EDITORIAL:
SPECIAL ISSUE ON "GREEN URBAN TRANSPORTATION"

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Introduction

The transportation sector is a major source of emissions, including greenhouse gases. It is important to promote green transportation in urban areas to provide a better living environment without affecting the mobility of goods and people. This special issue focuses on green urban transportation. A total of 57 papers was received and finally, 14 papers are included in this special issue, which can be broadly classified into three categories, including electric vehicles, sharing economy, and traditional green transport modes.

1. Electric vehicles

Depending on the fuel and technology, electric vehicles contribute to green urban transportation by giving from zero to low roadside emissions. This special issue has 8 papers on this topic, which can be further classified into facility location problems, location routing problems, a joint charging mode and location choice problem, and battery degradation and behavior. These papers have different contributions to the literature, as explained below.

1.1 Incorporating demand dynamics in multi-period capacitated fast-charging location planning for electric vehicles

Zhang et al. develop a multi-period capacitated flow refueling location model for electric vehicles (EV) with considerations of EV demand dynamics and charging availability. These considerations are important as the planning decisions affect not only the demand (i.e., coverage and growth) but also the supply (i.e., charging infrastructure) as well as the supply-demand interaction. Using the northeast region in the United States (Washington, D.C., New York City, and Boston) as a case study, different dynamic scenarios are tested to obtain insights into this multi-period planning problem with growing EV market share.

1.2 Locating multiple types of charging facilities for battery electric vehicles

Liu and Wang propose a trilevel model for locating multiple types of charging facilities for battery electric vehicles. The top level problem determines the best locations of different types of charging facilities to minimize social cost. The second level problem considers the acquisition choice of electric vehicles users. The lowest level problem depicts the route choice of electric vehicle drivers. To solve the model, Liu and Wang introduce an efficient stochastic radial basis function based algorithm. Their study contributes to the literature by introducing a new problem and a solution method for the problem.

1.3 Investing in logistics facilities today to reduce routing emissions tomorrow

Tricoire and Parragh develop a bi-objective location-routing model to examine the trade-off between strategic investment in logistic facilities and the environmental impact of daily logistics operations. Different from the literature, the bi-objective location-routing model also considers fleet-size-and-mix decisions. A decomposition approach is developed to solve instances of realistic size. Experiments on small and large instances are carried to examine the optimality of the solutions as well as the trade-off between investment costs and CO_2 emissions in the city of Vienna. The results show that the model and solution approach can serve as a useful tool for making long-term decisions.

1.4 Joint charging mode and location choice model for battery electric vehicle users

Xu et al. develop a mixed logit model to examine the simultaneous charging mode and location choice behavior of battery electric vehicle users, which has not been studied at the time of their writing. To develop their model, they propose a tangible procedure to clean the real revealed preference data and identify an instrumental variable to solve the endogeneity issue. Their model, findings, and discussion provide useful insights for policy-makers to increase electric vehicle market share.

1.5 The electric vehicle routing problem with nonlinear charging function

Montoya et al. introduced a new vehicle routing problem that considers the limited driving ranges of electric vehicles and nonlinear battery charging functions. Iterated local search with heuristic concentration is proposed to solve the problem. The solution quality of the hybrid heuristic is evaluated using 120 new instances generated from on real data. The results show that the hybrid heuristic can produce high-quality solutions. A computation experiment is also conducted to illustrate the importance of considering nonlinear battery charging functions. The results show that infeasible or expensive solutions can be generated if traditional linear instead of nonlinear battery charging functions are used.

1.6 Energy-efficient shortest routes for electric and hybrid vehicles

Strehler et al. develop a general model for routing electric and hybrid vehicles with considerations of convertible resources and intermediate stops at charging stations. The authors also develop schemes to prevent/exclude cycles in the constrained shortest path problem for finding fast and energy-efficient routes. Approximation schemes with guaranteed optimality and feasibility are rigorously proved for some general conditions. Finally, the authors discuss some future research directions of the proposed model and potential applications of using the constrained shortest path problem with convertible resources and charging stations.

1.7 Path-constrained traffic assignment: Modeling and computing network impacts of stochastic range anxiety

Xie et al. develop models and solution algorithms for assessing the impacts of range anxiety associated with driving electric vehicles on travel choices and network performance. The network equilibrium models consider activity location and travel path choices on the trip chain level subject to stochastic driving ranges of electric vehicles. Both convex optimization and variational inequality formulations are provided for characterizing the equilibrium conditions under discretely and continuously distributed driving ranges, respectively. The projected gradient method is adopted for solving both formulations. Numerical experiments are also conducted to show the applicability of the models and solution algorithms as well as the impacts of range anxiety on travel choices and network performance.

1.8 Battery degradation and behaviour for electric vehicles: Review and numerical analyses of several models

Pelletier et al. review existing models and provide tractable models for predicting battery degradation and behavior for electric vehicles. The authors also provide insights for electric fleet management and suggest that the charging of fleet vehicles should always be performed as closely as possible to their departure time. Finally, the authors point out some future research directions.

