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Accessibility

The Impact of Transit Monetary Costs on Transport Equity Analyses

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Transport equity analyses are often informed by accessibility estimates based solely on travel time impedance, ignoring other elements that might hinder access to activities, such as the monetary cost of a trip. This paper examines how and to what extent incorporating both time and monetary costs into accessibility measures may impact transport equity assessment. We calculate job accessibility by transit in the city of Rio de Janeiro, Brazil, using cumulative opportunity measures under distinct combinations of temporal and monetary thresholds, and compare how inequality levels vary across different scenarios. We find that the most common research practice of disregarding monetary costs tends to overestimate accessibility levels. However, stricter monetary constraints do not necessarily result in less equitable scenarios. How accessibility inequality is affected by monetary costs is highly dependent on what combinations of temporal and monetary cut-offs are considered in the analysis. In the case of Rio, opting for more rigid monetary thresholds might underestimate inequality levels in shorter trips, but overestimate them when allowing for longer trips. This is the consequence of a complex interaction between fare policies, the spatial organisation and operational characteristics of Rio's transit system, and the spatial co-distribution of jobs and residential locations in the city. The paper thus highlights that conclusions and policy recommendations derived from transport equity analyses can be affected in non-intuitive ways by the interplay between temporal and monetary constraints. Future research should investigate how different combinations of travel time and monetary costs thresholds affect equity analyses in different contexts.

Disparities Versus Insufficiencies: Equity Analysis of Accessibility Patterns

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Abstract. Many studies on equity in transport have analyzed disparities in access to destinations between different population groups. In this paper, we challenge this disparity-focused approach to equity and propose an alternative: the analysis of accessibility insufficiencies. We argue that a disparity-focused analysis fails on two accounts. First, such analyses are based on aggregated group averages that inherently hide possibly large in-group variance. Second, these studies compare levels of accessibility between groups, without addressing whether these levels actually allow people to engage in daily activities. The proposed sufficiency approach, in contrast, avoids the former ecological fallacy and addresses the latter by setting an explicit benchmark for accessibility. The presented empirical analyses for 49 of the 50 largest US metropolitan areas confirm the problematic nature of disparity-focused analyses. In line with most literature, our analyses of disparities show that disadvantaged groups, defined along lines of income or income and race jointly, are virtually always better served by public transport than their more advantaged counterparts. Yet, a systematic sufficiency analysis reveals large inequities in accessibility, irrespective of the exact sufficiency threshold employed. Even for a modest sufficiency threshold of 10\% of average car-based accessibility, a total of 19 million people is affected, representing 15\% of the total

population in the 49 metropolitan regions. A further assessment shows a clear racial dimension in the observed insufficiencies, with the poor Black population carrying a substantially larger share of accessibility insufficiency than their share in the poor population. We end with a call for more systematic equity analyses, even if that implies inevitably normative, and thus difficult, decisions and the moving away from a seemingly neutral analysis of disparities.

Bicycle and Equity: Exploring the Distributive Impacts of Bicycle-related Benefits

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Abstract. Encouraged by the sustainable development goals, cities around the world are defining planning strategies to promote the bicycle as a suitable and accessible transportation option. Yet, despite the political efforts to change the current car-oriented paradigm, it remains overlooked to what extent issues of equity have been addressed within the scope of bicycle planning and policy. By adopting a heuristic approach, this paper delves into the current distributive justice debate and equity-based assessments, exploring representative literature concentrated on both social and spatial impacts of cycling. Findings from the United States, South America, Canada, United Kingdom and Europe reveal that often bicycle benefits such as infrastructure coverage, mobility and accessibility are unevenly distributed in cities, disregarding disadvantaged areas and vulnerable population groups. Whereas empirical evidence suggests that equity issues have been neglected during bicycle planning and decision-making processes, this review highlights methodological strengths and limitations, as well as future research pathways to support planners, politicians, and practitioners towards more equitable approaches.

Examining the Performance of Transport Systems in Large US Metropolitan Areas

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Abstract. The assessment of transport systems has traditionally focused on congestion and ridership as its core performance measures. These perspectives fail to account for the actual service people seek from the transport system – the ability to reach destinations. Recent studies have shifted to focus on accessibility as a performance indicator, but these studies do not address the question whether the observed accessibility is sufficient for meeting people's daily needs. This paper contributes to the accessibility literature by (1) applying a people-centered approach to the performance assessment of a transport system to (2) explore the factors explaining the differences in performance between regions. Such an analysis requires developing a performance standard against which transport systems can be evaluated. The paper proposes the Accessibility Sufficiency Index (ASI) as the standard. The ASI is based on a sufficiency threshold representing an accessibility level that enables adequate access to destinations. The paper uses neighborhood public transport accessibility and metropolitan average car accessibility data to calculate separate ASI scores for different sufficiency thresholds for 49 large US metropolitan areas. Regression analyses show that population size does not explain transport system performance. The most important factors explaining performance are public transport provision in terms of vehicle revenue miles and land use patterns, though the size of these effects varies by the sufficiency threshold used. The results have implications for the ways we evaluate the transport system and for our understanding of the factors that affect its performance.

Mobility and Accessibility Paradigms in Dutch Policies: An Empirical Analysis

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Abstract. To promote sustainable urban development, transport policies need to change from a car-oriented mobility planning paradigm to an accessibility-based paradigm, integrating land-use and transport policies. This paper uses the concept of planning paradigms to describe the current status of municipal transport planning and problem framing. The dominant transport planning paradigm of 172 Dutch municipalities was determined, based on a conceptual framework with 24 mobility and accessibility planning criteria. Statistical analysis was conducted to find linkages between the planning paradigm and transport, land-use and institutional characteristics of the municipalities. We show that the mobility planning paradigm still dominates Dutch municipal transport planning, and the accessibility planning paradigm is mostly found in large cities and highly urban municipalities. However, we do find indications of slow change in the transport planning paradigms in Dutch municipalities, as older policy documents are more (car) mobility focused than newer policy documents. Further research is necessary to examine the evolution of the paradigm shift in municipal transport planning over time and what factors promote the realization of such a paradigm shift.

The Relationship Between Transport Accessibility and Employment Duration

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Abstract. The purpose of this research is to investigate whether transport accessibility influences the employment duration of individuals in South Africa. The South African Revenue Service's IRP5 administration datasets, which indicate employment duration and spatial location data (where workers reside and work) for all income earners in South Africa, were used to determine individuals' employment duration, as well as the travel distances between their residence and place of employment. Airline distance was used as a proxy for transport accessibility. The results indicate a negative relationship between increased commuting distance and employment duration for lower-income individuals, with these commuters being more affected by greater travel distances than higher-income groups. Spatial mapping indicates a job–housing mismatch in South African metropolitan areas and limited employment search areas for lower-income workers compared with higher-income workers, leading to further inequality.

A Multi-modal, Multi-activity, Multi-scalar Analysis for Sustainable Accessibility Planning

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Abstract. This paper explores the question of accessibility and sustainable mobility by the use of accessibility measures that combine transport mode, settlement type and amenity category. The overarching questions it how to better understand the potential for sustainable living through good access to important every-day amenities within short travel times and how this differs across different geographies and modes of travel.

The analysis is focused on region Västra Götaland, Sweden and draws on a unique combination of novel open-source data of the transport system and official Swedish register data of the total population of individuals and workplaces geocoded at a 100-meter resolution. The results are presented with a variety of different maps and multidimensional plots and confirm the strengths of the car as provider of good accessibility. However, for short trips of 10 minutes the bicycle provides a very competitive alternative in urban and suburban areas. Access to every-day amenities by slow modes is limited outside the built-up areas. Public transport is not a viable alternative until travel times are reaching 25-30 minutes.

Results are discussed with emphasis on how measures relate to the interests of planning practice. For example, the selection of parameters and its problems, limitations and need for further development as well as the potential to develop measures that might respond to planners need for policy support.

By way of conclusion, this paper is contributing with an exploration of measurement for comparison of all modes, in a detailed geography of settlement categories together with an in-depth consideration of the destination component of accessibility in terms of different activities/amenities.

Step-free Railway Station Access in the UK: The True Value of Inclusive Design

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Abstract. Background: Despite substantial investment in step-free access at UK railway stations, persons with reduced mobility (PRMs) continue to travel less than their able-bodied counterparts and little is known about the value of step-free access for these people. This research examines the benefits of step-free access and its impact on rail usage among PRMs.

Methods: These issues are explored through a mixed methods approach. Semi-structured interviews with ten key organisations were undertaken, as was an analysis of Senior/Disabled Persons Railcard data from 17 railway stations in Buckinghamshire, each with varying levels of step-free accessibility.

Results: The results show that the benefits of step-free access extend beyond benefits at the individual level typically associated with those limited to PRMs, and demonstrate the potential to positively affect the society at large economically, environmentally, and socially. The findings also show a positive relationship between the level of step-free accessibility at a railway station and the percentage of PRMs using it.

Conclusions: This research argues that government and interested stakeholders should commit to expanding the number and coverage of step-free stations throughout the UK. They should ensure that the appraisal process for investment in step-free accessibility appropriately captures both user and non-user benefits.

