Planning Dockless e-Bike Sharing Service for Chennai:
Segmenting and Clustering Neighbourhoods

1 Introduction to Chennai City Transportation Systems

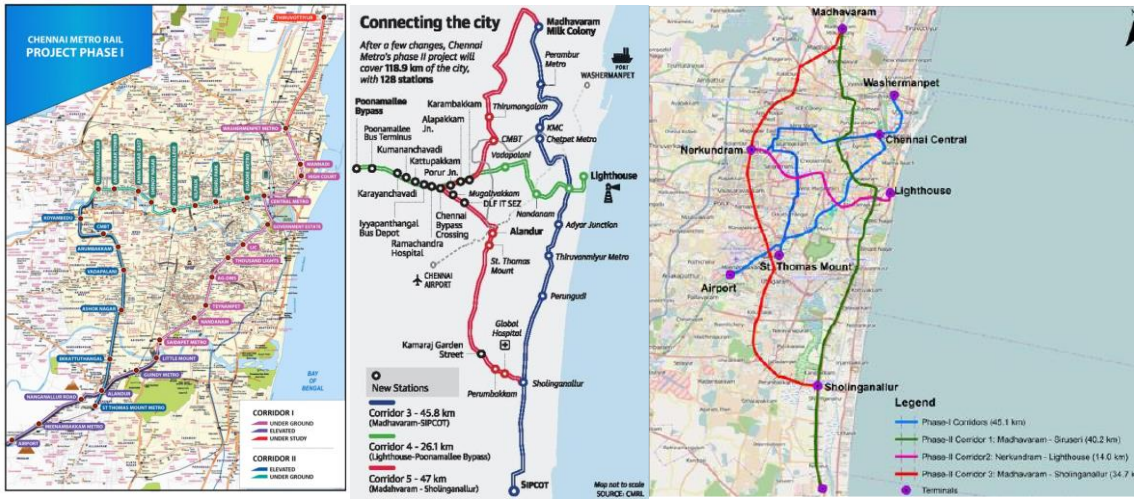
The metropolitan city of Chennai (capital of Tamilnadu state, India) with a population of more than 10 million, is the 4th most populous metro in India, 22nd in Asia and 40th in the world. Chennai metropolitan area (also referred to as Greater Chennai Corporation) is spread across 426 sq. kms. To address increasing needs of urban transportation within the city, several modes of public transportation systems are currently in operation:

- Chennai metro bus network with a fleet of about 4000 buses operating across 1000 routes criss-crossing the city, serving more than 5 million commuters per day.
- Chennai sub-urban rail network with more than 1000+ services every day and serving more than 1 million commuters per day.
- Chennai mass-rapid-transit train network serving more than 100K commuters every day.

Besides these public transportation systems, there are several privately-operated services comprising of 4-wheeler (call-taxis, cabs, share-autos) and 3-wheelers (autos) serving more than 10% of the requirement of population, either for end-to-end commute or for purpose of first-and-last-mile connectivity to above mentioned public transportation services.

2 Chennai Metro Rail System

One of the biggest concerns of these transportation systems is ever-increasing levels of pollution across the city. To holistically address this concern, government had planned for overhauling of urban transportation system, through Chennai metro trail network. Chennai metro phase-I project was commenced in 2010 and the staggered-rollout of the service commenced from 2015. Phase-II project has commenced in 2020 and staggered-rollout of the service is expected from 2026.



Map-1: Chennai Metro Phase-I; Map-2: Chennai Metro Phase-II; and Map-3: Combined Map
(src: https://chennaimetrorail.org/)

- Phase-I: 45 Kms, 32 Stations, Launched in 2019, Average Commuters/Day: 1 Lakh
- Phase-2: 120 Kms, 100 Stations, expected to be launched by 2026. Expected Commuters/Day: 20 Lakh/Day

3 Business Problem Description (Need for e-Bike Sharing Service)

While this large network of electric metro train network (100+ stations spanning 150+ KMs) has well addressed the pollution concern of the city, it has opened another concern viz. last-mile connectivity to/from these 100+ locations (metro stations). All the current modes of last-mile connectivity are fossil-fuel-based modes (2/3/4-wheelers, privately-owned/operated).

