An approach based on the integration of GIS and Machine Learning is used to assess the socio-economic potential of electric vehicle charging infrastructure in the Marrakech-Safi region, Morocco

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ABSTRACT

The evaluation of socio-economic potential plays a pivotal role in advancing sustainable transportation systems, particularly in Electrical Vehicle charging infrastructure PLANning [1]. In this study, we present a comprehensive methodology that integrates the Analytic Hierarchy Process (AHP) [2] and machine learning techniques to evaluate the socio-economic potential of the Marrakech-Safi region. By employing AHP, we determine the target variable, and subsequently apply RF (Random Forest) [3] and SVM (Support Vector Machine) [4] models incorporating 11 key factors such as demographics, road network, public facilities, typology, and power grid. The findings of our study reveal that the RF model, with an accuracy of 96.37%, outperforms the SVM model, which achieved an accuracy of 94.81%, in accurately predicting the socio-economic potential of our region. Building upon these results, we employ the RF model to project the potential of the Casablanca-Settat region, uncovering promising opportunities for the construction of an infrastructure for electric vehicle charging, notably in the city of Casablanca. The information provided by this study hold significant implications for decision-makers and policymakers involved in the planning and promotion of sustainable transportation infrastructure. By leveraging the combination of AHP and machine learning techniques, our methodology provides a solid framework for evaluating a region's socioeconomic potential, contributing to the formulation of informed strategies for sustainable transportation systems.

OBJECTIVES

In this study, research was conducted in the Marrakech-Safi region as an actual case study with the greatest diversity of economic levels across cities. The objective of this project is to assess and forecast the economic potential of our region for the planning of electric vehicle charging infrastructure using GIS technologies and machine learning techniques. then project these results in the Casablanca-Settat region.

The main objectives of this study are:

(a) Investigate the efficacy of models for estimating socioeconomic potential in the research region.

(b) The proposed models are used to generate economic potential maps, allowing for the identification of areas with high socio-economic potential.

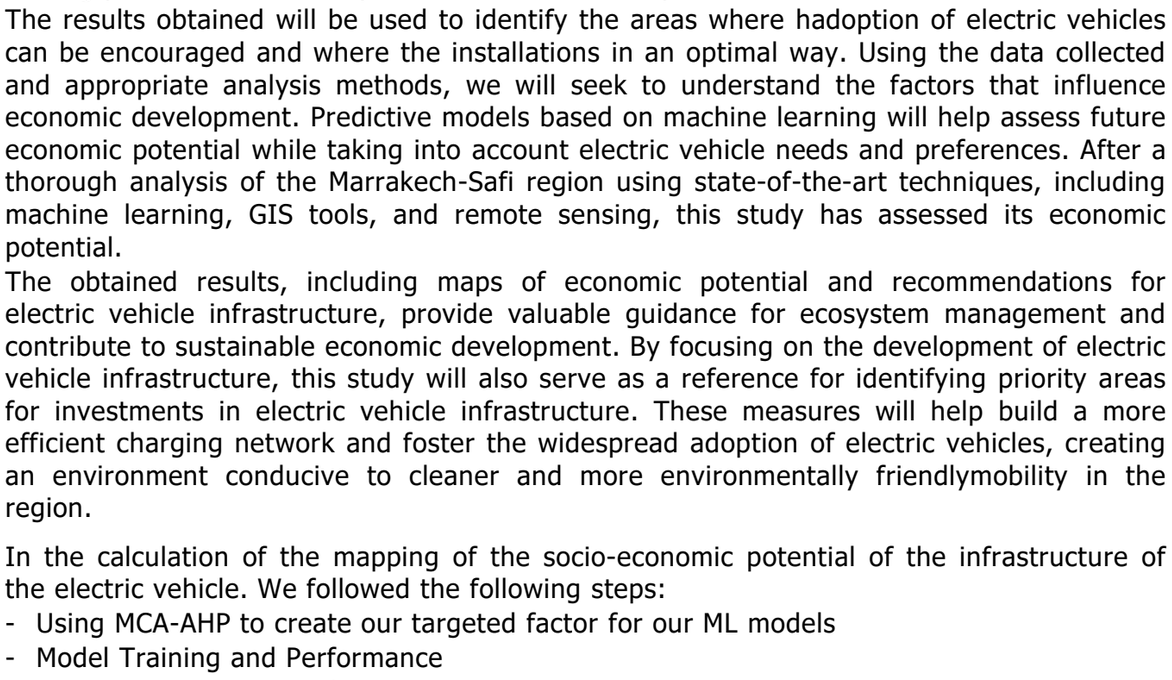
These findings serve as a valuable and practical tool for ecosystem management and the development of electric vehicle infrastructure, providing essential guidance for decision-making processes. This study also covers the development of electric vehicle infrastructure.