The Multimodal Accessibility Target (MAT)

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Abstract. Accessibility research in the transportation and land-use literature has been dominated by unimodal and comparative approaches to analyze accessibility. Little attention has been paid to quantifying multimodal accessibility or the interactions between modes, and how these can impact overall accessibility. Moreover, the use of targets for accessibility in planning has been largely ignored. Particularly important to the evaluation of transportation planning outcomes is accessibility to employment as it is a key element and predictor of urban economic prosperity. This paper, building on the work of Alain Bertaud, proposes the Multimodal Accessibility Target or MAT. The MAT has been designed to allow for a more accurate picture of overall (across mode) accessibility to jobs in a city, and to be used in the evaluation of transportation intervention scenarios. It also provides a target for accessibility that is an easily interpretable indicator that can serve as a goal in accessibility-based transportation planning. It can be used to provide a clear idea of how overall accessibility will increase or decrease as a result of transportation infrastructure investments. A case study of the proposed implementation of a BRT system in Montreal, Canada is used as an empirical example of the use of the MAT. In the case study, predicted multimodal accessibility to employment in the study area (and thereby the MAT) is found to increase as a result of the BRT implementation compared to the base case scenario.

Immigrant Settlement Patterns, Transit Accessibility, and Transit Use

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Abstract. Public transit is immensely important among recent immigrants for enabling daily travel and activity participation. The objective of this study is to examine whether immigrants settle in areas of high or low transit accessibility and how this affects transit mode share. This is analyzed via a comparison of two gateway cities: Sydney, Australia and Toronto, Canada. We find that in both cities, recent immigrants have greater levels of public transit accessibility, on average, compared to the overall population, but the geography of immigrant settlement is more suburbanized in Toronto than in Sydney. Secondly, using logistic regression models with spatial filters, we find significant positive relationships between immigrant settlement patterns and transit mode share, after controlling for transit accessibility and other socio-economic factors, indicating an increased reliance on public transit by recent immigrants. Via a sensitivity analysis, we find that these effects are greatest in peripheral suburbs and rural areas. These findings highlight the overall importance of providing public transit to immigrant communities, but transit usage by recent immigrants will vary regionally and depending on local neighbourhood context.

Accessibility to Employment in the City of Toronto by Level of Income

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Abstract. Accessibility has been a popular indicator for measuring system performance, policy effects and, more lately, inequities in the urban planning field. However, the measurement of accessibility itself remains controversial. This study uses a utility-based accessibility measure to calculate access to employment in the Greater Toronto-Hamilton Area (GTHA) by workers from different income levels living in the City of Toronto. Accessibility calculated for workers from four occupation types (General Office, Manufacturing, Professional, and Sales/Services) are aggregated into five Income Categories. Spatial variation and distinctive patterns of employment accessibility are observed for the employees indicating a significant difference in levels and variability of the measure depending on level of income.

Applying Utility-based Accessibility Measures in Nairobi, Kenya: Comparing Accessibility Impacts of Transportation and Land Use Improvement with Logsums

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Abstract. Accessibility is an important consideration in improving networks, modes, and/or land use patterns, in any transport setting. In countries like Kenya, many travelers do not have access to cars, and transit service is key to access, economic development, and community welfare. This paper uses monetized differences in nested logsums to value changes in Nairobi's residents across destination zones and three travel modes. Results show how transit versus land use improvement policies affect residents of formal and informal (slum-area) housing differently. Welfare changes are compared when assuming independent error terms in before-after cases and allowing for perfect correlation in error terms (to recognize the same persons and modes are present in both settings). Under both access-improvement scenarios, residents of formal housing tend to benefit more than those in Nairobi's informally developed areas (largely slum settlements).

Planning For Accessibility: Frameworks Toward Measuring, Understanding, and Realizing Transportation Land Use Coordination for Sustainability, Livability, and Equity

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Abstract. The coordination of transportation and land use (also known as "smart growth") has been a long-standing goal for planning and engineering professionals, but to this day remains an elusive concept to realize. In response, this paper dialogues literature and practices related to transportation and land use coordination (TLC), as well as sustainability, livability, and equity (SLE), finding that a comprehensive approach is to focus on the equitable access people have to opportunities to improve their quality of life (namely jobs and housing) which, in turn, can provide a pathway to lower amounts of vehicle travel. This paper also reviews various performance measure and place typology frameworks used by transportation agencies, with an aim to synthesize insights from various sources for application in professional practice and to frame the idea of a new tool, the Smart Mobility Calculator, to help agencies (MPOs, DOTs, and local land use authorities) coordinate and achieve a balance between transportation and land use.

This paper concludes that effective planning and evaluation frameworks must: (1) help understand current conditions and future scenarios; (2) help create context-sensitive and inclusive processes; and (3) screen, prioritize, and mediate strategies in support of TLC in order to achieve sustainability, livability, and equity goals.

Access-oriented Design? Disentangling the Effect of Land Use and Transport Network on Accessibility

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David Levinson (University of Sydney)

Abstract. In urban planning and design, a holistic perspective is needed to analyse the efficiency of different plans. Access (or accessibility) is a concept that measures the performance of a city in terms of how easily residents can reach their desired destinations. The land use pattern and the transport network configuration are the two critical elements of locational access measures. This study investigates whether access-oriented design can improve accessibility outcomes, and disentangles access benefits from network design and land use patterns. A generic superblock with two types of street network design is defined and populated with two different land use allocation strategies. Local access is measured from transit stops. Furthermore, to test the hypothesis at a larger scale, the Liverpool LGA in Sydney is selected, and different combinations of land use pattern and network topology are tested. Results indicate that the land use pattern plays a vital role in the local access; however, the network configuration significantly impacts the access at the regional scale. The application of access-oriented design in future urban growth is discussed.

Rent/Price Ratios and Access to Jobs by Transit

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David Levinson (The University of Sydney)

Abstract. The ratio of housing rent to sales price is not uniform within metropolitan areas or over time for a variety of reasons. The relationship between rent/price ratios and access to jobs has not been explored. Given that there is enough evidence to the influence of access on housing prices and rents, we hypothesise that access also influences rent/price ratios, and that sales prices react to future expected changes in access before rents. To test our hypothesis, we model rent/price ratios and differences in rent/prices ratios over time against changes in access values for the Greater Sydney region at the postal area level. Rent/price ratios are computed as the ratio of weekly rents to weekly mortgage repayments on housing prices using rental and sales data for 2015 and 2017, and changes in access values are assessed between 2015 and 2019. The results corroborate our hypothesis for increase in access. The estimates for decrease in access, however, could not be explained and need further investigation.

Towards a General Theory of Access

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Abstract. This paper integrates and extends many of the concepts of accessibility deriving from Hansen's (1959) seminal paper, and develops a theory of access that generalizes from the particular measures of access that have become increasingly common. Access is now measured for a particular place by a particular mode for a particular purpose at a particular time in a particular year. General access is derived as a theoretical ideal that would be measured for all places, all modes, all purposes, at all times, over the

lifecycle of a project. It is posited that more general access measures better explain spatial location phenomena.

The Relationship between Walkability and QOL Outcomes in Residential Evaluation

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Abstract. To improve social factors related to quality of life (QOL), slow travel modes, represented by walking, may enable more opportunities for physical activities/social contacts. The impacts of walking may vary by the walkability of spatial environments, namely, by how accessible activities are by walking, and how safe, comfortable, and pleasant neighborhood streets are for walking. Little is yet known about the influence of walkability on various QOL outcomes, especially in car-oriented Asian cities. This study aimed to comprehensively explore the relationship between walkability and QOL outcomes by assessing the relationship between their multiple indicators. We first defined the indicators of walkability and QOL. Then, a questionnaire-based survey was administered to 500 inhabitants of Nagoya city (Japan) for evaluations of their neighborhoods with the indicators of walkability (neighborhood street accessibility and street quality) and QOL (health, social relationship, and residential satisfaction). Finally, the relationships between walkability and QOL outcomes were analyzed using structural equation modeling (SEM). Results showed that, although neighborhood street accessibility to activities affected QOL outcomes in various ways (through the interrelationship among the outcomes), neighborhood street quality (particularly pleasurability) significantly affected all the QOL outcomes. The findings suggest the importance of street quality in land-use transport studies.

Accessibility under Limited Transport Services: The Case of Marinduque, Philippines

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Abstract. The study of sustainable mobility, as well as equity in mobility as part of social development, has been less conducted in rural areas as compared to urban areas, specifically in developing countries. This could be due to some reasons such as the small population and limited economic and social activities in rural areas. Marinduque, an island province of the Philippines, is facing limited public transport services, and many low-income households cannot afford to own private vehicles. Given the need for effective urban planning, this study assessed the accessibility of residential areas to key destinations by different passenger transport modes in the island province. The study area was divided into 65 zones based on the conditions and characteristics of the adjacent barangays (the small administrative zones) to distribute the data during the sampling process. The study used the primary dataset of 1,103 households collected throughout the province in 2019. A gravity-based accessibility approach was applied for the data analysis with five accessibility models developed for hospitals, schools, markets, workplaces, and an aggregated mix considering the four facility types. The workplace and school destinations have the best accessibility because these facilities are spatially scattered throughout the province. The residents living along the national roads lead to higher accessibility to key destinations as compared to the residents living in the central part of the province. The findings of this study provide urban planners and transport policymakers insights on how to enhance urban planning and transport policy for sustainable mobility and equity in social development in the province.

