier 1 company wants to cater products to all automotive manufacturing plants in India, where should it place itself?

The ideal location is the industrial areas nearest to the centroid of all the manufacturing plants in India.
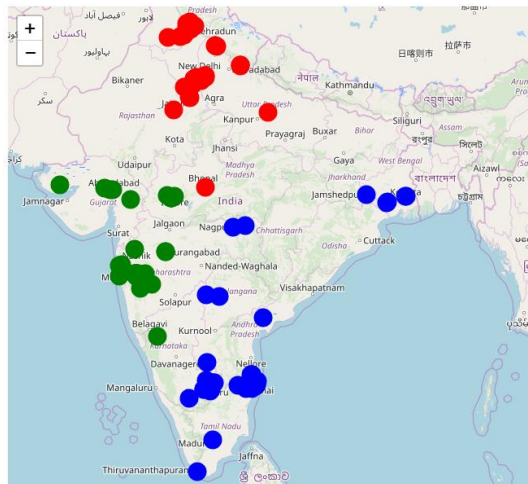
2. If a tier 1 company wants to cater products to automotive manufacturing plants in a large part of India, where should it place itself?

To answer this, I have clustered all manufacturing plants in India into 3 clusters based on their geographical coordinates. The ideal location to place such a company is in the industrial areas nearest to the centroid of the cluster with the most number of companies in it. I have called the three clusters as "**Super-clusters**" in my notebook.
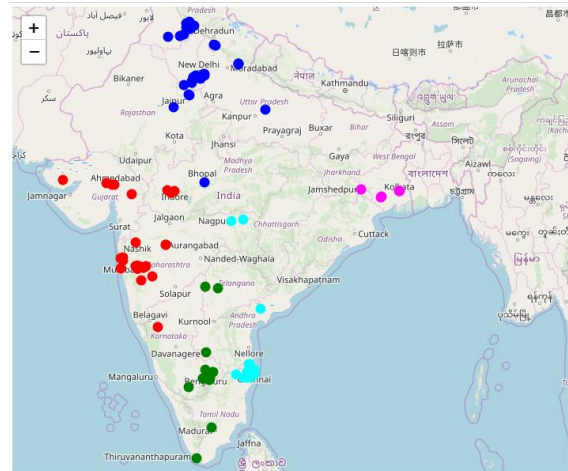
3. If a tier 1 company wants to cater to the automotive manufacturing plants in a small part of India, where should it place itself?

To answer this, I have clustered all manufacturing plants in India into 5 clusters based on their geographical coordinates. The ideal location to place such a company is in the industrial areas nearest to the centroid of the cluster with the most number of companies in it. I have called the three clusters as "**Sub-clusters**" in my notebook.

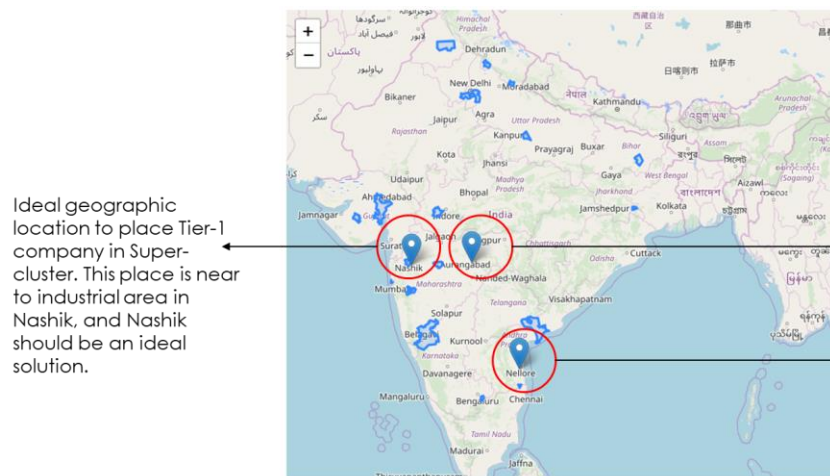# Results: K-means clustering based on geographic coordinates

K=3 (Superclusters)

K=5 (Sub-clusters)

Results: Geometric centers of clusters with most business opportunities

Ideal geographic location to place Tier-1 company in Super-cluster. This place is near to industrial area in Nashik, and Nashik should be an ideal solution.