To overhaul this last-mile connectivity based on green-modes, government is planning for dedicated cycle/e-bike tracks along the city roads. This initiative has created interest in mobility service providers to plan for rolling out e-bike services across the city.

Key business problem to be solved for these prospective e-bike service provides is to identify zones/locations within the city to profitably-deploy this e-bike based shared mobility service, and thereby enabling switch-over the last-mile connectivity to green-mode of transportation.

4 Data Required for Analysis

Data required for solving this business problem (segmenting and identification of potentially profitable locations within the city) needs to be fetched from several sources, as listed below:

- **Metro station data:** List of metro stations and estimated commuters boarding and alighting at each station can be fetched from the official portal of Chennai Metro Rail Limited (CMRL; https://chennaimetrorail.org/)

- **Venues and venue categories data:** Exploring neighbourhood around each metro station for most common/popular venues and their categorization would help analyse commuting needs/patterns. This would in turn help segmenting the locations into potentially profitable locations for operating e-bike shared mobility service (as last-mile connectivity solution) between stations and these venues. Foursquare API-based data access would help fetch this data.

    - Searching for specific venue categories:
      https://api.foursquare.com/v2/venues/search?client_id=CLIENT_ID&client_secret=CLIENT_SECRET&ll=LATITUDE,LONGITUDE&v=VERSION&query=QUERY&radius=RADIUS&limit=LIMIT

    - Exploring specific locations:
      https://api.foursquare.com/v2/venues/explore?client_id=CLIENT_ID&client_secret=CLIENT_SECRET&ll=LATITUDE,LONGITUDE&v=VERSION&limit=LIMIT

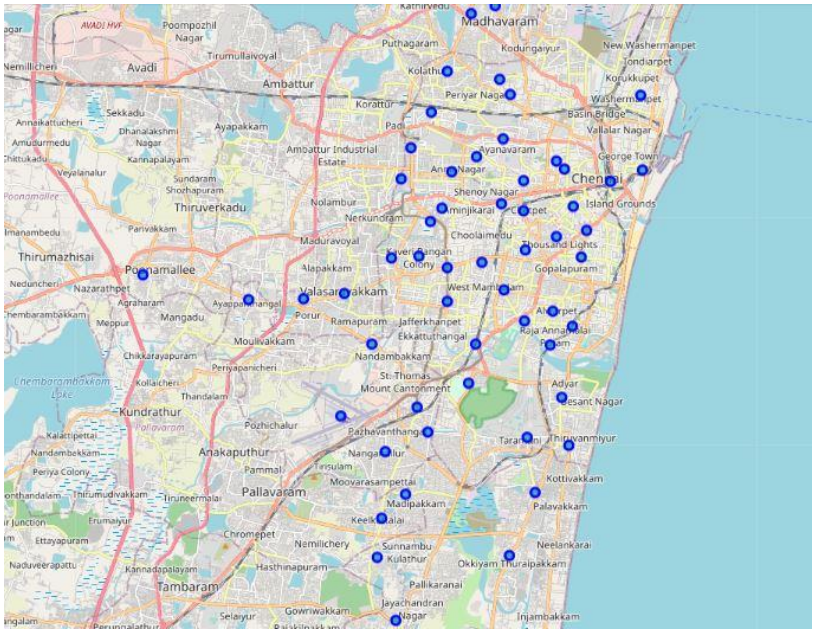
- **PinCode data:** Distance between two adjacent stations for most of the metro stations are less than 1 km. We can choose to explore neighbourhoods around stations with a radius for 1 Km, as e-bike services are generally convenient for these short distance rides. Therefore, we can prune the list of stations by considering one station per pin-code.