Data

A Brief Discussion on the Treatment of Spatial Correlation in Multinomial Discrete Models

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Abstract. Spatial dependence plays a key role in all phenomena involving the geographic space, such as the social processes associated with transport and land use. Nevertheless, spatial dependence in multinomial discrete models has not received a similar level of attention as other kinds of correlations in the discrete modeling literature, mainly due to the complexity of its treatment. This paper aims at offering a brief discussion on the different kinds of spatial correlation affecting multinomial discrete models and on different ways in which spatial correlation has been addressed in the discrete modeling literature. Furthermore, the paper offers a discussion on the advantages and limitations of the different approaches to treat spatial correlation and it also proposes a compromise solution between complexity, computational costs, and realism that can be useful in some specific situations.

Unique Computational Methods to Model Rideshare Behavior and Estimate Applications for Transit

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Abstract. Ridesourcing services have become important part of local transportation ecosystems globally. They offer new new opportunities to access rides for travelers of all kinds, and also new ways to think about variants of traditional transit and affordable transportation for those without auto access. At the same time, the tension between private companies who own and have few incentives to share data has grown. Cities want to understand trips and travel trends while private sector companies view user data and trip data as a part of their most valued intellectual property. In response to this tension this paper uses a unique and original computational approach to estimate and explore trends in ride sourcing data, without having to exchange that data. This is modeled and simulated on networks in both San Francisco and Boston, and followed by discussion of our results and how they can be informed how planners and engineers can better plan for the future of local transport using using sophisticated computational data simulation methods.

Advances in Pedestrian Travel Monitoring: Temporal Patterns and Spatial Characteristics Using Pedestrian Push-button Data from Utah Traffic Signals

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Abstract. In this study, we advanced pedestrian travel monitoring by utilizing and testing a novel source of pedestrian activity information: pedestrian push-button data, obtained from archived traffic signal controller logs at more than 1,500 signalized intersections in Utah over one year (July 2018 through June 2019). The purposes of the study were to: (1) quantify pedestrian activity patterns at signalized intersections; (2) create factor groups and expansion/adjustment factors based on these temporal patterns; and (3) explore relationships between factor groups and spatial characteristics. Using empirical clustering, we classified signals into five groups based on the normalized hourly/weekly counts (each hour's proportion of weekly totals, or the inverse of the expansion factors), and three clusters, each with similar monthly adjustment factors. We also used multinomial logit models to identify spatial and climatic characteristics (land use, built environment, and socio-economic characteristics, as well as climatic

regions) that helped to predict and explain which locations saw different temporal patterns in pedestrian activity levels. In addition to documenting the influence of various built environment attributes (population density, residential and commercial land uses, and connected street networks), the most notable finding was related to schools: Signals near schools were much more likely to have bimodal daily peak hours and lower pedestrian activity during out-of-school months from June through August. Despite these good results, hourly/weekday patterns differed less in this study than in past research, highlighting a limitation of relying upon existing infrastructure to capture all kinds of activity patterns. Nevertheless, we demonstrate that traffic signals with pedestrian push-button data are a useful supplement to existing permanent counters within a broader pedestrian traffic monitoring program.

Disparities and Equity Issues in Electric Vehicles Rebate Allocation

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Abstract. The path towards light-duty vehicle electrification promises benefits like lower costs for drivers and reduced environmental externalities for all. Incentives such as electric vehicle rebates assist with alleviating high capital costs of alternative fuel cars. We uncover distributional effects of plug-in electric vehicle rebates, focusing on a program in the State of California. We leverage economic attributes representative of populations of census tracts as well as data on rebates distributed to plug-in electric vehicle buyers through the Clean Vehicle Rebate Project from 2010 to 2018. Horizontal and vertical equity measures are evaluated, while measurement of spatial association characterizes spatial patterns of rebates allocation across the State. We evaluate the distributional fairness of rebates allocation between income groups and disadvantaged communities. We find that rebates have been predominantly given to higher-income electric vehicle buyers. However, the share of rebates distributed to low-income groups and disadvantaged communities increased over time and after an income-cap policy was put into effect. Spatial analysis shows high spatial clustering effects and rebates concentration in major metropolitan regions. We reveal neighborhood effects: communities with lower median income or disadvantaged receive higher rebate amount when these are geographic neighbors to clusters characterized as high income and high rebate amount receivers.

Building Distance as Simplified Indicator of Walkable Streetscape Design

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Abstract. Urban design is broadly recognized as an important influence on walking but measuring design variables that impact walkers from a street-level perspective, and integrating these variables into travel analyses, remains a substantial challenge. Design is often characterized by measures of street network accessibility, which can be easily calculated from widely available datasets. These measures do not, however, account for more finely grained aspects of streetscape morphology that may influence walkers' perceptions of safety, comfort, or interest. Urban design literature discusses numerous variables that may contribute to pedestrian-friendly places, but they are often difficult to define and require obscure data inputs or field measurements. In order to facilitate more widespread investigation of the influence of streetscapes on pedestrian transportation, I propose a simplified measure, building distance, which is the Euclidean distance between sampling points along street centerlines and the closest building. Building distance is conceptually related to streetscape design qualities such as enclosure, human scale, complexity, transparency, and imageability, and can be measured efficiently across entire regions from common data sources. This methods paper discusses the rationale for a simplified streetscape measure, describes how building distance relates conceptually to existing design qualities, demonstrates how the measure can be operationalized efficiently, and reports on an exploratory analysis of correlations between building distance and conventional built environment measures and walking mode share at the block

group level across the 100 largest U.S. urban areas. Results show that building distance is moderately independent of common built environment variables, but correlations with walking mode share vary substantially across urban areas and have unexpected directionality in some cases. This encourages further examination of how relationships between streetscapes and travel behavior may vary across geographies.

Freight

Distribution Facilities in California: A Dynamic Landscape and Equity Considerations

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Abstract. This work studies the distribution of warehouses and distribution centers (W&DCs) in California and analyzes their potential relationships with disadvantaged communities (DACs). Through aggregated spatial analyses and econometric modeling, the research compares the concentration of W&DCs in five metropolitan planning organizations (MPOs) areas in California. The analyses show that the weighted geometric centers of W&DCs have shifted slightly towards city central areas in all five MPOs in the last few years, contrasting to the logistics sprawl trends evidenced in previous research. In the Bay Area and Southern California, W&DCs are more prevalent in areas with higher pollution burden according to the CalEnviroScreen (CS) score. In Southern California, the study analyzed disaggregate industrial real estate data of 49,697 property transactions (properties leased or sold) between 1989 and 2018. On average, the size of the facilities transacted have decreased, especially for those closer to the urban center. These results are confirmed using parametric and non-parametric data analyses. During recent years, smaller and closer facilities represent the largest share in the transactions, consistent with the trends in e-commerce and its associated distribution requirements. Moreover, the data shows a disproportionate sitting of facilities in areas where DACs reside. The paper ends with a discussion of policy and planning recommendations.

A Review of the Literature on Cargo Bikes as a Microfreight Mode with a Focus on the United States

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Andrew Duvall (National Renewable Energy Laboratory)

Abstract. The electrification of cargo bikes presents a profound opportunity to capture a multitude of co-benefits by converting a subset of urban freight deliveries and a portion of personal vehicle travel to a more sustainable mode. This literature review presents a brief background on bicycles and cargo bikes as delivery vehicles, then focuses on several reasons why e-cargo bikes merit further adoption, instead of simply converting existing deliveries to electric vehicles. This is followed by an exploration of the connection with land use and planning, as these are key underlying factors when it comes to mode shift feasibility. The literature review concludes with a summary of existing commercial deployments in the United States, and discussion of barriers and opportunities for expanded use of this mode.

Health

Does Undirected Travel Compensate for Reduced Directed Travel during Lockdown?

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Frank Witlox (Ghent University)

Abstract. The COVID-19 pandemic lockdown undeniably impacted travel behavior. It is assumed that directed (commute and non-work) trips reduced following reduced out-of-home activities. Therefore this study analyzing 764 respondents in Flanders, Belgium, explores whether undirected trips, or travel for the purpose of travel itself, increase as compensation or to 'get out and about'. Additionally, change in commute and non-work trip mode and frequency is analyzed to assess whether a shift from public to private transport modes and from motorized to active modes occurred. The effect of urbanization on travel behavior change was also evaluated. Results did not indicate a shift from public to private transport modes, suggesting a general decrease in directed trips, but indicated compensation for decreased car use with both undirected and active trips. The built environment was not significantly related to changes in travel behavior, suggesting that respondents participated in compensatory behavior during the lockdown regardless of residential urbanization.

