Editorial

Environmental implications of emerging transportation technologies

1. Background

With the rapid development of information and communications technology, novel transportation technologies, which can be characterized by sharing, electrification, and automation, have been emerging worldwide. They could have great potential to enhance the sustainability of the transportation system. For example, shared mobility services may help curtail car ownership and usage, resulting in fewer emissions; autonomous vehicles could optimize driving patterns to improve fuel efficiency; and electric vehicles powered by renewable energy could emit fewer greenhouse gases and air pollutants than conventional vehicles.

Despite the hopeful potential, the environmental benefits of emerging transportation technologies merit further investigation (Guo et al., 2021). To begin with, it remains unclear how large the benefits are. Moreover, emerging transportation technologies may have negative environmental impacts. For instance, although they may reduce trip costs, the reduced cost may also lead to increased vehicle usage and associated impacts. Empirically, some studies have found that ridesourcing is responsible for a significant decline in transit ridership and increased traffic congestion (Diao et al., 2021; Erhardt et al., 2019). On the other hand, it has been evident that ridesourcing does not worsen traffic congestion during peak hours (Bialik et al., 2015). The discrepancies suggest the need for a better understanding of the impacts of emerging transportation technologies. Furthermore, different emerging transportation technologies compete with or complement each other. Disentangling travelers' preferences for emerging transportation options from the behavioral perspective is the premise of a better understanding of the impacts (Storch et al., 2021). The different modes that these technologies substitute for also have different environmental implications. In addition, quantifying the net environmental impacts of emerging transportation technologies requires a life cycle perspective and system thinking. For example, the production, recycling, and disposal of batteries for electric vehicles and the rebalancing of micromobility modes may offset the emissions reduction from their usage (Luo et al., 2019; Zhou et al., 2023).

Against this backdrop, we launched this Virtual Special Issue (VSI) in October 2020. This VSI attracted more than 100 submissions from scholars worldwide. After standard peer reviews, we selected 37 papers for publication. One hundred forty-three researchers from 19 countries authored the papers, with the most authors from the United States, followed by China and Western European countries.

All the accepted papers are original research articles. Most are empirical studies, and more than ten are method-oriented. These studies adopt a wide range of modeling/evaluation approaches, such as simulation, regression analysis, machine learning, life cycle assessment, and mathematical programming. They include work from multiple disciplines, including transportation engineering, urban planning, environmental science, transport geography, public administration, and urban management.

2. Summary tabulations of accepted papers

The accepted papers encompass a variety of emerging transportation technologies. We categorized them into four groups: shared micromobility, ridesourcing, electric vehicles, and other technologies such as green containers and on-demand delivery. The papers covering multiple modes/technologies (e.g., Zhao and Ke, 2021) are assigned to the most relevant group.

2.1. Shared micromobility

This VSI has 14 papers on shared micromobility. Among them, ten papers are from the United States, two are from Europe, and two are from Asia. Regarding travel mode, e-scooters receive more attention than bike sharing. The topics include key factors influencing the use of shared micromobility (e.g., intention to use, demand, and route choice), mode substitution induced by shared micromobility, management and planning, and the energy impacts of shared micromobility. Table 1 summarizes these papers in terms of scope, title, study area, key data, method, and key findings.

