New insights in travel satisfaction research

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Subjective wellbeing (SWB) has been increasingly used as a measure of social sustainability in many cities and nations (Kyttä et al., 2016; Stiglitz et al., 2009). As a specific domain of SWB, travel satisfaction has recently attracted significant attention (Chatterjee et al., 2020; De Vos et al., 2013; Ettema et al., 2011). It offers a direct measurement of individuals' mood, emotion and cognitive judgement on travel experiences, and thus captures the experienced utility of travel (Bergstad et al., 2011; Ettema et al., 2010; Ye and Titheridge, 2017).

In the past decade, many studies have defined and measured travel satisfaction, and investigated its correlates such as trip characteristics (e.g., mode choice and trip duration) (St-Louis et al., 2014), the built environment (Ye and Titheridge, 2017), and travel attitudes (Cao and Ettema, 2014). However, the literature has outstanding gaps. First, a limited number of studies have focused on travel satisfaction in developing countries. Second, from the equity perspective, more research is needed to understand the extent to which vulnerable groups (e.g., older people, children, disadvantaged populations including minority groups, those with disabilities, and those with lower-incomes) are satisfied with their travel and the correlates of their satisfaction. Third, the literature has little information on how people experience new forms of mobility (e.g., shared mobility and autonomous vehicles). Fourth, open and real-time sensor data and new data analytical methods may provide opportunities to examine various aspects of travel satisfaction from a new perspective. Fifth, the broad impacts of travel satisfaction on personal health, family life, social interactions, and work productivity also merit further investigation. Aiming to fill these research gaps, we launched a call for papers on travel satisfaction in August, 2020. We received 69 submissions and accepted 24 articles (Table 1). These papers bring novel insights into travel satisfaction research and help address some gaps as presented above. We discuss the unique contribution of these articles based on the following topics.

[Insert Table 1 here]

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- **Travel satisfaction in developing countries**

The 24 articles cover case studies from 11 countries. Fourteen papers focus on cities/regions in developing countries, including China, India, Nigeria, and Vietnam. The unique socio cultural and travel characteristics of developing countries provide new opportunities for travel satisfaction research. First, because transit is a primary travel mode in developing countries, several studies emphasize satisfaction with bus and subway services in Chinese and Indian cities. Fang et al. (2021) explored the travel satisfaction of bus riders in Harbin, China. Two studies investigated the relationship between subway access and travel satisfaction (Yin et al., 2021; Zhai et al., 2021) using data from two Chinese cites. Mandhani et al. (2021) examined gender disparity in metro service satisfaction in Delhi, India. Furthermore, air pollution and a lack of green space are important urban issues in developing countries that influence people's travel experience. Ma et al. (2020) examined how exposure to air and noise pollution is associated with activity satisfaction using both environmental sensor and survey data collected from Beijing, China, and they found that air pollution has a greater effect than noise pollution on activity satisfaction. Ta et al. (2021) explored the relationship between exposure to green space and travel satisfaction in Beijing, China, and they found that green exposure contributes to higher walking satisfaction and greater satisfaction with nonwork travel.

- **Travel satisfaction of vulnerable populations**

Four articles investigate travel satisfaction of vulnerable populations. Fang et al. (2021) compared bus service attributes that affect travel satisfaction of choice and captive bus riders in Harbin, China, and found that bus convenience and comfort are more important for the satisfaction of captive riders, while choice riders are more concerned with bus availability. Humagain et al. (2021) created an innovative indicator of travel captivity by measuring the gap in travel satisfaction between the chosen and alternative commute modes. Based on

survey data from Portland, Oregon, they found that auto users are mostly captive and less satisfied than active travelers, while active travelers are more likely to be choice users. Mogaji and Nguyen (2021) examined factors associated with travel satisfaction among disabled passengers in Nigeria and its potential impact on their social life. They found that many vulnerable individuals and minority groups in Nigeria are experiencing a low level of travel satisfaction. The lack of transportation infrastructure in Nigeria forces many disabled passengers to adjust their travel behavior, reducing their participation in social activities. Females are significantly underrepresented in transit use in India because of service accessibility, sexual harassment, and other safety concerns (Shah et al., 2017). Mandhani et al. (2021) compared men's and women's perceptions of metro services in Delhi, India, and found that males attach more importance to passenger ease while females value service availability and security.