The results obtained will be used to identify the areas where hadoption of electric vehicles can be encouraged and where the installations in an optimal way. Using the data collected and appropriate analysis methods, we will seek to understand the factors that influence economic development. Predictive models based on machine learning will help assess future economic potential while taking into account electric vehicle needs and preferences. After a thorough analysis of the Marrakech-Safi region using state-of-the-art techniques, including machine learning, GIS tools, and remote sensing, this study has assessed its economic potential.

The obtained results, including maps of economic potential and recommendations for electric vehicle infrastructure, provide valuable guidance for ecosystem management and contribute to sustainable economic development. By focusing on the development of electric vehicle infrastructure, this study will also serve as a reference for identifying priority areas for investments in electric vehicle infrastructure. These measures will help build a more efficient charging network and foster the widespread adoption of electric vehicles, creating an environment conducive to cleaner and more environmentally friendlymobility in the region.

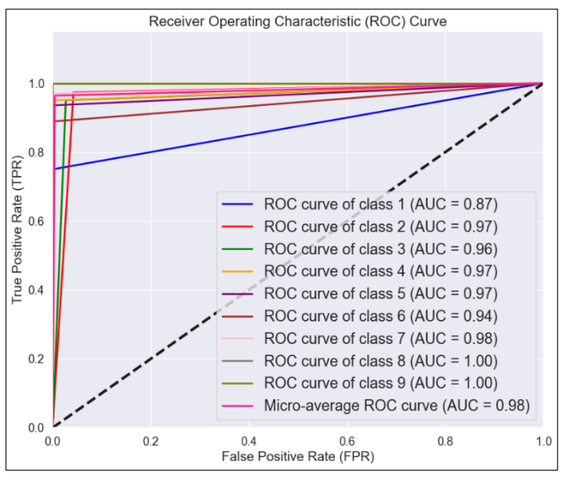
In the calculation of the mapping of the socio-economic potential of the infrastructure of the electric vehicle. We followed the following steps:

- Using MCA-AHP to create our targeted factor for our ML models
- Model Training and Performance
- Socioeconomic potential map



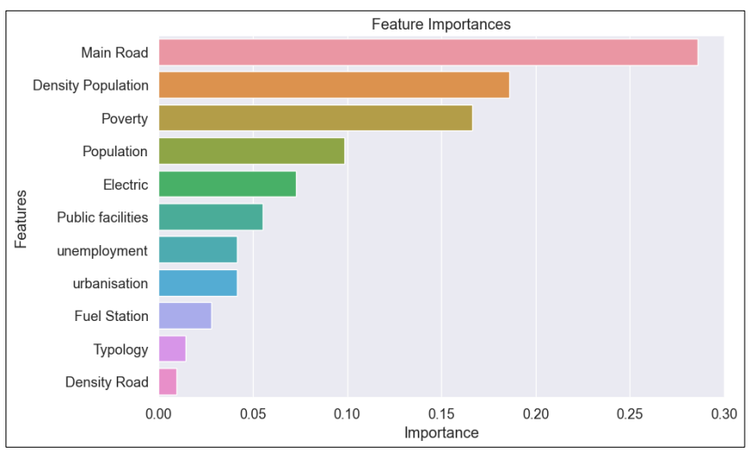
RESULTS

As part of our study on assessing the socio-economic potential of charging infrastructure for electric vehicles, we compared the performance of the SVM and RF classification models. The results showed that the RF model performed better overall than the SVM model. Where the AUC of RF = 0.96

