# MGT 6203 Group Project Proposal – Team # 30

**Toronto EV Charging Network Expansion: A Sustainable Urban Mobility Initiative**

## TEAM INFORMATION (1 point)

**Team Members:**

1. Jacob M Liu; jliu3124

   Background: I am currently working at Walmart as a Senior Store Performance Analyst. My previous experience was at Insight Global, as a lead sales analyst intern during my senior year at Georgia State University, where I received my Bachelor of Business Administration (BBA) in Marketing and Computer Information Systems, with a specialization in Data Analytics. Previous analytics projects include developing machine learning models to predict bank churn rates and developing dashboards for small to medium firms through Upwork freelancing.

2. Hecheng Wang; hwang3002
   Background: Currently working full time as Engineering Manager in Automotive Electronics Manufacturing. Bachelor of Electrical and Computer Engineering from the University of Toronto. Previous analytics related projects include Machine Capability Study, Measurement System Analysis from work, and Medical Image Segmentation from another OMSA course project.

3. Aayushi J Patel; apatel3052
   Background: Worked as a Data Analyst at SCC Infotech LLP. Completed Bachelor of Information Technology from P P Savani University, India. Previous analytics projects include Superstore Dataset Analysis using Python, NYC Airbnb Data Visualization in Tableau and Gesture and Emotion Detection Application using Python and Java.

4. Supranee Saringkarnpoonperm; ssaringk3
   Background: Worked as VP Sourcing and Supply Chain Management for Home Improvement Retailer in Malaysia. Bachelor and Master of Electrical Engineer from Chulalongkorn University, Thailand and been working in Telecoms around the globe until 2013 before switching to Supply Chain Management. Previous analytics work in the retails' supply chain management such as inventory management, supply chain network, distribution center planning, etc.

## OBJECTIVE/PROBLEM (5 points)

**Project Title:** Toronto EV Charging Network Expansion: A Sustainable Urban Mobility Initiative

**Background Information on chosen project topic:**

The global electric vehicle market is growing rapidly, with increasing demand for charging infrastructure. City planners are integrating EV charging into urban infrastructure to support sustainable transportation. Allocating space for EV charging on street parking requires balancing the needs of EV drivers, other vehicles, pedestrians, and the budget constraint of the city.

**Toronto Parking Authority's EV Charging Network**

The Toronto Parking Authority (TPA) is leading North America's EV transition with plans for a city-wide EV charging network. They have installed eight Level 2 chargers in a downtown parking facility, with more to come. Supporting Toronto's Net Zero strategy, TPA aims for 30% of registered vehicles to be electric by 2030. They will manage 47 on-street chargers from a 2020 pilot project and plan to use almost 100 more on-street and 300 off-street chargers by 2023. By 2025, TPA expects 650+ chargers, offering simplicity, speed, and choice for EV owners. They also plan to set up more electric Bike Share stations. [1]

**Problem Statement (clear and concise statement explaining purpose of your analysis and investigation):**

The objective is to determine the order of street parking conversion to EV charging stations considering factors such as parking utilization, needs of EV drivers, accessibility, the potential community benefits and maximize the effectiveness of the budget.

**State your Primary Research Question (RQ):**

How to prioritize the conversion of street parking to EV charging stations?

**Add some possible Supporting Research Questions (2-4 RQs that support problem statement):**

1. What is the traffic volume and mode of transportation on the streets of Toronto?
2. What are the typical parking utilization rate and peak usage times for these public street parking spaces?
3. How does proximity to amenities, such as shopping centers, restaurants, and public transportation, influence the suitability of public parking spaces for EV charging station conversion?
4. What are the best data analysis models to be used?

**Business Justification: (Why is this problem interesting to solve from a business viewpoint? Try to quantify the financial, marketing or operational aspects and implications of this problem, as if you were running a company, non-profit organization, city or government that is encountering this problem.)**

"Benchmarks set by the International Energy Association (IEA) suggests the minimum acceptable ratio of EVs to charging stations is about 10 EVs for every 1 charging station." [2] As the current EV/HPEV adoption is still low in most places, the ratio of EVs to charging station may seem sufficient. However, as the adoption increases,

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[1] Toronto Parking Authority launches its own EV charging network (electricautonomy.ca)

[2] https://storymaps.arcgis.com/stories/d17375a971cd42b79f32cea160868e88

more charging stations are required. In addition, one of the hinders to higher adoption is the ‘range anxiety’ which requires more charging infrastructure investment.

Norway, the highest adoption with recorded nearly 80% of new car sold in 2022 were ZEV (Zero Emission Vehicle), have implemented several policies including subsidizing the construction of charging station to encourage consumers[3]. As a lot of cities like Toronto are looking into similar policies, the ability to prioritize the area of construction will i) ease consumer on the ‘range anxiety’, ii) increase the adoption of zero emission vehicles as well as iii) ensure the efficiency of budget use in building such infrastructure.