Table 1. Summary of shared micromobility papers

Scope	Reference	Title	Study areas	Key data	Key methods	Key findings
Use	Bai et al. (2021)	*The relationship between E-scooter travels and daily leisure activities in Austin, Texas*	Austin, United States	Visiting activity data, E-scooter usage data, GIS data for urban environment indicators, and socioeconomic/demographic data	Spatiotemporal similarity analysis and difference-in-differences model	E-scooter use is related to daily dining/drinking, shopping, and recreational activities. However, it has an insignificant effect on the generation of more visits.
Use	Hosseinzadeh et al. (2021)	*Factors influencing shared micromobility services: An analysis of e-scooters and bikeshare*	Louisville, United States	Shared e-scooter and docked bike-share trip records collected from Louisville Metro Government's Open Data platform from January 2019 to January 2020	Negative binomial generalized additive model	Similarities and differences co-exist between the correlates of shared e-scooter and docked bike-share trips. The common correlates include, but are not limited to, weather, temperature, and day of week.
Use	Rejali et al. (2021)	*Assessing a priori acceptance of shared dockless e-scooters in Iran*	Iran	Online questionnaire survey data	Structural equation model	Subjective norms play the largest role in predicting the intention to use shared dockless e-scooters. Environmental awareness also matters.
Use	Sadeghinasr et al. (2021)	*Mining dockless bikeshare data for insights into cyclist behavior*	Boston region, United States	GPS trajectories of dockless bike-share trips that were captured over 18 months	Spatio-temporal analysis	Dockless bike-share serves many more functions than connecting transit (e.g., supporting the local economy). Riders strongly tend

		and preferences: Evidence from the Boston region				to use the most direct route, resulting in frequent contraflow riding.
Use	Wang et al. (2022)	*Nonlinear effects of factors on dockless bike-sharing usage considering grid-based spatiotemporal heterogeneity*	Beijing, China	Dockless bike-sharing data of Mobike from August 1 to October 31, 2018	Random forest	Many variables, such as government agencies and metro accessibility, have nonlinear and threshold effects on dockless bike-sharing use. A one-size-fits-all policy is unsuitable for dockless bike-sharing management.
Use	Zhao et al. (2021)	*Impact of data processing on deriving micro-mobility patterns from vehicle availability data*	Zurich, Switzerland	Micromobility vehicle availability data from dockless e-bike operators	A generally applicable data processing framework	The choice of the sampling rate has a complex impact on the derived micromobility patterns.
Mode substitution	Fukushige et al. (2021)	*Factors influencing dock-less E-bike-share mode substitution: Evidence from Sacramento, California*	Sacramento, United States	Two-wave longitudinal survey of dock-less E-bike-share users in 2018 and 2019	Bayesian multinomial logit model	The substitution of dockless e-bike-share for other modes is influenced by various factors, such as trip characteristics, socio-demographics, land use, mode availability, and attitude. Most short e-bike-share trips substitute walking.

Mode substitution	Lee et al. (2021)	*Forecasting e-scooter substitution of direct and access trips by mode and distance*	New York	E-scooter ridership data, 2017 American Community Survey, New York Metropolitan Transportation Council 2010/2011 Regional Household Travel Survey data, and Citi Bike data	Log-log regression model and nonlinear multifactor model	E-scooters can replace 32% of carpool trips, 13% of bike trips, and 7.2% of taxi trips.
Mode substitution	Yan et al. (2021)	*A spatiotemporal analysis of e-scooters' relationships with transit and station-based bikeshare*	Washington DC, United States	Data scrapped from public APIs for various e-scooter vendors and bikeshare and transit data before and during the COVID-19 pandemic	Spatiotemporal analysis	E-scooters have competing and complementary effects on transit and bike-share. E-scooters improve mobility services for a few underserved communities.
Mode substitution	Ziedan et al. (2021)	*Complement or compete? The effects of shared electric scooters on bus ridership*	Nashville, United States	Transit data, shared e-scooter data, population data, employment data, and weather data	Fixed-effects regression	The net effect of e-scooters on weekday bus ridership is marginal.
Energy impacts	Sun et al. (2021)	*Estimating energy bounds for adoption of shared micromobility*	The United States (for national analysis) and California (for city-level analysis)	E-scooters and e-bikes data from Austin, Texas, bike-share data from Denver, Colorado, and the 2017 National Household Travel Survey	Scenario analysis	The peak adoption of shared micromobility can decrease energy consumption from reported passenger travel by 1% and 2.6% at the national and city levels, respectively.