5 Annexure (Dataset)

A list of 59 metro stations considered for this analysis is tabulated here:

S. No.	PostalCode	Neighborhood	Latitude	Longitude	S. No.	PostalCode	Neighborhood	Latitude	Longitude
1	600102	Anna Nagar East	13.092	80.2236	31	600004	Mandaveli	13.0279	80.2605
2	600040	Anna Nagar Tower	13.0863	80.2138	32	600028	Greenways Road	13.0208	80.252
3	600016	Alandur	12.9975	80.2006	33	600020	Adyar	13.0012	80.2565
4	600106	Arumbakkam	13.0724	80.2102	34	600041	Thiruvanmiyur	12.983	80.2594
5	600083	Ashok Nagar	13.0373	80.2123	35	600113	Taramani Link Road	12.9863	80.2432
6	600027	Chennai Airport	12.9941	80.1709	36	600096	Perungudi	12.9654	80.2461
7	600008	Egmore	13.0732	80.2609	37	600097	Thoraipakkam	12.9416	80.2362
8	600032	Guindy	13.0067	80.2206	38	600119	Sholinganallur	12.901	80.2279
9	600002	LIC	13.0642	80.266	39	600130	Navalur	12.8459	80.2265
10	600104	High Court	13.0867	80.2877	40	603103	Siruseri	12.8352	80.2011
11	600010	Kilpauk	13.0828	80.2417	41	600018	Alwarpet	13.0335	80.2531
12	600107	CMBT	13.0675	80.2056	42	600017	T. Nagar	13.0418	80.2341
13	600015	Saidapet	13.0213	80.2231	43	600024	Kodambakkam	13.0521	80.2255
14	600035	Nandanam	13.03	80.2421	44	600093	Saligramam	13.0545	80.2011
15	600061	Nanganallur	12.9807	80.1882	45	600087	Valasaravakkam	13.0403	80.1723
16	600030	Pachaiyappas College	13.0741	80.2332	46	600116	Porur	13.0382	80.1565
17	600003	Central Station	13.0825	80.2755	47	600056	Iyyapanthangal	13.0381	80.1354
18	600050	Thirumangalam	13.0835	80.1945	48	600123	Poonamallee	13.0473	80.0945
19	600006	Thousand Lights	13.0617	80.2544	49	600060	MMBT	13.1456	80.2215
20	600026	Vadapalani	13.05	80.2121	50	600099	Kolathur	13.124	80.2121
21	600021	Washermanpet	13.1148	80.2872	51	600049	Villivakkam	13.1086	80.2061
22	600051	Madhavaram	13.1488	80.2306	52	600101	Anna Nagar Depot	13.0952	80.1981
23	600011	Sembiyan	13.1154	80.2367	53	600092	Elango Nagar	13.0537	80.1906
24	600012	Perambur	13.121	80.2326	54	600089	Manapakkam	13.0213	80.1832
25	600023	Ayanavaram	13.0986	80.2337	55	600088	Adambakkam	12.988	80.2047
26	600007	Doveton	13.0872	80.2575	56	600091	Madipakkam	12.9647	80.1961
27	600084	Purasaiwakkam	13.0902	80.2543	57	600117	Kilkattalai	12.9556	80.1869
28	600031	Chetpet	13.0714	80.2417	58	600129	Kovilambakkam	12.9409	80.1851
29	600034	Nungambakkam	13.0569	80.2425	59	600100	Medavakkam	12.9171	80.1923
30	600014	Royapettah	13.054	80.2641					

These 59 stations are shown on the Chennai city map as depicted below:



With this dataset as the starting point, we propose to carry out exploratory analysis and then use k-means clustering method to segment these neighbourhoods and identify a sub-set of stations/locations that are potentially profitable for rolling out e-bike shared mobility service, as a solution to the last-mile connectivity problem.