# DATASET/PLAN FOR DATA (4 points)

**Data Sources**:

| Dataset Name | Link |
|---|---|
| Green P Parking Location | https://open.toronto.ca/dataset/green-p-parking/ |
| Traffic Volume | https://open.toronto.ca/dataset/traffic-volumes-at-intersections-for-all-modes/ |
| Intersection Location: | https://open.toronto.ca/dataset/intersection-file-city-of-toronto/ |
| Business License and customer visit duration (Simulated) | https://open.toronto.ca/dataset/municipal-licensing-and-standards-business-licences-and-permits/ |

**Data Description (describe each of your data sources, include screenshots of a few rows of data):**

The data source consists of multiple sets of data which can be combined and correlated to create a master database for our project. First, the traffic volume dataset spans multiple decades within the city of Toronto up from 1980 to 2023 in a csv format. The record is collected in the form of TMCs (Turning Movement Counts) that indicates the specific intersection volume observed across the city, segmented by direction, transportation mode etc. A sample raw data looks like follows, in addition metadata about the counting location and the TMC data itself are also included in the dataset.

| A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | C |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| _id | count_id | count_date | location_id | location | lng | lat | centreline_type | centreline_id | px | time_start | time_end | sb_cars_r | sb_cars_t | sb_cars_l | nb_cars_r | nb_ca |
| 1 | 39337 | 2020-01-08 | 13060 | BROADVIEW AVE AT ERINDALE AVE | -79.35865235 | 43.67752083 | 2 | 13462138 | | 2020-01-08T07:30:00 | 2020-01-08T07:45:00 | 0 | 121 | 5 | 2 | |
| 2 | 39337 | 2020-01-08 | 13060 | BROADVIEW AVE AT ERINDALE AVE | -79.35865235 | 43.67752083 | 2 | 13462138 | | 2020-01-08T07:45:00 | 2020-01-08T08:00:00 | 0 | 117 | 2 | 2 | |
| 3 | 39337 | 2020-01-08 | 13060 | BROADVIEW AVE AT ERINDALE AVE | -79.35865235 | 43.67752083 | 2 | 13462138 | | 2020-01-08T08:00:00 | 2020-01-08T08:15:00 | 0 | 132 | 4 | 2 | |

Second, the Green P parking dataset specifies the current location of all available parking locations operated by Toronto Parking Authority. The on-street parking locations will be of our interest and the location data is key in our analysis choosing the potential EV charging stations out of the existing parking spots. The data is in JSON format, which includes information such as parking location type, payment info, location coordinates, etc. A snippet of the raw JSON file looks like follows:


```
1  {"carparks":[{"id":"1","slug":"https:\/\/parking.greenp.com\/carpark\/1_20-charles-street-east\/","address":"20 Charles Street East","lat":"43.669282202140174",
"lng":"-79.3852894625656","rate":"$2.50 \/ Half Hour","carpark_type":"garage","carpark_type_str":"Garage","is_ttc":false,"is_under_construction":false,
"changing_rates":false,"rate_half_hour":"2.50 ","capacity":"641","max_height":"2.00","bike_racks":"available","payment_methods":["Bills","Coins","Charge (Visa \/
Mastercard \/ American Express Only)","GreenP Express (Fast Track Card)"],"payment_options":["Auto Express Pay Stations","Credit Card at Entry & Exit","Pay at
Entrance Lane Stations"],"rate_details":{"periods":[{"title":"Monday - Sunday & Holidays","rates":[{"when":"Day Maximum (7am - 6pm)","rate":"$14.00"},
```


[3] In Norway, the Electric Vehicle Future Has Already Arrived - The New York Times (nytimes.com)

Furthermore, a GeoJASON file of all Toronto intersection and street centerline dataset is available for our analysis.


```
{ "type": "Feature", "properties": { "_id": 1, "INTERSECTION_ID": 13470264, "DATE_EFFECTIVE": "", "DATE_EXPIRY": "", "ELEVATION_ID": 13, "INTERSECTION_DESC": "Robindale Ave \/ Rimilton Ave", "CLASSIFICATION": "MNRSL", "CLASSIFICATION_DESC": "
{ "type": "Feature", "properties": { "_id": 2, "INTERSECTION_ID": 13470193, "DATE_EFFECTIVE": "", "DATE_EXPIRY": "", "ELEVATION_ID": 4718, "INTERSECTION_DESC": "Bellman Ave \/ Valermo Dr", "CLASSIFICATION": "MNRSL", "CLASSIFICATION_DESC": "
{ "type": "Feature", "properties": { "_id": 3, "INTERSECTION_ID": 13470188, "DATE_EFFECTIVE": "", "DATE_EXPIRY": "", "ELEVATION_ID": 32728, "INTERSECTION_DESC": "Rimilton Ave \/ Valermo Dr", "CLASSIFICATION": "SEUSL", "CLASSIFICATION_DESC": "
```