Management or planning	Liazos et al. (2022)	*Geofence planning for electric scooters*	Athens, Greece	A real-world urban network comprising 488 edges	Non-dominated sorting genetic algorithm	Results highlight the complexity of restricting e-scooter access and the need to consider a battery of solutions. Design criteria substantially influence the quality of solutions.
Management or planning	Ma et al. (2021)	*Examining municipal guidelines for users of shared E-Scooters in the United States*	156 cities in the United States	E-Scooter user guidelines established by city governments	Multifaceted analysis	Comparative results show the completeness of information and similarities among cities. City governments are recommended to introduce actionable guidelines featuring quantitative performance metrics.
Management or planning	Zakhem and Smith-Colin (2021)	*Micromobility implementation challenges and opportunities: Analysis of e-scooter parking and high-use corridors*	Dallas, Texas, United States	Data from two sit-down e-scooter companies	An unsupervised learning algorithm and a Simplified Matching Heuristic	Using the GPS trajectory data is fundamental for capturing the actual high-use roadway segments.

2.2. Ridesourcing

This VSI has ten papers on ridesourcing, with one theoretical work and nine empirical studies (four on American cities/regions, four on Asian cities, and one on cities in OECD countries). Four papers examine mode substitution effects of ridesourcing, while the remaining emphasize system management (pricing and vehicle charging and dispatching), pooling behaviors, and environmental and economic impacts of ride-hailing and pooling. Table 2 summarizes the ridesourcing papers.

Table 2. Summary of ridesourcing papers

Scope	Reference	Title	Study areas	Key data	Key methods	Key findings
Use	Taiebat et al. (2022)	*Sharing behavior in ride-hailing trips: A machine learning inference approach*	Chicago, United States	Ride-hailing trip data in 2019	Ensemble machine learning models	Travel impedance variables play an essential role in predicting the tendency to share and the successful matching of a trip.
Mode substitution	Lee et al. (2022)	*Substitution or complementarity? A latent-class cluster analysis of ridehailing impacts on the use of other travel modes in three southern U.S. cities*	Three cities in the southern U.S. (Phoenix, Arizona; Atlanta, Georgia; and Austin, Texas)	1,438 ride-hailing user respondents for a transportation survey	Latent-class cluster analysis	The effects of ride-hailing adoption on the use of other travel modes greatly vary across latent groups, each of which presents distinctive travel demands, attitudes, and lifestyles. Thus, policy responses need to be tailored to users' socioeconomics, land-use attributes, and other traits.
Mode substitution	Shi et al. (2021)	*The influence of ride-hailing on travel frequency and mode choice*	Chengdu, China	Face-to-face structured survey data collected between June and August 2019	Multinomial logistic regression model and binary logit model	16.8% of the respondents increased their trip frequency because of the adoption of ride-hailing services. The use of traditional trip modes (particularly public transit) is largely substituted by ride-hailing services.

Mode substitution	Wang et al. (2021)	*Impact of ride-hailing usage on vehicle ownership in the United States*	Forty-two metropolitan areas in the United States	2017 National Household Travel Survey	Bivariate ordered probit model	Regular and active ride-hailing users are more likely to possess fewer cars than occasional users. No discernable difference in owning vehicles is observed between regular and active users.
Mode substitution & Environmental impacts	Yang et al. (2022)	*How does the suspension of ride-sourcing affect the transportation system and environment?*	Chengdu, China	Stated-preference questionnaire survey data, Baidu Map Place API data, Baidu Map Direction API data, Open Street Map data, and official household travel survey data	Mixed logit model and Monte-Carlo Markov Chain simulation	With the suspension, most ride-sourcing trips would shift to public transit and taxis. The suspension can halve vehicle emissions related to ride-sourcing trips.
Environmental impacts	Li et al. (2021)	*How does ridesplitting reduce emissions from ridesourcing? A spatiotemporal analysis in Chengdu, China*	Chengdu, China	GPS trajectory data from Didi Chuxing	COPERT model and spatial error model	Compared with regular ridesourcing, ridesplitting decreases CO_2, CO, NO_x, and hydrocarbon emissions per ride-km by 28.7%, 32.5%, 27.7%, and 31.2%, respectively. The trajectory-overlapping rate of shared rides is the dominant determinant of emission reductions.
Environmental impacts	Tikoudis et al. (2021)	*Ridesharing services and urban transport CO_2 emissions: Simulation-based*	247 cities in 29 OECD countries	Survey data from mode choice experiments (including ridesharing) collected by the International Transport Forum	Discrete choice model and forward simulation up to 2050	With the support of government policies for ridesharing services, CO_2 emissions from passenger transport in 2050 will be 6.3% lower than their reference level. The reduction of CO_2