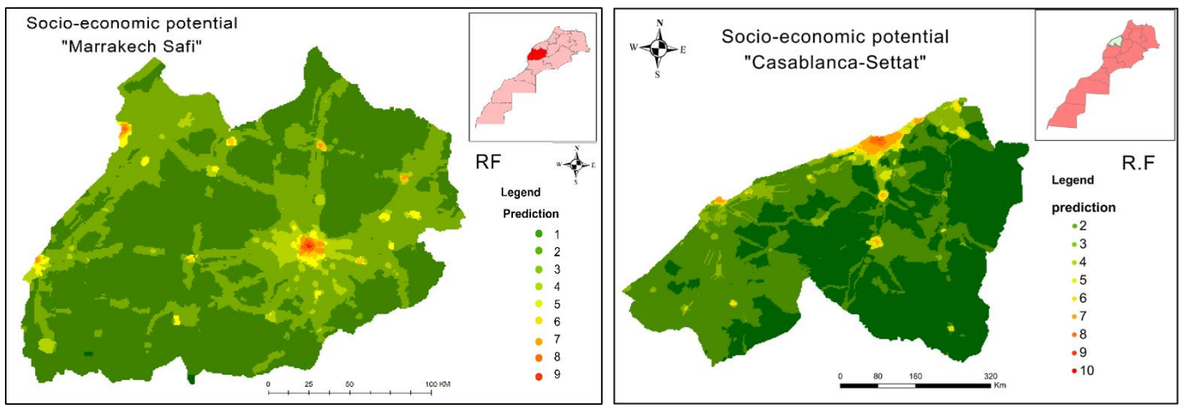


Evaluation Metrics	RF	SVM
Accuracy	96,37%	94,81%
Precision	96	71
F1 Score	0.96	0.95
AUC	0.98	0.97

Among the various factors influencing this superiority, our analysis highlighted the importance of the "main road" as a determining variable.



Based on this conclusion, we now plan to project the RF model in a new region, namely the Casablanca-Settat region. By extending our analysis to this new region, we will be able to assess its socio-economic potential using the RF model which has demonstrated its ability to capture important factors and provide accurate predictions. Class 9 in the RF model projection signifies a category with high socio-economic potential (Figure 13), indicating that it offers many economic opportunities and a high level of development. This information can be valuable for investment decisions, urban planning and economic development strategies in our region.



These results underline the crucial role of the socio-economic context in the planning and evaluation of electric vehicles (EVPLAN). Socio-economic factors such as local economic conditions, government policies, recharging infrastructure and consumer preferences play a key role in the successful transition to electric vehicles.

References

[1] A. Rochd, M. Laamim, A. Benazzouz, M. Kissaoui, A. Raihani, and H. Sun, "Public charging infrastructure for EVs: A comprehensive analysis of charging patterns & real-world insights—Case study of Rabat City, Morocco," Energy Reports, vol. 9, pp. 216–234, Sep. 2023, doi: 10.1016/j.egyr.2023.05.259.

[2] J. Gyani, A. Ahmed, and M. A. Haq, "MCDM and Various Prioritization Methods in AHP for CSS: A Comprehensive Review," IEEE Access, vol. 10, pp. 33492–33511, 2022, doi: 10.1109/ACCESS.2022.3161742.

[3] Breiman, "Random Forests | SpringerLink," 2001. https://link.springer.com/article/10.1023/A:1010933404324 (accessed Jun. 27, 2023).

[4] Yao, "Landslide susceptibility mapping based on Support Vector Machine: A case study on natural slopes of Hong Kong, China - ScienceDirect," 2008.

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