Development of a Quantitative Assessment Approach for Car Dependence: A Case Study in Munich

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Abstract. Dependence on the car is discussed as a complex problem. Since the 1970s, disadvantages of car-oriented development have been debated in the scientific community. Besides ecological aspects, problems regarding equity and for the economy have been identified. Car dependence cannot be reconciled with a sustainable future. While discussions are ongoing about what exactly car dependence means, its assessment has been mostly qualitative. Previous of the few quantitative approaches tended to analyse either high car usage and ownership or accessibility by public transport as indicators of car dependence. This study aims to quantitatively evaluate car dependence after merging these two aspects. In addition, the role of trips made on foot or by bicycle is also considered, as well as the proximity of places to meet basic needs. The methodology is applied to regional traffic zones and is divided into two parts, the calculation of an indicator for car dependence and its linkage with socio-spatial factors using multiple linear regression. An application for assessing car dependence quantitatively was conducted in the transit service area around the city of Munich, Germany. It was found that car dependence is higher in suburban areas. Other parameters, such as the local number of employees, average income tax payments, or the sales price of land were identified as factors associated with car dependence. For local stakeholders, the findings are useful for exploring car-oriented development in the area and for considering measures to prevent it. Future research may focus on application in additional regions and further combination with qualitative research.

How Commuting (Time) Satisfaction is Influenced by Changes in Employment Status, While Accounting for Satisfaction with Life Domains: A European Analysis

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Abstract. While many studies focus on the effect of change in travel-related characteristics or a change in residential location on travel satisfaction, surprisingly, no studies have yet focused on the effect of change in employment status on travel satisfaction, or in this case on satisfaction with commuting time (CTS). Work activity is also an important anchor point around which other daily activities and trips are organized. Therefore, we analysed this relationship with CTS by performing a multivariate logistic regression analysis using the European Union Statistics on Income and Living Conditions (EU-SILC) 2013 dataset for 32 countries. These countries were further classified into well developed and less-developed countries. To the best of our knowledge, this is the first study that analyses the link between employment variables, satisfaction with life and life domains on CTS for 170,750 respondents. The study concludes that part-time employees and employees with a permanent contract have higher satisfaction levels with their commuting time compared to their counterparts. Likewise, employees who did not change their employment status have higher CTS than those who experienced a change from unemployment to now being employed (i.e. from zero commutes to now commuting to work). Furthermore, the likelihood of being satisfied with commuting time verses not satisfied increases with the increase in satisfaction with the other life domains. Our analysis also includes interactions between social networks, emotions and trust on CTS. Future studies should include more employment-related variables for a robust examination of the effect of change in employment status on travel satisfaction.

The Impacts of COVID-19 Protocols on Sustainable Land Transportation

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Abstract. Covid-19 has unsustainably changed the world in many ways, with particular effects on mobility. Considering social practice theory and the theory of interpersonal behavior, the author relied on primary data sourced from transportation users and applied ordinal logistic regression models to explore the associations among covid-19 spread-containment protocols with trip sharing, the extent of commuting, and modal shift. Commuters for work-related trip purposes, for example, had 1.882 times the rate willing to share personal cars with family and friends and 2.411 times the rate willing to share public vehicles in comparison to commuters who went out for leisure. The incidence rates of change to a preferred means were higher during covid-19 than precovid, revealing further that the pandemic set an inertial phase that excited the modal share from public to private vehicle use. Furthermore, the study showed evidence that covid-19 protocols caused a surge in domestic travel within the locality than traveling outside their local government areas, which is also more than traveling outside their resident states. The paper provides a conceptual travel behavior framework towards a sustainable transportation system during a pandemic.

Flexible Parking Norms and Sustainable Mobility Choices

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Abstract. Parking is considered a key policy for achieving sustainable mobility. Swedish public agencies have promoted lowering parking requirements to decrease automobile travel, oil consumption and carbon

emissions. However, the implementation of restrictive parking policies lacks discussions about the role of the built environment and accessibility. If low parking norms are introduced in developments where it is impossible to walk, cycle or use public transportation, they do not work. This paper proposes a conceptual framework that links parking with the research on the effect of built environment on travel. It describes a model to calculate flexible parking norms based on built environment and accessibility factors commonly used in urban design and planning practices. Transportation systems need environmental preconditions. Parking requirements and expressways support driving around. Research shows that integrating walking, cycling and public transportation need complex sets of factors. The rationale is that parking norms can be lowered if the built environment supports walking, cycling and public transportation. The model aims to inform municipality officials, developers, architects, urban designers and planners about sustainable mobility choices and integration of the built environment with walking, cycling and public transportation and possibilities to reduce parking requirements to meet sustainable mobility goals.

The Political Economy of Streetspace Reallocation: Aldgate Square and Bank Junction, London

Robin Hickman (UCL)

Abstract. Streetspace reallocation projects are being implemented in many cities internationally, giving greater space to walking and cycling. But, often, they are difficult to plan and implement, attracting great controversy with residents and other actors.

This paper considers two streetspace reallocation projects, in Aldgate Square and Bank Junction, London. 15 in-depth interviews are used to explore the competing discourses on each project. The discussion examines the political economy of project implementation, including the different viewpoints on perceived problems and opportunities, project impacts and effectiveness, distribution of benefits, technical assessment, participatory processes and the resulting sanctioned discourse. Using content analysis, with NVivo software, it particularly examines the language used by the different actors in the process. The successful delivery of streetspace reallocation projects, including enhancing walking and cycling provision, needs to manage these multiple dimensions, mediating the different viewpoints and actors to help shape a beneficial project and positive narrative.

Does Street Context and Level of Traffic Stress Explain a Preference for Better Cycling Facilities?

Patrick Yutiga (Ryerson University)
Raktim Mitra (Ryerson University)

Abstract. Urban planners, transportation engineers, and public health professionals are faced with the challenge of promoting cycling as an alternative method of transportation to private automobiles, which includes creating an enabling built environment for cycling. Currently, there is limited evidence concerning the relationship between road characteristics, levels of traffic stress (LTS), and preference for cycling facilities. Within this context, and using cyclist intercept data collected from ten streets in the City of Toronto and surrounding suburban municipalities in Canada, we explored the correlation between level of traffic stress, street contexts, and preference for higher levels of cycling facilities. High-stress cycling environments, the presence of frequent transit and suburban contexts were positively associated with current cyclists' preference for higher levels of cycling facilities compared to what currently exists on the street. The presence of a bicycle lane/cycle track was negatively correlated with a preference for higher-level cycling facilities. Those who bicycle almost every day preferred higher-level cycling facilities. Our findings can be used to guide planning and policy for current and future cycling infrastructure and identify streets where improved cycling facilities may welcome more cyclists.

Quantifying the Impact of Transportation and Energy Usage on Air Quality and Health in the United States

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Jooyong Lee (University of Texas at Austin)
Huizhong Shen (Georgia Institute of Technology)
Yilin Chen (Georgia Institute of Technology)
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Abstract. The impact of electric vehicles (EVs) on energy demand, emissions and air quality has been explored in a number of studies, many of which assess EV impacts in the context of various energy supply scenarios along with increased travel demand. Many however, do not take into account the impact of self-driving vehicles (Autonomous Vehicles (AV) or Shared Autonomous Vehicles (SAVs) in quantifying EV effects. In this study, we assess the impact of AVs, SAVs and EVs in future years under a range of energy policies (EP) which include relaxed controls across multiple emission sectors. These are compared using the climate projections under Representative Concentration Pathways (RCPs). In all cases, the on-road fleet of internal combustion vehicles (ICVs) is largely expected to be more efficient and less polluting than it is at present, such that non-tailpipe emissions are a major fraction of the particulate matter emissions, limiting the positive impacts of EVs on air quality in a future scenario. The results for 2050 RCP 4.5, presented in this paper for the future climate projection scenarios found reductions in primary and secondary pollutants from 2011. The impact of increased VMT due to AV, SAV and EV utilization between the two 2050 scenarios (with/without electrification) showed further reductions due to fleet electrification in NOx (max ~0.5ppb), O3 (max~2ppb), and daily maximum 8HR O3 (max~2ppb).

University Campus Parking: It's all the Rage

Hayley Schinkowsky (University of Wisconsin-Milwaukee)
Robert J. Schneider (University of Wisconsin-Milwaukee)

Abstract. Transportation planners, engineers, and researchers have long lamented the highly emotional public responses often garnered by changes to parking policies. We know that reducing the supply and increasing the price for parking—while intended to advance sustainability and other important community goals—seems to fuel an angry response, but this knowledge is often vague and anecdotal. This study combined qualitative coding of open-ended survey responses with quantitative analyses of sociodemographic and commute characteristics using descriptive statistics and binary logistic regression models to reveal a strong correlation between parking and anger among University of Wisconsin-Milwaukee (UWM) campus users. Higher probabilities of anger were also positively associated with annual household incomes below $50,000, university employees (staff and faculty), bus pass holders, residential locations outside of the immediate UWM neighborhood, and driving more in Fall 2020 than in the respondent's first year at UWM. Qualitative themes from angry comments include frustrations about parking price, supply, and duration, questions about the motivations for university parking policies, and a sense of entitlement among campus users to free and inexpensive parking options. The study interprets these variables and themes together to provide insights into the complicated relationship between parking and anger and the importance of analyzing angry feedback to inform future policies.