		evidence from 247 cities				emissions varies across cities and time.
Economic impacts	Zhao and Ke (2021)	*The impact of shared mobility services on housing values near subway stations*	Beijing, China	Hundreds of thousands of apartment resale records collected from the online platform of Lianjia	Hedonic pricing and quantile regression models	Ridesourcing steepens the property price gradient by 1.26%. By contrast, dockless bike-share flattens the gradient by 2.61%.
Managemen t	Hong and Liu (2022)	*The optimal pricing for green ride services in the ride-sharing economy*	-	-	Analytical model	If consumers outnumber drivers for the green ride service, the optimal solution does not depend on the opportunity cost of electric vehicle drivers.
Managemen t	Yi and Smart (2021)	*A framework for integrated dispatching and charging management of an autonomous electric vehicle ride-hailing fleet*	New York, United States	New York City taxi data	System optimization approach	To meet 100,000 daily requests minimum with 1750 autonomous electric vehicles, optimization-based centralized fleet management meets 14% more requests and wastes 43% less on zero-occupancy miles than AEVs operating on heuristic strategies.

2.3. Electric vehicles

This VSI has eight papers on electric vehicles, including electric buses, cars, trucks, and drones used for both goods and passenger delivery. Five papers choose Asian cities as study areas. Two case studies are from the United States and Germany, respectively. The research topics focus on infrastructure support and management (especially for vehicle charging and discharging) and the impacts of electric vehicles (including emissions, welfare impacts, and travel demand change). Table 3 summarizes these papers.

Table 3. Summary of electric vehicle papers

Scope	Reference	Title	Study area	Key data	Key methods	Key findings
Use	Cheng et al. (2021)	*Flow-based unit is better: exploring factors affecting mid-term OD demand of station-based one-way electric carsharing*	Shanghai, China	Two years of carsharing transaction data, POI data, census data, and taxi trajectory data	Gradient boosting tree-based Tweedie model and Shapley additive explanations (SHAP) framework	The OD trip attributes are an essential predictor of the carsharing OD demand. The OD demand is an appropriate analysis unit for one-way carsharing systems. Taxi and carsharing demands have an insignificant partial overlap. Carsharing may compete with buses and substitute the metro. Travel purposes using carsharing are diverse for all land uses.
Impacts	Baldisseri et al. (2022)	*Truck-based drone delivery system: An economic and environmental assessment*	-	Primary and secondary data	Life cycle assessment and the total cost of ownership	Electric trucks equipped with drones lead to significant emissions reductions. Additionally, its cost performance is mainly influenced by the drone automation level.
Impacts	Hardman (2021)	*Investigating the decision to travel more in a partially automated electric vehicle*	California, United States	Data from qualitative semi-structured interviews with thirty-five owners of Tesla battery electric vehicles with a partial automation system in 2019	Qualitative analysis	Partial automation and electrification greatly shape drivers' travel behavior. Specifically, it makes interviewees drive more and choose to drive rather than fly, thereby increasing vehicle miles traveled.

