**Title:** Optimizing Electric Vehicle Charging Infrastructure through Predictive Analytics and Usage Pattern Analysis

**Background**

The transition towards electric vehicles is a pivotal component of global efforts to reduce carbon emissions and combat climate change (Erdélyi, 2024). As EVs become more prevalent, the demand for effective and efficient charging infrastructure grows (Apurvkumar Desai, 2023). Workplace charging stations represent a significant part of this ecosystem, providing essential charging opportunities for daily commuters. Studying how these facilities are used can lead to improvements in station design, placement, and management, enhancing the overall efficiency of the network and supporting broader adoption of EVs.

This project delves into the critical area of optimizing electric vehicle (EV) charging infrastructure at workplace locations. With the surge in EV adoption, efficiently managing charging resources has become essential to ensure accessibility and convenience for EV drivers (Muhammad Shahid Mastoi a, 2022).

**Research Questions:**

* How do specific characteristics of electric vehicle (EV) drivers (e.g., frequency of use, preferred stations) correlate with charging station choice and occupancy times at workplace locations?
* Can we identify peak usage hours for charging stations and predict future trends in station occupancy using time series analysis?
* Using cluster analysis, can we categorize charging stations based on usage patterns and driver interactions to optimize resource distribution?
* What machine learning model best predicts the availability of charging stations at any given time, and what features are most influential in these predictions?

**Objectives:**

* Analyze driver-specific patterns influencing EV charging station usage.
* Predict peak usage times and future trends in station occupancy.
* Categorize charging stations for optimized resource allocation.
* Develop a predictive model for charging station availability.

**Task List and Project Timeline**

**Task List:**

* **Literature Review:** Study current methodologies and findings related to EV charging patterns.
* **Data Preprocessing:** Clean and prepare the dataset for analysis.
* **Descriptive Analysis:** Identify key patterns and statistics from the data.
* **Predictive Model Development:** Develop and train models for predicting station occupancy.
* **Evaluation and Optimization:** Test and refine models based on performance metrics.
* **Documentation and Reporting:** Prepare the final report and presentation of the findings.

**Project Timeline:**

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| --- | --- | --- |
| **Start Date** | **End Date** | **Task to be Done** |
| 27-05-2024 | 02-06-2024 | Initial Literature Review |
| 03-06-2024 | 09-06-2024 | Continue Literature Review and Define Methodology |
| 10-06-2024 | 16-06-2024 | Data Acquisition and Initial Data Cleaning |
| 17-06-2024 | 23-06-2024 | Data Validation and Handling Missing Data |
| 24-06-2024 | 30-06-2024 | Exploratory Data Analysis |
| 01-07-2024 | 07-07-2024 | Advanced Data Analysis (Feature Engineering) |
| 08-07-2024 | 14-07-2024 | Initial Model Development |
| 15-07-2024 | 21-07-2024 | Model Refinement and Tuning |
| 22-07-2024 | 28-07-2024 | Model Testing and Evaluation |
| 29-07-2024 | 04-08-2024 | Model Optimization and Validation |
| 05-08-2024 | 11-08-2024 | Preparation of Final Report Draft |
| 12-08-2024 | 18-08-2024 | Review and Revision of Report |
| 19-08-2024 | 23-08-2024 | Final Review, Submission Preparation, and Submission |

**Data Management Plan**

**Overview of the Dataset:**

* **Source:** The dataset originates from Harvard Dataverse and is publicly available on Kaggle.
* **Description:** This dataset encompasses detailed logs of 3,395 electric vehicle charging sessions across 105 stations managed by 85 drivers at various workplace locations. These locations include research and innovation centres, manufacturing sites, and office headquarters involved in the U.S. Department of Energy's workplace charging challenge.

**Data Collection:**

* **Method of Collection:** The data has been pre-collected and is accessed via Kaggle.
* **Link to Dataset:** <https://www.kaggle.com/datasets/michaelbryantds/electric-vehicle-charging-dataset>

**Summary of Data:**

* **File Formats:** The data is stored in a Comma-Separated Values (CSV) file, which is compatible with most statistical software packages.
* **Records:** The dataset contains records for 3,395 sessions, detailing timestamps, session durations, charging station IDs, and anonymized driver IDs.

**Document Control and Versioning:**

* **Tool:** GitHub will be used for version control of all documents, code, and analyses.
* **Repository:** GitHub Repository Link: https://github.com/dm23aau
* **Versioning Policy:** Versioning will be managed through Git commits. Each commit will include a detailed message describing the changes made to ensure traceability.

**Ethical Considerations:**

* **Compliance with GDPR:** The dataset's public availability and its compliance with GDPR have been verified through its listing on Kaggle.
* **University Ethical Approval:** The project will adhere to all ethical guidelines laid out by the university, ensuring that all data usage is responsible and justifiable.

**Metadata Management:**

* **Documentation:** A README file will be maintained within the GitHub repository, detailing the dataset's structure, variables, and any modifications made during the project.
* **Metadata Standards:** The documentation will adhere to best practices in data documentation to ensure that the data and findings are reproducible and understandable to other researchers or stakeholders.

# **References**

Apurvkumar Desai, K. C. (2023, October). The impact of electric vehicle charging infrastructure on the energy demand of a city. *Science Direct, 9*(10), 814-823. doi:https://doi.org/10.1016/j.egyr.2023.05.177

Erdélyi, F. (2024, January 10). *Electric vehicles*. Retrieved June 9, 2024, from European Environment Agency: https://www.eea.europa.eu/en/topics/in-depth/electric-vehicles#:~:text=In%20this%20context%2C%20electric%20vehicles,vans%20by%2050%25%20by%202030.

Muhammad Shahid Mastoi a, S. Z.-S. (2022, November). An in-depth analysis of electric vehicle charging station infrastructure, policy implications, and future trends. *Science Direct*, 11504-11529. doi:https://doi.org/10.1016/j.egyr.2022.09.011