Electrifying Urban Mobility: An Analysis of EV Impact on Daily Travel Patterns

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1 Introduction

The adoption of electric vehicles (EVs) is a pivotal step toward reducing urban carbon emissions and fostering sustainable transportation. EVs offer environmental benefits by decreasing reliance on fossil fuels, but they also introduce challenges related to limited driving range, charging times, and infrastructure availability. These factors can influence users' daily mobility patterns, making it essential to understand and address potential impacts on individual travel behavior.

In our previous work, "From Fossil Fuel to Electricity: Studying the Impact of EVs on the Daily Mobility Life of Users," [2] we developed a methodology to assess how transitioning from fossil fuel-powered vehicles to EVs affects users' mobility. We utilized a large dataset of real GPS trajectories to model users' travel behaviors over time. By constructing Individual Mobility Networks (IMNs) [1], we identified key locations such as home and work, which are crucial for understanding charging opportunities and mobility habits.

Our simulation framework integrated enriched road network data, including elevation information and estimated battery consumption for each road segment. This allowed us to accurately model the energy requirements for trips and to consider the availability of charging stations along routes. We incorporated battery constraints and simulated both active charging at public stations and passive charging at home or work locations.

The results of our study indicated that, collectively, the switch to EVs would result in moderate impacts on overall mobility, such as slight increases in travel distance due to routing to charging stations. However, on an individual level, users might experience significant adjustments in their travel and charging behaviors. Some users could face challenges related to range limitations or charging accessibility, highlighting the importance of personalized analyses.

2 Current Research Focus

Building on the foundation of our previous study, we are now investigating how integrating carpooling and shared mobility services can enhance EV efficiency and sustainability. This work in progress aims to explore whether combining EV adoption with shared mobility strategies can mitigate some of the inherent challenges of EVs, such as limited range and charging infrastructure demands.

Our approach involves analyzing the existing trajectory data to identify potential opportunities for carpooling. By detecting spatial and temporal overlaps in users' trips, we can simulate shared journeys within our framework. Adjustments to our trip planning heuristics will account for multiple passengers and possible deviations for pick-ups and drop-offs.

3 Presentation Structure

In the presentation, I will discuss how IMNs are used to model human mobility behavior and identify significant locations. I will provide an overview of our previous work on the impact of EV adoption on daily mobility and introduce our current research on the effects of carpooling and shared mobility on EV efficiency. Additionally, I will present preliminary results and discuss their potential implications for sustainable urban transportation.

References

[1] Omid Isfahani Alamdari, Mirco Nanni, and Agnese Bonavita. On the pursuit of graph embedding strategies for individual mobility networks. In *2023 IEEE International Conference on Big Data (BigData)*, pages 4382–4391, 2023.

[2] Mirco Nanni, Omid Isfahani Alamdari, Agnese Bonavita, and Paolo Cintia. From fossil fuel to electricity: Studying the impact of evs on the daily mobility life of users. *IEEE Transactions on Intelligent Transportation Systems*, 25(6):5780–5790, 2024.