Why Cities with High Bicycling Rates are Safer for All Road Users: An Analysis of Mid-Size Cities

Nicholas Ferenchak (University of New Mexico)
Wesley Marshall (University of Colorado Denver)

Abstract. Several existing studies found better traffic safety outcomes for all road users in large cities with high bicycling rates. Does this relationship hold for mid-size cities? If so, which factors are correlated with better safety outcomes? To explore these research questions, we investigated total, pedestrian, and bicycle fatality rates for fourteen mid-size U.S. cities: seven cities that have high bicycling rates and seven paired comparisons. We then explored three categories of possible pathways towards better road safety outcomes: i) travel behavior differences; ii) built environment differences (land use and street networks); and iii) socio-demographic and socio-economic factors (resident age, income, and percent White). Findings suggest that mid-size cities with higher bicycling activity are safer for all road users. They are also denser in terms of land use and transportation systems, which suggest that the cities are more amenable to transit and walking. But while high-bicycling cities also see more walking and transit use, evidence suggests that less driving has a stronger relationship with improved road safety outcomes than the proliferation of any one other mode. We found no major differences in socio-demographics or socio-economics.

Non-linear Influences of the Built Environment on Older Adults' Walking Duration: Focusing on Age and Retirement Status Differences

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Wang Wenxiao (Shanghai Jiao Tong University)
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Abstract. When examining environmental correlations of the built environment and older adults' walking duration, few studies report the importance of spatial attributes relative to different age groups and retirement status. Furthermore, previous studies often assume that they have linear relationships with walking behavior. Based on this framework, this study applies the gradient boosting decision trees method (GBDT) to analyze the nonlinear or non-monotonic relationships between the built environment and the walking duration of older adults. The data was derived from Zhongshan Household Travel Survey (ZHTS) in 2012. The sample size of old adults aged 60 or over was 4784 from 274 urban and rural neighborhoods. Results showed that the built environment attributes collectively have larger predictive power on older adults' walking duration, especially for old adults 70+ years old or not working. Moreover, they tend to have nonlinear associations with walking duration. We further identified the most effective ranges of built environment attributes to offering concrete evidence for local planning.

Subjective and Objective Built Environment Correlates of Walking Frequency among Older Adults in China

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Abstract. China is ageing rapidly and the population ageing problem will be an important in China's future development in China. The walking behaviors of older adults can be improved by rational planning

of the built environment and transportation facilities. However, these planning policies are scarce as little is known on the relationships between the built environment and older adults' walking. In this paper, the associations of the subjective and objective built environment on the walking frequency among urban older adults (age ☐ 60) in China were examined. The data were collected by an online survey and Baidu Map. Factor analysis was employed to reduce the number of subjective built environment variables into three. The ordinal logit modelling result shows that the frequency of walking among older adults is mainly influenced by subjective perception of the built environment. The mixed land use development, clean air, and safe and pleasant traffic conditions may stimulate the willingness to walk among older adults.

The Value of Green Infrastructure: Evidence from the Gold Coast, Queensland, Australia

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Corinne Mulley (The University of Sydney)
Heather Shearer (Griffith University)

Abstract. Green infrastructure is important to underpin residential choice, provide sustainable transport and contribute to a liveable neighbourhood. This study investigates the value of green infrastructure to property owners where green infrastructure is defined as including built environment features (e.g., green spaces, beach), facilities (e.g., fitness equipment in parks) and infrastructure (e.g., heavy rail, light rail). Gold Coast, Queensland, Australia is the case study. To capture geographical differences across the city, a multi-level regression modelling approach is used to measure the implicit value of green infrastructure in the property price. The results suggest only those elements of green infrastructure that can provide a service (e.g., fitness equipment) are positively valued. Importantly from a sustainable transport perspective, the current public transport network and services make a negative contribution to property price suggesting these might not meet with residents' expectation. The conclusions of the paper discuss the implications of this for literature and policy in respect of green infrastructure.

Housing

Freedom of Choice? Social and Spatial Disparities on Combined Housing and Transport Affordability

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Abstract. Housing and transport affordability (H+TA) analysis has been receiving increasing attention among academics and practitioners worldwide, particularly in Global North settings. These studies usually use aggregate averages of expenditure-to-income ratios and affordability thresholds without considering household types, overlooking spatial and socioeconomic distributional considerations that potentially under-estimates the simultaneous impact of transport and housing costs on lower-income family budgets.

Our work seeks to address these knowledge gaps by understanding and measuring housing and transport affordability, considering different types of households in Santiago, Chile, a Latin American city that face significant inequality and urban segregation issues. Combining income, housing, transport, and census

data, we estimate H+T costs using spatial clusters and probability functions, analyzing the "degree of choice" that socially disadvantaged groups have given their financial constraints.

The results show that families with children, the elderly, and immigrants are among the most affected. Most central and eastern sectors of the city are out of reach for the three lowest-income deciles given the high combined costs of H+TA, being dependents on government benefits and/or social housing. Middle class, from the 4th to 6th income deciles, can choose from between 30% and 65% of the housing and transport combinations, but from less than 6% of the two clusters with the best transport and urban conditions. These groups usually are neither poor enough to access government housing or benefits nor rich enough to easily access mortgage loans, making their housing and transport choices very limited to avoid falling into significant financial stress. These findings bring into question current intersectoral policies to alleviate the "cost pressure" for different households.

¿Which Dots to Connect? Subcentres and Commuting Inequalities in Bogotá

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Luis A. Guzman (Universidad de los Andes)
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Abstract. Workplace location is often neglected as a contributor to inequalities regarding the travel experience within an urban area. Traditionally urban planning connects high-demand areas with the best quality transport infrastructures. However, there is evidence that employment subcentres receive mainly workers in certain middle-to-high income occupations. This condition results in a type of segregation pattern associated with trip destinations similar to those reported for the household location. This paper investigates commuting from a different standpoint, emphasizing the need to account for workplace location. We identify job subcentres in Bogotá and explore the commuting mode choice of population segments using mixed logit models. Results indicate that people who work in any job subcentre tend to use more public transport. However, this differs among income groups. Specifically, when travelling to a subcentre, public transport utility for low-income commuters is lower than that for middle-income commuters. It might be related to the fact that low-income workers live more frequently in the city periphery, away from the good transport connected employment hubs and budget restrictions force them to prefer active modes. This study finding can inform decision-makers to develop targeted policies for improving commuting conditions of specific income groups departing from macro-level planning.

"Home Sweet Home." How did COVID-19 Affect Residential Satisfaction and Residential Attachment in Sydney, Australia?

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Corinne Mulley (The University of Sydney)
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Abstract. COVID-19 led to lockdowns in the major economies of the world, and Sydney, Australia, was no exception. Lockdowns have led to employees spending increasing amounts of time at home and in their residential neighbourhood undertaking 'working from home' or WFH. An internet-based survey is used to investigate how residential satisfaction and residential attachment may have changed as a result of this increase in WFH. The results suggest that residential satisfaction seems not to be affected by WFH experience. For residential attachment, residents who experience increased residential satisfaction also feel more attached to their home. The survey also allows an in-depth analysis of objective and subjective perceptions of the residential neighbourhood and the way in which these influence residential satisfaction and residential attachment. The results suggest that residential satisfaction is significantly influenced by the latent variables of 'perceived safety' and 'perceived accessibility'. As part of the analysis, the paper

also provides empirical evidence to support how residential satisfaction affects life satisfaction, thus contributing additional evidence in the direction of causation which has had mixed outcomes in previously reported empirical research. The paper concludes with some policy implications of how policy makers can encourage residential attachment which brings with it benefits of greater commitment to, and willingness to work to improve the neighbourhood.

Regional Transport Accessibility and Housing Market Dynamics: The Case Study of the Greater Toronto-Hamilton Area

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Lisa Li (University of Toronto)
Shivani Raghav (PSD)
Amer Shalaby (University of Toronto)
Eric J. Miller (University of Toronto)

Abstract. There has been a growing interest in land value capture as a means of funding investments in transport infrastructure (TI), reflected in a vast literature analysing the relationship between sales prices and accessibility provided by TI in general and transit specifically. There has, however, been limited research on the role of network-level regional transport accessibility and the intra-regional spatial heterogeneity of the price effects. Furthermore, studies usually focus on one transportation mode, disregarding the multi-modal competition, and are mostly cross-sectional or pooled cross-sectional/time series analyses which do not reflect the dynamic nature of developments in TI and housing markets. To address these gaps, this paper empirically investigates the roles of local and regional transport accessibility by car and transit on the evolution of sales prices of detached houses from 2001 to 2016, across different geographical contexts while controlling for an extensive list of other determinants in the Greater Toronto-Hamilton Area (GTHA). The spatial panel models' results confirm that regional transport accessibility does indeed play a significant role in sales prices, with variations between transit and car and over the rural-urban spectrum, over and above the local proximity to TI which needs to be accounted for in land value capture policies.

