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Editorial

Travel Behavior and Transportation Systems Analysis of Electric Vehicles

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Electrification of personal transportation is widely regarded as an effective solution to relieve some increasingly serious crises facing our society today and in the near future, such as energy security, climate change, and air quality. Depending on the type of power sources, electric vehicles (EVs) may be categorized into hybrid electric vehicles (HEVs), plug-in hybrid electric vehicles (PHEVs), and battery electric vehicles (BEVs). While HEVs and PHEVs may better satisfy people's travel need nowadays, especially for long-distance trips, it is generally believed that BEVs will most probably dominate the EV market, after charging infrastructures are sufficiently expanded and charging time is reduced to a satisfactorily short level. Partially for this reason, an increasing number of EV-related scientific studies have focused on BEVs in recent years.

The last decade observed a fast climb of the market penetration level of EVs in many economies, especially in China, the United States, and the European Union. The increasing global market share leads to a series of new engineering, economic, environmental, and institutional problems and concerns we have not dealt with in our past transportation systems development and management experience, like electricity-charging infrastructure planning for EVs, EV-based travel and charging demand analysis, EVs' energy consumption and cost analysis, EVs' market penetration forecasting, air quality and environment improvements due to EV adoption, and so on. These new problems and concerns gained much attention from the research community and general public. Moreover, with the continuous advances in EV technologies and increasing willingness of consumers purchasing and utilizing EVs, the mechanism, means, and magnitude of these impacts on transportation systems as well as their evolution have developed to a highly complex and unprecedented level that we might have underestimated before, if we still made judgments by fully relying on our existing knowledge.

In additional to electric cars, electrification of transportation is also reflected by the increasing penetration of electric bicycles, which now are widely adopted in many large cities with high population density, especially in Asian and European countries. Their influences on urban travel behaviors and transportation planning are not fully investigated yet and worth being further discovered.

As a forum for exchanging and broadcasting recent research advances in the above area and fostering further discussions on data, models, and methods for analyzing relevant behavioral and systems issues, this special issue was created and published by Journal of Advanced Transportation. After a rigorous multiround review process, the editors finally selected 8 papers for publication from 20 submissions. The topics of these accepted papers are so diverse, ranging from electricity consumption to range anxiety evaluations, from vehicle market penetration to electricity charge demand forecasting, and from planning charging infrastructure locations to analyzing charging station usage, covering both electric cars and bicycles.

T. Miwa et al. consider how range anxiety and the risk of battery depletion affect the behavior of battery electric vehicle drivers. Their study is multifaceted, considering the variation of distance driven over days, how range anxiety affects decisions related to electric vehicle purchasing, and how the presence of charging infrastructure at workplaces or shopping destinations impact these attitudes. They also conduct a survey, whose results suggest that drivers tend to compare the range of a vehicle to a desired value, rather than considering probabilities of depletion.

K. Hu et al. conducted an empirical study on energy efficiency of electric vehicles. They recorded energy consumption and operation data of 13 Nissan Leaf drivers using an on-board diagnostics device (OBD) data logger, along with the GPS location and ambient temperature. The impacts of personal driving styles, traffic conditions, and infrastructure design on battery electric vehicle energy efficiency are analyzed.

R. R. Desai et al. conducted a pattern analysis of plug-in electric vehicle charging data. They identified five distinct clusters of daily charging profiles observed at the public charging stations. A significant amount of operational inefficiency is observed, where 54% of the total parking duration PEVs do not consume electricity, preventing other users from charging. Reducing the inefficient use of public charging stations will lead to significant reductions in emissions.

M. Sekour et al. studied EVs' longitudinal stability control based on a newly developed multimachine robust control system. The system realizes the acceleration slip regulation and antilock braking system functions, based on nonlinear model predictive direct torque control (NMD-DTC). It uses the fuzzy logic control (FLC) technique that determines online the accurate values of the weighting factors and generates the optimal switching states that optimize the EV drivers' decision. The simulation results built in Matlab/Simulink indicate that EVs can achieve high-performance vehicle longitudinal stability control with the proposed new multimachine robust control.

S. Li et al. studied the short-term forecast accuracy on the market penetration of BEVs between two models: A modified Bass model and Lotka-Volterra model using the data collected in China. They found that both models exhibit good accuracy in prediction, but the Bass model is more accurate, partly because it is simpler so that the variances would be smaller given some parameters are unknown. Such findings could help policy makers better understand the market of BEVs, since the market of BEVs largely depends on the governments' subsidy and policy support.

W. Jing et al. formulated and solved a problem for optimally locating charging stations for electric vehicles in a traffic network. Their formulation results in a bi-level nonlinear integer programming model, in which the upper level sets an objective of maximizing the coverage of electric vehicle flows while the lower level describes a stochastic user equilibrium flow pattern subject to distance constraints imposed by driving range limit. A key setting in their work is to use the concept of feasible subpaths to characterize the feasibility of paths subject to range anxiety.

A. Munkácsy and A. Monzón studied an electric, pedal-assisted bike-sharing system in Madrid, Spain. By studying both users and nonusers of this system, they identified relationships between potential and actual users of this system and propose that price levels, station placement, and raising awareness of the program could increase participation levels. These insights were possible because the study involved longitudinal data with the same participants over time.

Though electric bicycles are more widely used in some Asian and European countries (e.g., China and the Netherlands), C. Gorenflo et al. from University of Waterloo described a field trial in Canada and conducted a statistical analysis on the data collected from this trial. They analyzed the travel and charging patterns of 30 electric bicycles and revealed the following behavioral findings: anticipated and actual usages of electric vehicles are uncorrelated; range anxiety does not affect riders' travel behaviors; electric bicycles are less known by the general public in Canada.

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