- **Satisfaction with emerging and future travel modes**

Three articles provide new evidence on satisfaction with emerging and future modes of transport. Aman et al. (2021) investigated satisfaction of e-scooter riders using app review data from two major micromobility companies in the U.S. (Lime and Bird). They found that ease of use, safety (speed and riding lane), and app features are the key factors that influence rider satisfaction. Nguyen-Phuoc et al. (2021) examined satisfaction and loyalty of ride-sourcing services in Ho Chi Minh City, Vietnam, and found that perceived vehicle- and driver-related risk has a direct effect on passenger satisfaction and loyalty, and that trust is a mediator between perceived booking app-related risk and satisfaction/loyalty. Li et al. (2021) explored the correlates of satisfaction with autonomous vehicles using a stated preference survey. They concluded that perceived benefit, perceived risk, interpersonal feelings, infrastructure adaptability, driving self-efficacy, and mental workload are all associated with satisfaction with autonomous vehicles.

- **New methods in travel satisfaction research**

Several studies apply new methods to examine travel satisfaction. Yin and Shao (2021) employed a gradient boosting decision tree approach to explore the nonlinear effects of specific travel characteristics on satisfaction, and they found that commuting duration shows nonlinear relationships with happiness, and the nonlinear patterns vary across commuting modes. Gao et al. (2021) applied a random forest approach to investigate the importance, complex nonlinear effects and interaction effects of various factors on airline travel satisfaction. They found that the effects of service attributes on airline travel satisfaction are nonlinear, and there are interaction effects between passenger characteristics and service attributes on airline travel satisfaction. These studies suggest that machine learning approaches are being increasingly used in recent travel satisfaction research. Compared with traditional regression models, machine learning approaches provide more accurate estimates and are able to model complex interaction effects and visualise nonlinear relationships between predictors and satisfaction variables. In addition to machine learning methods, Sukhov et al. (2021) employed a fuzzy set Qualitative Comparative Analysis to explore the complex interaction effects of different transit service attributes on overall travel satisfaction. They found that overall transit satisfaction is determined by satisfaction with multiple service quality attributes, not just by satisfaction with a single service attribute. Moreover, two studies utilized latent class models to examine the heterogeneity in the correlates of travel satisfaction among different population groups. In particular, Choi et al. (2021) found that commute satisfaction is heterogeneous among people with different attitudes toward commuting. Yuan et al. (2021) found that reliability, ticket service, operation schedule, and connectivity of integrated air-rail services affect satisfaction of all intermodal passengers, while the key correlates of satisfaction varies among different passenger groups. Finally, different from most studies that are primarily based on survey data, Koller (2021) relied on a

driving simulator to study the affective judgment of drivers in different route scenarios using an experimental design. The driving simulator enables researchers to measure momentary affect in an experiment and global affective judgements immediately after the experiment, reducing the recall bias which is a typical limitation of survey studies.