Residential Location Choice and its Effects on Travel Satisfaction in a Context of Short-term Transnational Relocation

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Nuno Afonso (CERIS / Instituto Superior Técnico, Universidade de Lisboa)
Jesper Bláfoss Ingvardson (Department of Technology, Management and Economics, Technical University of Denmark)
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Abstract. Focusing on factors influencing residential and travel satisfaction of transnational short-term residents, this study highlights the occurrence of residential self-selection and its impacts on residential and travel choices, and on the derived levels of satisfaction. We have estimated a Bayesian Structural Equations Model and found that lower levels of residential satisfaction (residential dissonance) are associated with lower rents, living away from the university/workplace and having higher transport expenditures, which reveals the trade-offs involving residential location, monthly rent and transport expenses. In contrast, higher residential satisfaction (residential consonance) is related to individuals' stronger preferences for non-motorized modes, lower levels of public transport use and transport monthly expenditure lower than 10 euros, evidencing shorter commuting distances, favoring the use of non-motorized modes. Thus, it seems that, in the context of transnational short-term residents, the stronger the preference for active travel one holds, the lower her/his sensitivity is to other features/trade-offs that

residential location options offer. For both cases, the model reveals that better transport supply and land use balance at the home location can improve both residential and travel satisfaction.

Longitudinal Machine Learning Modelling of Housing Prices

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Eric Miller (University of Toronto)

Abstract. Housing price has been extensively modelled through hedonic-based spatio-temporal regression and machine learning (ML) approaches. However, the comparison of different longitudinal analysis methods is rarely considered in housing price modelling. This paper examines three machine learning algorithms (linear regression machine learning, random forest and decision trees) applied to housing price trends from 2001 to 2016 in the Great Toronto and Hamilton Area (GTHA), and compares the performance of the ML algorithms with traditional temporal lagged regression models. The empirical results show that although the ML algorithms achieve good accuracy (R^2 of 0.873 after cross validation), the temporal regression produces even better results (R^2 of 0.876). Temporal lag effects play a key role in housing price modelling, along with accessibility and socio-economic factors.

Policymaking and Planning for Transit-oriented Development in California Cities

Elisa Barbour (Institute of Transportation Studies, UC Davis)

Abstract. Results are analyzed from a survey conducted in 2019 of city planning directors in California's four largest metropolitan areas, assessing motivations and perceived obstacles to improving transit-oriented development (TOD), transit, and active transport (AT), as well as adoption rates for multiple associated policy, planning, and finance tools. The findings reveal prolific, diverse, and complex policymaking patterns, not easily reducible to differences among cities in basic built-environment and socio-demographic characteristics. Discernible patterns include an observed association between political liberalness of city residents with stronger motivation for TOD policymaking among city leaders, and lower perceived barriers for implementation. Regarding motivations, the likelihood that city leaders prioritize mobility/accessibility as a goal for TOD policymaking is associated with higher adoption of some politically challenging policy measures, including systematic upzoning; this finding underscores that some cities are "making a transportation-land use connection" in their policy choices. Another key finding is a that a certain set of widely-adopted policies was also rated very important by planning directors for achieving cities' TOD goals, namely the combination of three regulatory techniques – upzoning, mixed use zoning, and reducing parking requirements – with development of neighborhood plans and use of associated permitting streamlining procedures. This finding indicates that effective TOD policymaking requires more than just regulation and rather also requires attention to developing effective neighborhood plans.

Viewpoint: Turning Streets into Housing

Adam Millard-Ball (UCLA)

Abstract. I argue that wide residential streets in US cities are both a contributor to homelessness and a potential strategy to provide more affordable housing. In residential neighborhoods, subdivision ordinances typically set binding standards for street width, far in excess of what is economically optimal or what private developer and residents would likely prefer. These street width standards are one contributor to high housing costs and supply restrictions, which exacerbate the housing affordability crisis in high-cost cities. Planning for autonomous vehicles highlights the overprovision of streets in urban

areas. Because they can evade municipal anti-camping restrictions that restrict the use of streets by unhoused people, autonomous camper vans have the ability to blur the distinction between land for housing and land for streets. I propose two strategies through which excess street space can accommodate housing in a formalized way. First, cities could permit camper van parking on the right-of-way, analogous to liveaboard canal boats that provide housing options in some UK cities. Second, extending private residential lots into the right-of-way would create space for front-yard accessory dwelling units.

Temporal Dynamics of the Effects of Light Rail on the Housing Prices: A Case Study of Portland, Oregon

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Liming Wang (Portland State University)
Hongwei Dong (California State University, Fresno)
Huajie Yang (City University of Macau)

Abstract. We explored the degree to which new and additional LRT openings triggered property value premiums, and the premiums evolved over a long period of time. To capture a detailed picture of the temporal dynamics, we selected two segments of MAX alignments in Portland, Oregon as case studies and employed a spatial lag Hedonic regression model with controls identified through a propensity score matching method. We found that single-family homes within the service areas of MAX stations sold at a higher price than otherwise identical properties before and after the first MAX line opening. Unique from previous research, the results revealed that the opening of additional LRT lines on an existing LRT line alignment did not bring additional premium, except for the second line in the east-side case, in which the second line opened for service fifteen years after the first line. In other words, the improved transit accessibility made by additional LRT lines did not capitalize on the valuation of single-family housing within the station area, unless the gap in time-period between the initial and additional LRT line operations was long enough. Additionally, our results showed that the value premium dissipated over time in both cases.

Sensitivity Analysis of Housing Market Simulation

Xiaohu Zhang (Massachusetts Institute of Technology)
Joseph Ferreira (Massachusetts Institute of Technology)

Abstract. Advances in technology have made it computationally feasible to simulate travel decisions and relocation at individual and building scale. Modelling daily housing market behavior can avoid ecological fallacy issues associated with batch adjustment of demand and supply, and it becomes more desirable than annual or even monthly aggregate adjustment to the supply and demand because the latter is ineffective to capture the impact of market shocks. However, such disaggregated systems are prone to stochastic variation and can be sensitive to parameter changes. In disaggregated simulations, as the spatial or temporal analysis unit increases, the variability also becomes larger. The sensitivity issue, although crucial, is least investigated in the urban simulation field. This work is thus conducted to examine the sensitivity of the housing market portion of SimMobility—an agent-based micro-simulation platform of land use and transportation interactions that simulates daily housing market bidding. Using a calibration for Singapore, it confirms that the model can be calibrated with reasonable parameters that lead to dynamic equilibrium under constant demand and supply conditions. The targeted awakening and choice set models add more realism and induce more competition but also lead to higher market volatility. The market response is sensitive to the ratio of supply and demand but relatively insensitive to initial conditions. A 'burn-in' period of 6-12 months is recommended before using model simulations to calibrate parameters and compare simulated scenarios. Spatial heterogeneity of sensitivity is observed across planning areas. The uneven competition in sub-markets results in different levels of volatility in

space. Also, a spillover effect is observed when relatively attractive types of housing are depleted in particular planning districts. The sensitivity analysis not only quantifies parameter choices that lead to a stable model, but also deepens our understanding of model mechanisms.

Rent Growth Near Rail Stations after the Great Recession

John Renne (Florida Atlantic University)
Jyothi Chava (Florida Atlantic University)
Bruce Appleyard (San Diego State University)
Tara Tolford (University of New Orleans)

Abstract. During the post-recession period, rental prices have seemingly outpaced the average market in transit-oriented developments (TOD), characterized by walkable, transit-accessible, compact, and mixed-use neighborhoods. This study examined rent growth in station areas, including TODs after the Great Recession, from January 2012 to June 2016. The study compares three types of regression methods, including 1. Ordinary least squares (OLS) regression, 2. Hierarchical spatial autoregressive model (HSAR), and 3. Geographically weighted regression (GWR). The results show that OLS and HSAR models follow the same pattern, revealing that density, walkability, percentage White, and income are positively associated with increases in rents. In contrast, land use mix, percentage Black, increasing distance to the station, and distance to the central business district (CBD) were each associated with downward pressure on rents. The GWR model revealed the significance and influence of independent variables vary from region to region and within a given region.

Exploring How Millennials Choose Where to Live: Life Cycle Effects and the Continuing Importance of Transportation

Jamey Volker (University of California, Davis)

Abstract. Millennials will drive the US housing market for years to come. The question is how. Surveys suggest that millennials have a stronger preference than previous generations for urban amenities. But studies also indicate that many of the millennials who currently live near urban cores could eventually decamp to the suburbs as their life cycles progress. That raises big questions. If most millennials will end up suburbanizing, will they seek out suburban neighborhoods with urban amenities? Or do their preferences simply change with time and major life events? I use in-depth interviews of 20 households who had recently purchased homes in the San Francisco Bay Area to explore how millennials choose where to live when they reach the life cycle stages typically associated with bigger homes in suburban areas. I find that most households suburbanized or began planning to suburbanize once they got married and started thinking about having children. Many still valued urban amenities, but they generally did not prioritize urban amenities when searching for their suburban homes, with one exception – proximity to commuter transit. The widespread importance of transit access amongst the suburbanizing households highlights the potential for millennials to suburbanize while minimizing increases in vehicle miles traveled.