Impacts	Straubinger et al. (2022)	*Going electric: Environmental and welfare impacts of urban ground and air transport*	A medium-sized German city	Numerous real-world city-level parameters, such as households, working hours per day, and gasoline producer price	The urban spatial computable general equilibrium model	The transition from gasoline to electric cars leads to a considerable decrease in CO_2 emissions and tax-induced welfare losses. Introducing urban air mobility as an additional mode results in emission reductions if introduced to a gasoline-car city, while emissions increase when urban air mobility replaces trips by electric cars.
Impacts	Yeow et al. (2022)	*Life cycle greenhouse gas emissions of alternative fuels and powertrains for medium-duty trucks: A Singapore case study*	Singapore	Engine data from a survey of medium-duty urban delivery trucks	Life cycle assessment	Battery electric and hydrogen fuel cell medium-duty delivery trucks can reduce greenhouse gas emissions by up to 11% and 30%, respectively, compared with diesel trucks.
Charging/discharging	Ding et al. (2022)	*Modeling the impact of vehicle-to-grid discharge technology on transport and power systems*	Baoding, China	Data from a pilot vehicle-to-grid (V2G) project	Bottleneck model incorporating the discharge option	Compared to the "without V2G case," traffic congestion is mitigated when commuters who plan to discharge arrive at the bottleneck earlier than those who plan not to do so.
Charging/discharging	Hsu et al. (2021)	*The depot and charging facility location problem for electrifying urban bus services*	Taoyuan	Urban bus service data offered by the bus operator	A two-stage heuristic	The required ratio of electric buses to the total is a key factor in the total operational cost. The bus fleet size affects the cost and robustness of system operation.
Charging/discharging	Liu et al. (2021)	*Optimal charging strategy for large-scale electric buses considering*	Zhengzhou, China	The real-world operation schedule of electric buses	A column-generation-based algorithm	The optimal charging strategy can decrease the charging cost by about 36.1% compared with the uncontrolled charging strategy. The utilization rate of nighttime charging resources can be increased to 97.96%.

		resource constraints				

2.4. Other technologies

Table 4 summarizes five papers on other emerging transportation technologies, including container shipping, on-demand food delivery, Mobility as a Service, passenger transportation, and automated minibus. These papers explore the impacts of these emerging technologies on emissions and food accessibility.

Table 4. Summary of other papers

Scope	**Reference**	**Title**	**Study area**	**Key data**	**Key methods**	**Key findings**
Impacts	Doukas et al. (2021)	*Low-cost emissions cuts in container shipping: Thinking inside the box*	The world	International Energy Agency (IEA) World Energy Balance and Shared Socioeconomic Pathways database (SSP2 projections)	"ModUlar energy system Simulation Environment (MUSE)" global integrated assessment model	The adoption of a lighter container type of a fully metallic floor could cut CO_2 emissions of the shipping industry by 4.7–18.8% and save approximately 44 million trees (and 109k acres of forest) by 2050.
Impacts	Huber et al. (2022)	*Climate and environmental impacts of automated minibuses in future public transportation*	Several European cities	Data from a minibus producer and field data	Environmental life cycle assessment	Electric automated minibuses contribute to a reduction in environmental impacts. The reduction depends on average utilization, mileage, lifetime and total mileage, the electricity mix used, and the substituted transport mode.
Impacts	Labee et al. (2022)	*The implications of Mobility as a*	Amsterdam, Netherlands	The Dutch national travel survey data	A Learning-Based Transportation Oriented Simulation	Different scenarios have different levels of emission reduction. Specifically, the conservative,

		Service for urban emissions			System	balanced, and optimistic scenarios decrease emission levels by 3–4%, 14–19%, and 43–54%, respectively.
Impacts	Silva et al. (2022)	*Assessment of decarbonization alternatives for passenger transportation in Rio de Janeiro, Brazil*	Rio de Janeiro, Brazil	The state's reference energy system	Energy systems model	The policy curtailing the most emissions (by 84%) combines the growth of renewable electricity generation and the implementation of a CO_2 price.
Impacts	Wang and He (2021)	*Impacts of food accessibility and built environment on on-demand food delivery usage*	Shenzhen, China	Online restaurant listings and monthly sales data collected from Ele.me	Negative binomial model	The use of on-demand food delivery concentrates in more urbanized areas, especially city centers. Food accessibility and many other built environment variables are critical determinants of food delivery use.