2. Sharing economy

Sharing economy contributes to green urban transportation by reducing the number of vehicles on urban roads through shared use of vehicles or by encouraging people to ride bikes in urban areas instead of travel by vehicles. Sharing economy includes bike sharing, taxi sharing, and vehicle sharing, each of which is considered by one paper in this special issue.

2.1 A time-space network flow approach to dynamic repositioning in bicycle sharing systems

Zhang et al. propose a new methodology for solving the dynamic bike repositioning problem. This problem is motivated by the daytime imbalanced bike distribution issue associated with bike sharing systems and the use of trucks to pick up bikes from excess stations and to drop off these bikes to shortage stations in practice. The methodology involves the development of a nonlinear multi-commodity time-space network flow model that simultaneously considers the user dissatisfaction forecasting, bike inventory level forecasting, the vehicle routing, and the bicycle repositioning. The nonlinear model is transformed into an equivalent mixed integer programming model and solved by an efficient heuristic.

2.2 Optimal assignment and incentive design in the taxi group ride problem

Qian et al. present the first study to investigate both the theoretical and practical issues of the taxi group ride problem. Taxi group ride requires gathering passengers with similar trip origin, trip destinations, and departure times at a designated location to ride in the same taxi and dropping them at another designated location convenient to all these passengers. By making use of the special graph structure of the taxi group ride problem, Qian et al. introduce the graph conversion method to solve the taxi group ride problem. They also develop a heuristic to solve real-world taxi group ride problems. Based on their proposed methodology and data from New York City, Wuhan, and Shenzhen, they examine various incentives for encouraging passengers and drivers to take part in taxi group ride.

2.3 Modeling and managing morning commute with both household and individual travels

Liu et al. extend the analysis of the morning commute problem in the literature by considering both shared rides of household members and individual rides simultaneously. Shared rides refer to the travels that travelers drive their children to school before going to work whereas individual rides refer to the travels that individual travelers directly drive to work. The authors show that both the traffic congestion at the highway bottleneck and total travel cost can be improved by a suitable coordination of the schedules of work and school. The authors also prove that the efficiency of this coordination is bounded. Moreover, they find that total travel cost can diminish as the ratio of shared to individual rides increases and that schedule delay cost may not increase as the difference between the desired arrival times for work and school increases.

3. Traditional green modes

Traditional green modes including buses and rail can handle many passengers simultaneously so that the emissions per passenger are lower than those of private car users. Encouraging people to shift to use traditional green modes can, therefore, reduce vehicle emissions. This special issue has three papers on developing new methodologies to examine the problem associated with traditional green modes as can be seen below.

3.1 Multi-objective optimal control formulations for bus service reliability with traffic signals

Chow et al. present two weighted-sum optimal control formulations for improving bus service reliability and surrounding traffic delays due to bus priority signal, based on two different definitions on service reliability: bus schedule and headway discrepancies. The variational formulation approach is used to capture traffic dynamics. The authors develop an open loop solution method to determine the best bus priority signal timing plan. They apply their methodology to an arterial in London to discuss the new insights on managing bus service reliability in urban arterials. Their study also contributes to the implementation and promotion of bus mode in busy urban networks.

3.2 Transit-oriented development in an urban rail transportation corridor

Peng et al. develop an analytical modeling approach to address the transit-oriented development (TOD) investment issues in a rail transportation corridor with the consideration of both public and private investment regimes. For each regime, a model is developed to determine the location, number, and size of the TOD zones along the rail line, and train headway to maximize social welfare, taking into account the interaction between the government, property developers, and households. Their study demonstrates that the TOD investment can be beneficial to individual households and the society but leads to population agglomeration and a compact city. Their study also shows that the private regime outperforms the public regime.

3.3 Alternate weibit-based model for assessing green transport systems with combined mode and route travel choices

Using the Weibull distribution, Kitthamkesorn and Chen develop a new combined modal split and traffic assignment (CMSTA) model for assessing green transport systems. The advantage of this new CMSTA is that it explicitly considers both similarities and heterogeneous perception variance under congestion. At the mode choice level, a nested weibit (NW) model is newly developed to handle both mode similarity and mode-specific perception variance. At the route choice level, the path-size weibit (PSW) model is adopted to handle both route overlapping and route-specific perception variance. An equivalent mathematical programming formulation for the combined NW-PSW model is provided with rigorously proved solution properties. Using this newly developed CMSTA model, different go-green strategies are quantitatively evaluated, and the results show the NW-PSW model is more sensitive to changes in model parameters and network characteristics than the traditional logit and extended logit models.

Conclusion

The 14 articles published in this special issue provide latest reviews and novel green urban transportation problems, new methodologies to model and solve the problems, or interesting findings on tackling the challenges of operation, management, design, control, and planning of green urban transportation systems. It is our hope that this special issue will stimulate new thinking from decision makers, transport authorities, researchers, and practitioners in the field.

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