Kicked to the Curb: A New Era for Transportation and Land Development Planning

Kelly Clifton (Portland State University)
Gabriella Abou-Zeid (Portland State University)
Kristina Currans (University of Arizona)
Amanda Howell (University of Oregon)

Abstract. As American cities densify, there must be joint consideration for urban freight transportation, curb space allocation, and passenger travel in transportation planning. This study aims to explore some of those initial relationships utilizing both cordon counts and survey data from 12 market-rate, multifamily housing developments in Portland, OR. We find that much of motorized vehicle travel at such developments occurs at off-site curb space, that delivery-making happens outside of peak hours, and that mode use for both delivery and non-delivery trips is diverse. Current industry-standard methods for evaluating transportation impacts at new developments fail to capture this. As such, implications of our findings for transportation and land development planning are presented. We argue that surveys are necessary to capture the complexity of development-level travel, technology can improve data collection efforts through reduced costs and exploration of travel variation by day or time, neighborhood-level considerations may be more appropriate than site-level to allocate curb space for freight, and that cooperation with the private sector can help encourage increasingly-needed data sharing.

The Inevitability of Automobility: How Private Car Use is Perpetuated in a Greenfield Estate

Jennifer Kent (The University of Sydney)

Abstract. Ongoing advances in technologies of connectivity have strengthened our capacity to envision urban environments less dominated by private car use. Yet many cities remain attached to, and defined by, the automobile. In challenging this status quo, we must understand the complex and varied ways private car use is reinforced in different urban environments. This paper provides such an understanding in the context of a low-density, and currently car dependent, city. It presents a detailed analysis of the system of automobility to demonstrate the way private-car use is unintentionally perpetuated through contemporary practices of planning, developing and inhabiting cities. A newly constructed suburb in Sydney, Australia, provides the case for analysis. The suburb - Oran Park - is a master-planned estate intentionally designed to encourage alternative transport modes, yet rendered ostensibly car-dependent as a result of a confluence of historical and contemporary structural and practical influences. The paper combines a detailed examination of the planning, transport, and land-use context of the suburb with survey data from 300 of its residents. The paper's novel contribution is to analyse these data sources using a social practice approach. The analysis lays bare the inevitability of automobility's reproduction in the estate – a story which is deconstructed to inform future challenges to the hegemony of the private car.

Age, Transport & Technology: Understanding the Transport and Transport-related Technology Choices of Older Queenslanders

Kelly Bertolaccini (Griffith University)
Mark Hickman (University of Queensland)

Abstract. As Queensland's population ages, the state's transport system will need to adapt and become more age friendly. To better understand the transport behaviours and transport-related technology use of older Queenslanders, we conducted 12 focus group discussions across the state, including in regional and remote areas. The transcripts of these discussions were analysed by our research team to determine

common themes, while paying specific attention to the impacts of location on the needs and behaviours of participants. While transport is difficult for non-driving seniors across the state, we found that transport is particularly difficult for older Queenslanders living in remote locations and secondary cities due to multiple issues: the long distances they must travel for services, limited transport options, and fewer younger people to offer rides to aging community members. We also found that available door-to-door transport services for non-driving seniors are not meeting current demand and, without intervention, will not be able to meet coming increases in demand. Finally, we found widespread distrust of mobile applications and cashless payment among even the most tech savvy seniors, suggesting new and emerging transport modes which rely on these methods will exclude rather than help older Queenslanders.

Measuring the Impact of Travel Behavior in Urban Form on Location Affordability in Rawalpindi-Islamabad, Pakistan

Abu Baker Khan (Ritsumeikan University)
Tomohiko Yoshida (Ritsuemikan University)

Abstract. The concept of location affordability (LA) incorporating combined housing and transportation (H+T) costs is widely used in western-developed cities. However, the broader thesis argues that other than H+T cost, urban form and travel behavior could also determine LA, which demands empirical evidence to guide policymakers in the Southern globe. For this purpose, this study takes the case of Rawalpindi-Islamabad Metropolitan Area (RIMA), Pakistan to understand the influence of an urban form, household characteristics and travel pattern to predict combined housing and transportation (H+T) cost so that affordable location can be determined. It specifically collected 435 individual-based samples from nine locations in RIMA to conduct linear regression analysis having H+T cost as the dependent variable. The study found that urban form and household characteristics had the most significant impact on H+T cost on average; while only some predictors of travel behavior to public facilities showed a significant association. Particularly, when moving from city core to mid-urban or suburban area, the average H+T cost significantly increased, which contradicts with previous studies conducted in global North. Additionally, though car ownership and its usage increased when moving away from the city centre, its impact on H+T cost on average decreased. This result proves that family income is a significant driving factor because the income greatly increases from the city core to mid-urban or suburban areas.

Transit Induced Gentrification: Threat for TOD Planning in the Socio-economic Context of Dhaka

Afsana Haque (Jahangirnagar University)
Fatima Kabir Sharna (Dhaka South City Corporation)

Abstract. Transit Oriented Development (TOD), adopted by different cities of the world as a solution of numerous urban problems like sprawling development, air pollution, regulating land development, car-oriented development, traffic congestion, etc. very little work has considered how transit system may impact social equity through land use changes. Theoretically, TOD can upsurge accessibility by transit proximity, which reflect in the high price of housing and land around the stations. This study shed a light on the transit-induced gentrification, a threat developing city face in planning TOD. Socioeconomic context of a developing city is quite different from the developed one. No rigorous empirical studies have looked specifically on the TOD association with gentrification, among the few, most are on developed cities. Using data on social, demographic, housing and travel behavior, this study has tried to evaluate the challenge of gentrification that Dhaka is going to face in TOD planning and implementation. Through evaluating relevant policies, the study has also tried to find the policy gap that needs immediate attention for effective TOD planning and minimizing the threat of gentrification in the context of Dhaka.

Latin America

Financing the Public Mass Transit System in São Paulo: Current Opportunities of Land Value Capture Instruments nearby the Mobility Axes based on the 2014 Strategic Master Plan (Plano Diretor Estratégico) Policy

Paulo Eduardo Scheuer (Universidade Presbiteriana Mackenzie)

Abstract. One of the biggest challenges currently faced by Brazilian cities is the unequal access to infrastructures and urban opportunities, especially by the more socially vulnerable layers of the population in a context of disperse and complex urban context that became more evident in the second half of the 20th century. In this context, the public transportation system becomes a potential element in amplifying the access to jobs, in reducing polluting gases emission and in making complex cities, like São Paulo, more economically efficient.

Using this rationale as a starting point, this article addresses alternative sources of urban financing based on land value capture and direct the collected resources towards the provision of mass transit systems. Our focus of study are the strategies laid out on the 2014 Strategic Master Plan (Plano Diretor Estratégico – PDE) of São Paulo which aim to make viable the financing of its urban mobility public policy, structured in a development model of the city along influence areas of the axes of the high-capacity network, by concepts like the Transit Oriented Development (TOD).

Land-use Patterns, Location Choice, and Travel Behavior: Evidence from the Global South

João António de Abreu E Silva (Universidade de Lisboa)
Shanna Trichês Lucchesi (UFRGS)

Abstract. We use a Structural Equation Model to study the effects of land-use patterns, both at the residence and work locations, on travel behavior in the Metropolitan Region of São Paulo, Brazil. The proposed model structure equation was already tested in three different cities from the Global North. This paper brings new evidence using a case study of a metropolitan region in the Global South. The model structure is adapted to include specific aspects of the studied region, with the inclusion of informal workers, and of the present time, by controlling for cohort effects associated with being a millennial. Our results support the claim that land-use patterns influence travel behavior, even in a metropolitan area showing strong income-based spatial segregation levels. More specifically, the results show that commuting distance and car ownership act as relevant mediators in the relationships between the total amount of travel by mode and land-use patterns. Nevertheless, differently from previous applications of this framework, income plays a central role, with low-income individuals dependent on transit systems and living away from the diverse and well-connected areas. The results obtained show that people with different socioeconomic characteristics tend to work- and live in places of substantially different urban environments. Millennials prefer to live in central, accessible, and mixed areas, own less cars, travel less by car, and use transit and nonmotorized modes more frequently.

Linking Sustainable Transport and Community Development: Testing a Digital Social Geo-communication Tool in the small island of Tobago

Julia Kotzebue (Department of Geography, University of West Indies)

Abstract. Worldwide the United Nations (UN) is promoting sustainable transport that requires the engagement of communities, to make it context and community sensitive. Governments started to use

web-based social geo-communication tools in urban areas to enhance community engagement. Nevertheless, a holistic sustainable transport planning is lacking, and community engagement is marginalized in transport development in Trinidad and Tobago, Generally, the use of digital tools is increasing but it can be questioned to what extent they can support community and context-sensitive sustainable transport development in rural, and peripheral areas like Charlotteville in Trinidad and Tobago. The paper presents the results of an ongoing pilot study in which Charlotteville in Tobago functions as a living lab to test a digital social geo-communication tool. Furthermore, the paper suggests a theoretical, analytical, and spatial governance framework to better understand the results. Furthermore, the study reveals that the majority depends on sharing mobility and that the tools support the community to formulate context-sensitive transportation solutions. However, the COVID-19 pandemic interrupted the digital capacity of the community.