3. Concluding remarks

This VSI assembles 37 papers investigating the environmental implications of emerging transportation technologies from multiple perspectives. Some technologies have gained considerable environmental benefits in terms of greenhouse gas emission reductions and energy consumption savings (e.g., Li et al., 2021; Tikoudis et al., 2021; Baldisseri et al., 2022; Straubinger et al., 2022), although there are exceptions (e.g., Yang et al., 2022). Individuals' use behavior of emerging transportation modes is associated with various factors, such as the type of transportation mode, trip attributes (e.g., distance, duration, and purpose), individuals' socio-demographic attributes, natural and built environments, and temporal attributes. There are similarities and differences between the correlates of the user behavior of different emerging transportation modes. Therefore, one-size-fits-all policies are unsuitable for the implementation and management of emerging transportation technologies. Instead, time- and space-varying and system-specific policies are desirable. Finally, these papers have extensively applied big data and novel monitoring tools, which enable scholars to measure the emissions of new technologies more comprehensively and precisely (Böhm et al., 2022).

These papers contribute to a better understanding of how to develop supporting infrastructure and management strategies to help achieve the environmental benefits of emerging transportation technologies. Future studies could enrich and strengthen the understanding from two aspects. First, it is beneficial to keep exploring the potential of using new data and analysis methods to gain a more comprehensive, accurate, and systematic understanding of the environmental benefits of emerging transportation technologies. Second, more research is needed to further clarify the net effect of various emerging transportation technologies on the environment to inform the development and adoption of the technologies.

Acknowledgments

We would like to express our sincere gratitude to the authors for their invaluable contributions to this VSI. We also extend our thanks to the reviewers for their constructive comments and the editors-in-chief, Prof. Jason Cao and Prof. Robert Noland, for their support and encouragement throughout the editing process.

References

Bai, S., Jiao, J., Chen, Y., Guo, J., 2021. The relationship between E-scooter travels and daily leisure activities in Austin, Texas. *Transportation Research Part D: Transport and Environment* 95, 102844.

Baldisseri, A., Siragusa, C., Seghezzi, A., Mangiaracina, R., Tumino, A., 2022. Truck-based drone delivery system: An economic and environmental assessment. *Transportation Research Part D: Transport and Environment* 107, 103296.

Böhm, M., Nanni, M., Pappalardo, L., 2022. Gross polluters and vehicle emissions reduction. *Nature Sustainability*, 1-9.

Cheng, J., Chen, X., Ye, J., Shan, X., 2021. Flow-based unit is better: exploring factors affecting mid-term OD demand of station-based one-way electric carsharing.