- **New evidence on the correlates of travel satisfaction**

Four articles provide new insights into the correlates of travel satisfaction that are different from the findings of previous studies. The literature suggests that a gap between the actual and ideal commute time is a major correlate of commute satisfaction (Humagain and Singleton, 2020; Ye et al., 2020). Using data from a retrospective survey among commuters following a workplace relocation, Ma et al. (2021b) found that the amount of variation in commute time has a greater impact on commute satisfaction than the gap between the actual and ideal commute time. Relying on a smartphone-based survey, Ermagun et al. (2022) examined the correlation between travel duration and emotional wellbeing. They found that bus, rail, and bike users withstand longer commute durations before their emotional wellbeing worsens, suggesting positive benefits of such travel modes. This finding also suggests that commute time has a threshold effect, challenging the linearity assumption commonly used in the literature. As reviewed by Ettema et al. (2016), many studies report that transit riders have lower levels of travel satisfaction compared with other mode users. Choi et al. (2021), however, found that most transit users are satisfied with their commute based on the evidence from Seoul, South Korea. They also found that bus users are more satisfied with their commute than subway users. These findings suggest that transit is not necessarily associated with a lower level of satisfaction as long as high quality of service is provided. Finally, Hook et al. (2021) is the only study in this special issue that focused on undirected travel (travel without a destination). They found that a longer duration of undirected trips is positively associated with undirected travel satisfaction suggesting a

positive utility of such trips. They also showed that the level of physical activity may be important to undirected travel satisfaction, which in turn is positively associated with subjective wellbeing.

- **Spill-over effects of travel and travel satisfaction**

Five articles examine the spill-over effects of travel and travel satisfaction on personal health, life satisfaction, and work/school performance. Ma et al. (2021a) explored the impacts of utilitarian bicycling on mental health, and found that regular bicycling ($\geq$ 3 days/week) may help reduce psychological distress and improve life satisfaction. Yin et al. (2021) investigated the link between access to subway and life satisfaction using residents living near and away from Line 2 in Xi'an, China, and found that access to subway is positively associated with life satisfaction, indirectly through walkability, accessibility and travel satisfaction. Wang et al. (2021) explored the interactive effects of haze pollution and commuting behavior on life satisfaction using survey data from 92 Chinese cities. They found that higher concentrations of PM2.5 are associated with lower life satisfaction, and increase the negative impact of commuting time on life satisfaction. Most studies examining the link between travel and SWB have focused on hedonic wellbeing. Little research has investigated the role of travel in eudaimonic wellbeing, which is concerned with the realization of self-worth and the achievement of goals. Liu et al. (2021) examined the relationship between commuting experience and eudaimonic wellbeing, and found that commute satisfaction is positively associated with eudaimonic wellbeing, and those who commute by transit, walking and cycling are more likely to report positive eudaimonic wellbeing. Few studies have examined the spillover effects of commuting on workers' performance and students' academic performance (Ma and Ye, 2019). Through an analysis of post-secondary students in the Greater Toronto and Hamilton area, Taylor and Mitra (2021) found that students' commute satisfaction is positively associated with their academic participation and success, and those

who walked or cycled to campus reported higher commute satisfaction, even after controlling for commuting duration.

- **Conclusions and Future Work**

The 24 articles provide unique contributions to the travel satisfaction literature from different perspectives. Additional research is still needed to advance the field. First, only two studies (Ma et al., 2021b; Sukhov et al., 2021) in this special issue employ a quasi-longitudinal design. We need more intervention studies or longitudinal studies to better quantify the causal effects between travel characteristics and travel satisfaction, and to gain more insights into how travel satisfaction can change over time (e.g., due to changes in travel patterns/options). Second, this special issue does not include studies addressing the effects of travel satisfaction on travel behaviour, travel attitudes, and residential location choice. The feedback effects of travel satisfaction on travel and location choice need further investigation. Verifying the feedback effects can have important policy implications, because improving travel satisfaction levels of active travellers and transit users may increase the use of these modes (De Vos, 2019). Third, future research should examine the interactive effects, nonlinear effects, and heterogeneous effects of travel characteristics on travel satisfaction. Several studies in this special issue have emphasized these effects. However, more research is needed to better understand the behavioural mechanisms underlying travel satisfaction and design-tailored transport policies. Fourth, given the growing importance of emerging travel modes (e.g., ride hailing, micromobility, automating transit), satisfaction with these modes merits further investigation.

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Table 1 A summary of 24 articles.

