SCHOOL OF COMPUTING
Faculty of Engineering

Project Proposal Form MCST1043
Sem: 2 Session: 2024/25

SECTION A: Project Information.

Program Name:	**Masters of Science (Data Science)**
Subject Name:	**Project 1 (MCST1043)**
Student Name:	ZHANG LONG
Metric Number:	MCS241034
Student Email & Phone:	zhanglong@graduate.utm.my
Project Title:	A Data-Driven Analysis of Low State-of-Charge Charging Behavior in Electric Vehicles
Supervisor 1:	
Supervisor 2 / Industry Advisor(if any):	

SECTION B: Project Proposal

Introduction:

Electric vehicles (EVs) are central to future urban mobility and affordable power systems. However, managing their charging behavior remains a practical challenge, especially in understanding when drivers continue to drive their vehicles at very low battery levels. This behavior is called low charge state (SOC) trips and may reflect fundamental issues such as range anxiety, insufficient charging infrastructure or irregular usage patterns.

This project aims to conduct a data-driven analysis of electric vehicle driving and charging behavior under low SOC conditions using a large-scale public dataset. By focusing on descriptive analysis, the study aims to reveal temporal and behavioral trends to inform future EV power management and user decision support systems.

Problem Background:

While most research on EV energy behavior has focused on route planning or charging station recommendations, there has been limited empirical attention to the specifics of drivers driving with batteries below 20% SOC. Such low SOC driving can pose operational risks and is often considered a precursor to emergency charging, but its actual occurrence, distribution, and consequences have not been fully explored in open datasets.

Given the increasing density of electric vehicles in urban environments, determining when low SOC driving occurs, the frequency of charging, and environmental factors is critical for infrastructure providers and vehicle management systems.

Zhao et al. (2022), in their study "Charging-Related State Prediction for Electric Vehicles Using the Deep Learning Model", reported that among multiple driving states, the prediction accuracy for low-SOC travel was the lowest, at just

38.4%, suggesting this type of behavior is highly irregular and poorly understood.

Problem Statement:

There is no detailed analysis of patterns of low-SOC electric vehicle usage, such as how often this travel occurs, when during the day it occurs, and whether or not it results in immediate charging. Without such analysis it is possible that charging behavior models and policies for charging infrastructure are not capturing important edge cases.

Aim of the Project:

This work aims to analyze and visualize real-world EV charging and driving patterns when the battery is in low range, with an aim to discover temporal and behavioral characteristics of low-SOC usage events.

Objectives of the Project:

1. Define and extract instances of EV travel sessions initiated or sustained at SOC levels below 20%.
2. Analysis the distribution of low-SOC by time of day and by day of week.
3. Compare characteristics of travel sessions (such as energy drawn) between low-SOC and normal-SOC cases.
4. Determine whether low-SOC travel sessions are more likely to transition into charging sessions, and if so, what the typical delay is before such a transition takes place.
5. Visualize the results and interpret the implications for the development of user support systems for EVs.

Scopes of the Project:

- This project focuses entirely on descriptive analysis and comparison based on real data.

- No new prediction models will be built; only statistical and visualization techniques will be used.

- The research will study the heading of EVs during the degradation phase using time, energy, and SOC related characteristics.

- The analysis will be limited to the UrbanEV dataset, which covers public EV hacking activities by thousands of hackers over a six-month period.

Expected Contribution of the Project:

- Underpinning empirical insights regarding frequency and nature of low-SOC charging behavior.

- Uncovering common temporal patterns or delay windows that precede or follow low-SOC usage.

- Visual evidence to support decision making for EV infrastructure providers and energy policy designers.

- Directions for future model-based behavior prediction research.

Project Requirements:

Software:	Python, pandas, matplotlib/seaborn, PyCharm
Hardware:	Personal laptop or Google Cload
Technology/Technique/ Methodology/Algorithm:	Data cleaning and labeling (SOC thresholds) Visualization (histograms, heatmaps, boxplots)

Type of Project (Focusing on Data Science):

[✓] Data Preparation and Modeling

[✓] Data Analysis and Visualization

[ ] Business Intelligence and Analytics

[ ] Machine Learning and Prediction

[ ] Data Science Application in Business Domain

Status of Project:

[✓] New

[ ] Continued

If continued, what is the previous title?

SECTION C: Declaration

I declare that this project is proposed by:

[√] Myself

[ ] Supervisor/Industry Advisor ( )

Student Name: ZHANG LONG

April 17, 2025

Signature **Date**

SECTION D: Supervisor Acknowledgement

The Supervisor(s) shall complete this section.

I/We agree to become the supervisor(s) for this student under aforesaid proposed title.

Name of Supervisor 1:

Signature **Date**

Name of Supervisor 2 (if any):

Signature **Date**

SECTION E: Evaluation Panel Approval

The Evaluator(s) shall complete this section.

Result:

[ ] FULL APPROVAL [ ] CONDITIONAL APPROVAL (Major)*

[ ] CONDITIONAL APPROVAL (Minor) [ ] FAIL*

***** Student has to submit new proposal form considering the evaluators' comments.

Comments:

Name of Evaluator 1:

Signature **Date**

Name of Evaluator 2:

Signature **Date**