Transportation Research Part D: Transport and Environment 98, 102954.
Diao, M., Kong, H., Zhao, J., 2021. Impacts of transportation network companies on urban mobility. *Nature Sustainability* 4(6), 494-500.
Ding, Y., Li, X., Jian, S., 2022. Modeling the impact of vehicle-to-grid discharge technology on transport and power systems. *Transportation Research Part D: Transport and Environment* 105, 103220.
Doukas, H., Spiliotis, E., Jafari, M.A., Giarola, S., Nikas, A., 2021. Low-cost emissions cuts in container shipping: Thinking inside the box. *Transportation Research Part D: Transport and Environment* 94, 102815.
Erhardt, G.D., Roy, S., Cooper, D., Sana, B., Chen, M., Castiglione, J., 2019. Do transportation network companies decrease or increase congestion? *Science Advances* 5(5), eaau2670.
Fukushige, T., Fitch, D.T., Handy, S., 2021. Factors influencing dock-less E-bike-share mode substitution: Evidence from Sacramento, California. *Transportation Research Part D: Transport and Environment* 99, 102990.
Guo, Y., Yang, L., Lu, Y., & Zhao, R. (2021). Dockless bike-sharing as a feeder mode of metro commute? The role of the feeder-related built environment: Analytical framework and empirical evidence. *Sustainable Cities and Society* 65, 102594.
Hardman, S., 2021. Investigating the decision to travel more in a partially automated electric vehicle. *Transportation Research Part D: Transport and Environment* 96, 102884.
Hong, J.H., Liu, X., 2022. The optimal pricing for green ride services in the ride-sharing economy. *Transportation Research Part D: Transport and Environment* 104, 103205.
Hosseinzadeh, A., Karimpour, A., Kluger, R., 2021. Factors influencing shared micromobility services: An analysis of e-scooters and bikeshare. *Transportation Research Part D: Transport and Environment* 100, 103047.
Hsu, Y.-T., Yan, S., Huang, P., 2021. The depot and charging facility location problem for electrifying urban bus services. *Transportation Research Part D: Transport and Environment* 100, 103053.
Huber, D., Viere, T., Nemoto, E.H., Jaroudi, I., Korbee, D., Fournier, G., 2022. Climate and environmental impacts of automated minibuses in future public transportation. *Transportation Research Part D: Transport and Environment* 102, 103160.
Labee, P., Rasouli, S., Liao, F., 2022. The implications of Mobility as a Service for urban emissions. *Transportation Research Part D: Transport and Environment* 102, 103128.
Lee, M., Chow, J.Y., Yoon, G., He, B.Y., 2021. Forecasting e-scooter substitution of direct and access trips by mode and distance. *Transportation Research Part D: Transport and Environment* 96, 102892.
Lee, Y., Chen, G.Y.-H., Circella, G., Mokhtarian, P.L., 2022. Substitution or complementarity? A latent-class cluster analysis of ridehailing impacts on the use of other travel modes in three southern US cities. *Transportation Research Part D: Transport and Environment* 104, 103167.
Li, W., Pu, Z., Li, Y., Tu, M., 2021. How does ridesplitting reduce emissions from ridesourcing? A spatiotemporal analysis in Chengdu, China. *Transportation Research*

Part D: Transport and Environment 95, 102885.
Liazos, A., Iliopoulou, C., Kepaptsoglou, K., Bakogiannis, E., 2022. Geofence planning for electric scooters. *Transportation Research Part D: Transport and Environment* 102, 103149.
Liu, K., Gao, H., Liang, Z., Zhao, M., Li, C., 2021. Optimal charging strategy for large-scale electric buses considering resource constraints. *Transportation Research Part D: Transport and Environment* 99, 103009.
Luo, H., Kou, Z., Zhao, F., Cai, H., 2019. Comparative life cycle assessment of station-based and dock-less bike sharing systems. *Resources, Conservation and Recycling*, 146, 180-189.
Ma, Q., Yang, H., Ma, Y., Yang, D., Hu, X., Xie, K., 2021. Examining municipal guidelines for users of shared E-Scooters in the United States. *Transportation Research Part D: Transport and Environment* 92, 102710.
Rejali, S., Aghabayk, K., Mohammadi, A., Shiwakoti, N., 2021. Assessing a priori acceptance of shared dockless e-scooters in Iran. *Transportation Research Part D: Transport and Environment* 100, 103042.
Sadeghinasr, B., Akhavan, A., Furth, P.G., Gehrke, S.R., Wang, Q., Reardon, T.G., 2021. Mining dockless bikeshare data for insights into cyclist behavior and preferences: Evidence from the Boston region. *Transportation Research Part D: Transport and Environment* 100, 103044.
Shi, K., Shao, R., De Vos, J., Cheng, L., Witlox, F., 2021. The influence of ride-hailing on travel frequency and mode choice. *Transportation Research Part D: Transport and Environment* 101, 103125.
Silva, T.B.D., Baptista, P., Silva, C.A.S., Santos, L., 2022. Assessment of decarbonization alternatives for passenger transportation in Rio de Janeiro, Brazil. *Transportation Research Part D: Transport and Environment*, 103161.
Storch, D.-M., Timme, M., Schröder, M., 2021. Incentive-driven transition to high ride-sharing adoption. *Nature Communications* 12(1), 1-10.
Straubinger, A., Verhoef, E.T., de Groot, H.L., 2022. Going electric: Environmental and welfare impacts of urban ground and air transport. *Transportation Research Part D: Transport and Environment* 102, 103146.
Sun, B., Garikapati, V., Wilson, A., Duvall, A., 2021. Estimating energy bounds for adoption of shared micromobility. *Transportation Research Part D: Transport and Environment* 100, 103012.
Taiebat, M., Amini, E., Xu, M., 2022. Sharing behavior in ride-hailing trips: A machine learning inference approach. *Transportation Research Part D: Transport and Environment* 103, 103166.
Tikoudis, I., Martinez, L., Farrow, K., Bouyssou, C.G., Petrik, O., Oueslati, W., 2021. Ridesharing services and urban transport CO2 emissions: Simulation-based evidence from 247 cities. *Transportation Research Part D: Transport and Environment* 97, 102923.
Wang, Y., Shi, W., Chen, Z., 2021. Impact of ride-hailing usage on vehicle ownership in the United States. *Transportation Research Part D: Transport and Environment* 101, 103085.