Finally, the business license dataset contains information on commercial business ventures that operate in the city of Toronto, such as restrictions, address, name, etc. However, information such as customer volume and visit duration will need to be simulated and added to this dataset for our analysis. For example, a record with simulated information added in would appear like follows:

| _id | sim_Daily Customer Volume | sim_avg_visit duration | Category | Licence No. | Operating Name | Issued | Client Name | Business Phone | Business Phone Ext. | Licence Address Line 1 | Licence Address Line 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 146 | 3.77 | PRIVATE TRANSPORTATION COMPANY | B02-4741962 | TAXIFY | 2018-01-18 | TAXIFY CANADA INC | | | 35 OAK ST, #304 | TORONTO, ON |
| 2 | 67 | 2.82 | PRIVATE TRANSPORTATION COMPANY | B02-4728645 | INSTARYDE | 2017-09-08 | INSTARYDE INC | | | 425 ALNESS ST | TORONTO, ON |
| 3 | 173 | 5.84 | PRIVATE TRANSPORTATION COMPANY | B02-4807677 | DRIVEHER TRANSPORTATION | 2018-03-08 | DRIVEHER TRANSPORTATION INC | | | 100 DUNDAS ST E, #502 | MISSISSAUGA, ON |

**Key Variables: (which ones will be considered independent and dependent? Are you going to create new variables? What variables do you hypothesize beforehand to be most important?)**

Once all data sources have been combined, the independent variables include location (e.g., lat, lng), traffic counts (e.g., sb_cars_t), customer volume ( sim_Daily Customer Volume), customer visit duration ( sim_avg-visit duration), business type, transport mode, etc. And dependent variable would be the parking spot locations which would be ranked according to the data model and analysis that we will perform. We anticipate certain new variables (dummy variables) may need to be created to analyze categorical variables and/or interactions between variables. We hypothesize the traffic volume and customer visit duration will be most important in determining the priority charging stations. At the same time, we anticipate other assumptions such as EV adoption rate. Charging speed will have a significant impact on analysis conclusions as well.

## APPROACH/METHODOLOGY (8 points)

**Planned Approach (In paragraph(s), describe the approach you will take and what are the models you will try to use? Mention any data transformations that would need to happen. How do you plan to compare your models? How do you plan to train and optimize your model hyper-parameters?))**

We will first clean and convert our data into a generic format and combine them into data frames as needed for our modelling. We can then model potential future EV demand based on historical traffic volume data and a time series forecasting analysis. A k-means clustering model would then help determine the optimal streets that an EV charging station should be located in. Following that, we could use multiple regression model and the data in business type, customer visit duration, etc. to determine the best possible parking location to convert into EV charging stations.

To train and optimize our models, we will first need to develop assumptions of the type of parking lots that could benefit in having EV charging stations and EV adoption rate for the future to predict EV charging demand. We will then build our models on the existing data and split the data set into training, validation, and testing sets to check our performance. Once we are satisfied with the model performance, we will use it to predict the result of our analysis.

For example, we can split the traffic volume data based on the dates into training, validate and test sets (65-20-15 split). A time series model can be trained using the training data set, validated using the validation set and tested in the test set. Afterwards, we can use it to predict future traffic and infer potential future EV demand. Similar approaches can be used for building other models.

**Anticipated Conclusions/Hypothesis (what results do you expect, how will you approach lead you to determining the final conclusion of your analysis) Note: At the end of the project, you do not have to be correct or have acceptable accuracy, the purpose is to walk us through an analysis that gives the reader insight into the conclusion regarding your objective/problem statement**

Hypothesis: The street with high traffic volume in surrounding area will be of high priority. And Parking spots near high traffic business locations should be converted first.

In our approach, we will determine the number of cars parked on certain streets/area based on traffic flow time series analysis and use clustering on business type and customer information to determine street priority.

**What business decisions will be impacted by the results of your analysis? What could be some benefits?**

By using the predictive analysis on the predicted number of EV/HPEV parking on a street, we could suggest which area/street will be prioritized to put the EV charging stations and further plan the phase of the implementation. As result, cities could plan the implementation of project and budgeting efficiently while achieving the zero emission vehicles target effectively.

## PROJECT TIMELINE/PLANNING (2 points)

| | |
|---|---|
| Feb 16 | Project team meeting / Finalize project topic and scoping |
| Feb 23 | Project team meeting / Review proposal before submission and work distribution |
| **Feb 25** | **Project Proposal report due date** |
| Mar 1 | Project team meeting / Dataset cleansing |
| Mar 8 | Project team meeting / First draft: Hypothesis Test |
| Mar 15 | Project team meeting / Second draft: Hypothesis Test with Predictive Model |
| **Mar 17** | **Project Progress report due date** |
| Mar 22 | Project team meeting/ Third draft: Predictive Model Tuning I |
| Mar 29 | Project team meeting/ Forth draft: Predictive Model Tuning II |
| April 5 | Project team meeting / Review result and fine tuning |
| April 12 | Project team meeting / Review final result |
| April 19 | Project team meeting / Finalize report |
| **April 21** | **Final project due date** |