Studies	Topics	Study Areas	Methods	Research Design	Data	Major Findings
Aman et al. (2021)	Satisfaction of e-scooter riders	United States	Logistic regression models	Cross-sectional	App review data	Ease of use, safety (speed and riding lane), and App features are the key factors that influence rider satisfaction.
Choi et al. (2021)	Transit satisfaction	Seoul, South Korea	Ordered probit model and latent class ordered probit model	Cross-sectional	Self-administered survey data	Bus users are more satisfied with their commute than subway users. Most of the transit users are satisfied with their commute in Seoul. Commute satisfaction is heterogeneous among people with different attitudes toward commuting.
Ermagun et al. (2022)	Travel duration tolerance and emotional wellbeing	Minneapolis-St. Paul, USA	Survival analysis	Cross-sectional	Smartphone based survey	Bus, rail, and bike users withstand longer commute durations before their emotional wellbeing worsens
Fang et al. (2021)	Bus satisfaction	Harbin, China	Impact asymmetry analysis	Cross-sectional	Self-administered survey data	Bus service attributes that affect the overall satisfaction of captive and choice riders are different. Convenience and comfort are more important for the satisfaction of captive riders, while the choice riders concern more on bus availability.
Gao et al. (2021)	Airline travel satisfaction	USA	Machine-learning	Cross-sectional	U.S. Airline passenger satisfaction survey data	The effects of service attributes on airline travel satisfaction are nonlinear, and there are interaction effects between passenger characteristics and service attributes on airline travel satisfaction.
Hook et al. (2021)	Satisfaction of undirected trips	Flanders, Belgium	Mean-comparison and generalized linear regression models	Cross-sectional	Self-administered survey data	Longer duration of undirected trips is positively associated with undirected travel satisfaction (UTS), suggesting a positive utility of such trips. The level of physical activity may be important to UTS. UTS is positively associated with subjective wellbeing.

Humagain et al. (2021)	Travel captivity and travel satisfaction	Portland, USA	t-test and linear regression	Cross-sectional	Self-administered survey data	Auto users are most captive and less satisfied than active travelers, while active travelers are more likely to be choice users.
Koller (2021)	Driving routes and affective wellbeing	Berlin, Germany	Linear mixed model	Simulation study	Driving simulation experiment	Optimized segmentation can increase the utility of impeded routes
Li et al. (2021)	Satisfaction with autonomous vehicles	China	Structural equation modeling	Cross-sectional	Self-administered survey data	Perceived benefit, perceived risk, interpersonal feelings, infrastructure adaptability, driving self-efficacy, and mental workload are all associated with satisfaction with autonomous vehicles.
Liu et al. (2021)	Commuting experience and eudaimonic well-being	Heze, China	ANOVA + linear regression and regression curve method	Cross-sectional	Self-administered survey data	Commute satisfaction is positively associated with eudaimonic well-being. Public transport, walking and cycling has positive effects on eudaimonic well-being.
Ma et al. (2020)	Pollution and activity satisfaction	Beijing, China	Multilevel logistic regression models	Cross-sectional	Portable sensor data + survey data	Perceived air and noise pollution are significantly associated with lower levels of activity satisfaction, while the sensor-based pollution metrics are not.
Ma et al. (2021a)	Bicycling and mental health	Victoria, Australia	Propensity score methods	Cross-sectional	Survey data	Regular bicycling may help to reduce psychological distress and improve life satisfaction.
Ma et al. (2021b)	Commute dissonance and satisfaction	Montreal, Canada	Ordered logistic model	Quasi-longitudinal	Self-administered survey data	A negative dissonance between actual and ideal commute time is negatively associated with commute satisfaction, while a positive dissonance is not. A dissonance between current and previous commute time is more impactful on commute satisfaction than a dissonance between the actual and ideal commute time.
Mandhani et al. (2021)	Gender disparity in metro service perception	Delhi, India	Bayesian Networks (BN)+Partial least squares structural equation modeling	Cross-sectional	Self-administered survey data	Gender disparity exist in perceptions of metro service quality, and males consider more on passenger ease while females consider security seriously.