Wang, Y., Zhan, Z., Mi, Y., Sobhani, A., Zhou, H., 2022. Nonlinear effects of factors on dockless bike-sharing usage considering grid-based spatiotemporal heterogeneity. *Transportation Research Part D: Transport and Environment* 104, 103194.

Wang, Z., He, S.Y., 2021. Impacts of food accessibility and built environment on on-demand food delivery usage. *Transportation Research Part D: Transport and Environment* 100, 103017.

Yan, X., Yang, W., Zhang, X., Xu, Y., Bejleri, I., Zhao, X., 2021. A spatiotemporal analysis of e-scooters' relationships with transit and station-based bikeshare. *Transportation Research Part D: Transport and Environment* 101, 103088.

Yang, H., Zhai, G., Yang, L., Xie, K., 2022. How does the suspension of ride-sourcing affect the transportation system and environment? *Transportation Research Part D: Transport and Environment* 102, 103131.

Yeow, L.W., Yan, Y., Cheah, L., 2022. Life cycle greenhouse gas emissions of alternative fuels and powertrains for medium-duty trucks: A Singapore case study. *Transportation Research Part D: Transport and Environment* 105, 103258.

Yi, Z., Smart, J., 2021. A framework for integrated dispatching and charging management of an autonomous electric vehicle ride-hailing fleet. *Transportation Research Part D: Transport and Environment* 95, 102822.

Zakhem, M., Smith-Colin, J., 2021. Micromobility implementation challenges and opportunities: Analysis of e-scooter parking and high-use corridors. *Transportation Research Part D: Transport and Environment* 101, 103082.

Zhao, P., Haitao, H., Li, A., Mansourian, A., 2021. Impact of data processing on deriving micro-mobility patterns from vehicle availability data. *Transportation Research Part D: Transport and Environment* 97, 102913.

Zhao, Y., Ke, J., 2021. The impact of shared mobility services on housing values near subway stations. *Transportation Research Part D: Transport and Environment* 101, 103097.

Zhou, Y., Yu, Y., Wang, Y., He, B., & Yang, L. (2023). Mode substitution and carbon emission impacts of electric bike sharing systems. *Sustainable Cities and Society*, *89*, 104312.

Ziedan, A., Shah, N.R., Wen, Y., Brakewood, C., Cherry, C.R., Cole, J., 2021. Complement or compete? The effects of shared electric scooters on bus ridership. *Transportation Research Part D: Transport and Environment* 101, 103098.

Linchuan Yang*
Department of Urban and Rural Planning, School of Architecture, Southwest Jiaotong University, Chengdu, China

Hua Cai
School of Industrial Engineering, Purdue University, West Lafayette, IN, USA
Environmental and Ecological Engineering, Purdue University, West Lafayette, IN, USA

W. Y. Szeto
Department of Civil Engineering, The University of Hong Kong, Hong Kong, China

* Corresponding author.
E-mail address: yanglc0125@swjtu.edu.cn