Ideal geographic location to place Tier-1 company that supplies to all plants in the country. **There is no industrial area nearby.**

Ideal geographic location to place Tier-1 company in Super-cluster. **This place is centrally located between two industrial areas. It will be most suitable to place this in the nearest industrial area.**

Discussion

As explained earlier, the ideal geographic centre is not good enough. Although placing the company at such a location will provide an optimal location for distribution of products, it won't make acquiring resources and workforce easier. Hence, any tier 1 automotive supplier company intending to set-up business in India should establish itself in the industrial area nearest to these coordinates.

Thus, I have evaluated the distances of these coordinates from all industrial areas. Following are the results.

	Place	Significance	Latitude	Longitude	Distance from ideal location at country centre	Distance from ideal location in best super-cluster	Distance from ideal location in best sub-cluster
1	Rudrapur	AUTOMOBILE, FMCG, CHEMICAL, PHARMACUETICAL,PRE...	28.987508	79.414121	1032.911893	1631.625159	1163.004903
5	Vijayawada	AUTO PARTS	16.506174	80.648015	521.859245	255.907108	799.540662
13	Jamshedpur	IRON AND STEEL, AUTO PARTS	22.804566	86.202875	981.393910	1154.013789	1315.208483
19	Kharagpur	CHEMICALS, MACHINERY, HEAVY METALS, AUTOMOBILE...	22.346010	87.231975	1070.166766	1181.419332	1409.537519
22	Pithampur	AUTO CLUSTER, MEDICINE, COTTON YARN, AUTO TEST...	22.611121	75.677269	341.643952	1022.911835	361.713750
23	Belagavi	HYDRAULICS, HEAVY TOOLS, AUTOMOTIVE EXPORTS, A...	15.849695	74.497674	537.587354	603.223890	443.621296
26	Noida	SOFTWARE, ELECTRONIC COMPONENTS,MOBILE PHONES,...	28.535516	77.391026	959.316330	1601.471957	1033.206645
30	Kanpur	LEATHER, CHEMICAL, FERTILIZERS, IRON AND STEEL...	26.449923	80.331874	792.454299	1349.427766	987.953446
31	Rajkot	AUTO-COMPONENTS, CASTING AND FORGINGS, JEWELRY...	22.303894	70.802160	719.941414	1306.142252	427.150392
39	Ahmedabad	AUTOMOBILE, ENGINEERING, PHARMACEUTICAL, CHEMI...	23.022505	72.571362	595.128738	1236.419509	384.747037
44	Ludhiana	BICYCLE MANUFACTURING, BICYCLE PARTS, METAL FA...	30.900965	75.857276	1230.263011	1889.130819	1249.861031
45	Pimpri-Chinchwad	AUTOMOBILE, CARPLANTS, FACTORIES ETC.	18.629781	73.799709	389.328917	806.673818	130.839252
46	Mumbai	PETROLEUM, AUTOMOBILES, ELECTRONICS, ENTERTAIN...	19.075984	72.877656	467.787780	914.684219	136.047277
52	Sri City	AUTOMOTIVE, CHEMICALS, COSMETICS, PACKAGING ...	13.526866	79.980175	767.364324	89.342116	950.253898
55	Nashik	AUTOMOBILE MANUFACTURING, GRAPES EXPORT, PHARM...	19.997453	73.789802	361.905954	904.256898	25.967811
57	Hosur	AUTO MOBILES, PLASTICS, CHEMICALS	12.740913	77.825292	799.976170	284.288519	888.770035
58	Haridwar	SUGAR MILL, CEMENT, AUTO MOBILES, PHARMACEUTIC...	29.945691	78.164248	1119.849703	1746.445734	1206.578640
59	Faridabad	AUTO COMPONENTS	28.408912	77.317789	945.152959	1588.840495	1017.506002
61	Gurugram	AUTOMOBILES, IT, AUTO COMPONENTS	28.459497	77.026638	951.024250	1599.650873	1013.231342
64	Pune	AUTOMOBILES, MANUFACTURING, PHARMACEUTICALS, I...	18.520430	73.856744	388.554444	794.739328	142.531029
65	Aurangabad	AUTOMOBILES, MANUFACTURING, PHARMACEUTICALS, C...	19.876165	75.343314	199.479352	783.876227	148.864127

Conclusion

As seen from the table shown in the discussion section above:

1. The most suitable industrial area to place a tier-1 automotive supplier company that delivers to all types of automotive manufacturing facilities in India is in Aurangabad.

2. The most suitable industrial area to place a tier-1 automotive supplier company that delivers to manufacturing facilities in an entire region is in Sri City in South India.

3. The most suitable industrial area to place a tier-1 automotive supplier company delivers to manufacturing facilities in a local (relatively smaller) region is in Nashik.

That concludes the solution of the mentioned business problem.