Author (Year)	Topic	Location	Method	Study Design	Data	Key Findings
Mogaji and Nguyen (2021)	Transportation satisfaction of disabled passengers	Nigeria	Qualitative analysis	Qualitative analysis	Semi-structured interviews data	The lack of transportation infrastructure in Nigeria forces many disabled passengers to adjust their travel behavior, reducing their opportunities in engaging important social activities. Both personal and place characteristics influence the evaluation of travel experiences and travel satisfaction. Many vulnerable individuals and minority groups in Nigeria are experiencing a low level of travel satisfaction
Nguyen-Phuoc et al. (2021)	Satisfaction and loyalty of ride-sourcing services	Ho Chi Minh City, Vietnam	Partial Least Squares - Structural Equation Modelling	Cross-sectional	Self-administered survey data	Perceived vehicle & driver-related risk has a direct effect on passenger's satisfaction and loyalty, and trust is a mediator between perceived booking app-related risks and satisfaction and loyalty.
Sukhov et al. (2021)	Transit satisfaction	Karlstad, Sweden	fuzzy set Qualitative Comparative Analysis (fsQCA)	Intervention study/repeated cross-sectional	Survey data	Overall transit satisfaction is determined by satisfaction with multiple service quality attributes, not just by satisfaction with a single service attribute.
Ta et al. (2021)	Green space exposure and active travel satisfaction	Beijing, China	Multilevel ordered logit models	Cross-sectional	GPS-facilitated surveys and street view images	Green exposure contributes to higher walking satisfaction, but is not associated with bicycling satisfaction. Green exposure has a positive impact on satisfaction with nonwork travel, but has no impact on commuting satisfaction.
Taylor and Mitra (2021)	Commute satisfaction of post-secondary student	Greater Toronto and Hamilton Area, Canada	Multivariate binomial logistic regressions+ ordinal logistic regression	Cross-sectional	2019 StudentMoveTO survey	Students commute satisfaction is related to their campus and academic participation. Students who walked or cycled to campus reported higher commute satisfaction.
Wang et al. (2021)	Impacts of commuting behavior, haze pollution and its changes on life satisfaction.	92 Chinese cities	Multilevel logit regression models	Cross-sectional	China Labor-force Dynamics Survey (CLDS) + Satellite derived PM2.5 data	Active commuters have higher life satisfaction while transit commuters have lower life satisfaction, compared with car commuters. PM2.5 concentration is associated with lower life satisfaction, and it increases the negative impact of commuting time on life satisfaction.

Yin and Shao (2021)	Nonlinear relationship between commuting, built environment and happiness	327 Chinese communities	Gradient boosting decision tree (GBDT)	Cross-sectional	2014 China Labor-force Dynamics Survey (CLDS)	The commuting duration shows nonlinear relationships with happiness, and the nonlinear patterns vary across commuting modes.
Yin et al. (2021)	Subway and life satisfaction	Xi'an, China	Structural equation modeling	Cross-sectional	Self-administered survey data	Access to subway is positively associated with life satisfaction, primarily through the paths of walkability, accessibility and travel satisfaction.
Yuan et al. (2021)	Satisfaction of air-rail integrated services	Shijiazhuang, China	Latent class clustering Partial least squares-structural equation model Importance-performance map analysis	Cross-sectional	Self-administered survey data	Reliability, ticket service, operation schedule and connectivity of air-rail integrated services affect the satisfaction of all intermodal passengers, while the key determinants affecting satisfaction varies in different passenger groups.
Zhai et al. (2021)	Rail access and commute satisfaction	Beijing, China	Bayesian multilevel ordinal response model	Cross-sectional	Self-administered survey data	Rail access improves commuting satisfaction.