Modal Equity of Accessibility to Healthcare in Recife, Brazil

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Genevieve Boisjoly (Polytechnique Montreal)
Bernardo Serra (Institute for Transport Policy & Development – Brazil)
Ahmed El-Geneidy (McGill University)

Abstract. In the context of increasing urbanization and income inequality, transport professionals in the Global South need to be prepared to effectively plan for the needs of various groups of population, particularly those regarding their health and well-being. Accessibility is widely used as a performance measure for land use and transport systems, it measures people's ease to reach desired destinations and incorporates mode, time, and/or cost constraints. There are considerable differences in the level of accessibility experienced by different mode users to reach health care facilities, which calls for additional equity considerations given the prevailing socio-demographic characteristics of the users of various modes and the importance of heath care facilities as a destination. In this study, we explore the distribution of accessibility to healthcare facilities by public transport and by car in Recife, Brazil through an equity assessment to identify areas with low accessibility by these modes at different times of the day. In general, higher accessibility by public transport as well as greater modal equity was observed in central regions of Recife, whereas the periphery, where many lower-income census tracts can be found, experiences significant inequity, when it comes to access by both modes to health care facilities. This analysis allowed us to classify locations to access impoverished, access absolutely impoverished, and access impoverished by public transport areas, which can be targeted with the appropriate land use and public transport policy interventions. This paper can be of value to professionals and researchers working towards equitable land use and transport systems in the Global South.

Models

Traffic Noise Feedback in Agent-Based Integrated Land-Use/Transport Models

Nico Kuehnel (Technical University of Munich)
Dominik Ziemke (Technische Universität Berlin)
Rolf Moeckel (Technical University of Munich)

Abstract. Road traffic is a common source of negative environmental externalities such as noise and air pollution. While existing models are capable of accurately representing environmental stressors of road traffic, this is less true for integrated land-use/transport models. So-called land-use/transport/environment models aim to integrate environmental impacts. However, the environmental implications are often

analyzed as an output of the model only, even though research suggests that the environment itself can have an impact on land use. The few existing models that actually introduce a feedback between land-use and environment fall back on aggregated zonal values. This paper presents a proof of concept for an integrated, microscopic and agent-based approach for a feedback loop between transport-related noise emissions

and land-use. The results show that the microscopic link between the submodels is operational and fine grained analysis by different types of agents is possible. It is shown that high-income households react differently to noise exposure when compared low-income households. The presented approach opens new possibilities for analyzing and understanding noise abatement policies as well as issues of environmental equity. The methodology can be transferred to include air pollutant emissions in the future.

Integration of Land Use and Transport to Reach Sustainable Development Goals: Will Radical Scenarios Actually Get Us There?

Carlos Llorca (Technical University of Munich)
Cat Silva (Technical University of Munich)
Nico Kuehnel (Technical University of Munich)
Ana Tsui Moreno (Technical University of Munich)
Qin Zhang (Technical University of Munich)
Masanobu Kii (Kagawa University)
Rolf Moeckel (Technical University of Munich)

Abstract. The United Nations have developed Sustainable Development Goals (SDG) to guide countries' development in the next decades. While most of the countries agreed on such goals, the way they are measured, and more importantly, forecasted, was not defined. In this paper, we first propose a set of measurable indicators that define the degree of achievement of SDG. Secondly, we use a microscopic integrated land use and transportation model to define future scenarios and measure SDG in the future. Such scenarios define radical policies, such as population relocation measures or extensive road network changes. The model is implemented in two study areas placed in developed countries: Munich in Germany and Kagawa in Japan. The results are not uniform across policies and study areas. In general, only strong (and perhaps implausible) relocation policies result in overall significant changes in the SDG indicators.

FABILUT: The Flexible Agent-Based Integrated Land Use/Transport Model

Dominik Ziemke (Technische Universität Berlin)
Nico Kuehnel (Technical University of Munich)
Carlos Llorca (Technical University of Munich
Rolf Moeckel (Technical University of Munich)
Kai Nagel (Technische Universität Berlin)

Abstract. Integrated land-use transport models often are accused of being too complex, too coarse or too slow. We tightly couple the microscopic land use model SILO (Simple Integrated Land use Orchestrator) with the agent-based transport simulation model MATSim (Multi-Agent Transport Simulation). The integration of the two models is person- centric. It means, firstly, that travel demand is generated microscopically. Secondly, SILO agents can query individually travel information to search for housing or jobs (and to choose among available modes). Consequently, travel time matrices (skim matrices) are not needed anymore. Travel time queries can be done at any time of the day (instead one or few time periods) and any x/y coordinate (instead of a limited number of zones). This way, we avoid aggregation issues (e.g. large zones that smooth out local differences) and we can account for individual constraints (e.g. nighttime workers who cannot commute by public transport for lack of service). Therefore, the

behavior of agents is represented with accuracy, which allows us to simulate their reaction to novel policies (e.g., specific vehicle restrictions) and to extract system-wide effects. The model is applied in two study areas: a toy scenario and the metropolitan region of Munich. We simulate various transport and land use policies to test the model capabilities, including public transport extensions, zones restricted for private cars and land use development regulations. The results demonstrate that the increase of the model resolution and model expressiveness facilitates the simulation of such policies and the interpretation of the results.

Gaussian Mixture-based Probabilistic Residential Location Search Model

Muntahith Orvin (University of British Columbia)
Mahmudur Fatmi (University of British Columbia)

Abstract. This paper develops a novel machine learning-based location search model considering the residential stress and desired characteristics of residential locations to develop the choice set for location choice model. Location search model adopts a Gaussian mixture-based modeling (GMM) approach that probabilistically assigns locations into several clusters that share some common features based on the residential stress. Residential stress is considered as the most significant reasons of moving out of the residences. Features are the desired characteristics of locations that release the stress. The optimum number of clusters is determined by testing the gradient of BIC and several cluster evaluation metrics. The pool of potential alternative locations for each household is generated probabilistically based on the results of cluster formation to develop the location choice model. In addition to the Gaussian mixture-based multinomial logit (GMML) model, random sampling-based multinomial logit (RSML) model is developed for comparison purposes. Goodness-of-fit measures suggest a better fit for GMML model. The predictive performance measure also suggests that GMML model outperforms the RSML model in terms of predictive performance measures. For example, percentage of correct prediction for GMML and RSML model are found as 59.83% and 47.54% respectively. The developed location search model captures important dynamic behavioral insights including the inter-dependency of residential stress and desired characteristics of locations. One of the immediate future extensions of this research is to develop an advanced residential location choice model within a joint modeling framework considering the duration of stay, stress-based location search and location choice.

Creating Spatially-detailed Heterogeneous Synthetic Populations for Agent-based Microsimulations

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Meng Zhou (Sun Yat-sen University)
Rounaq Basu (Massachusetts Institute of Technology)
Joseph Ferreira (Massachusetts Institute of Technology)

Abstract. Agent-based microsimulations (ABMs) of urban systems have grown in popularity and complexity due to the availability of high-performance computing resources and data storage capabilities. Credible synthetic populations are crucial for the application of ABMs to understand urban phenomena. Although several (agent) population synthesis methods have been suggested over the years, the spatial dimension of synthetic populations has remained largely neglected. This study addresses this myopic treatment of synthetic populations by creating two distinct components - agents and the built environment - that are integrated to form a 'full' spatially-detailed synthetic population. To generate agents, we used multiple Bayesian Networks (BN) to probabilistically draw pools from the microsample, followed by a Generalized Raking (GR) adjustment to match marginal controls. Using various measures, we demonstrate that our BN + GR framework performs better than more commonly used synthesis methods in both capturing the heterogeneity in the microsample and matching marginal controls. We also highlight

the importance of accounting for heterogeneity by using separate type-specific models based on an explicitly defined household typology. For built environment synthesis, we generated various spatial entities such as buildings, housing units, establishments, and jobs at distinct spatial locations by fusing data from various spatial datasets. Their spatial distributions are found to effectively approximate the 'real' built environment in our study area. Our proposed framework can be used to generate a 'full' synthetic population for use in ABMs with more spatio-demographic heterogeneity than can otherwise be well estimated using traditional methods.

Networks

Assessing Pedestrian Impacts of Future Land Use and Transportation Scenarios

Qin Zhang (Technical University of Munich)
Rolf Moeckel (Technical University of Munich)
Kelly Clifton (Portland State University)

Abstract. Portland Central City has experienced growth in population and employment over the last decades, which leads to an increase in travel demand. One of the visions of the Central City 2035 plan is to encourage walking. This paper presents a model of pedestrian travel demand to help assess the impact of land use and transportation policies in the Central City area. The model is an enhancement version of the Model of Pedestrian Demand (MoPeD). Realistic scenarios and the projected population and employment are incorporated in this study. Four future scenarios for 2035 are tested and compared to the 2010 base conditions. The results suggest that demographic growth and job increase can help to encourage a large share of walk trips. Pedestrian behavior is also sensitive to network connectivity, but the influence is marginal at the district scale. Furthermore, model results show that a good street network and a dense and diverse land use plan can maximize the effects to promote walk trips.

Dynamic Land Use: An Explorative Study on the Implications for Transport and Spatial Planning

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Rob van Nes (Delft University of Technology)
Bert van Wee (Delft University of Technology)

Abstract. The urban agenda is demanding new approaches for urban development. Urban flexibility has been recognized as crucial for coping with uncertainty and smart growth has been advocated as a sustainable urban practice. Flexibility applied to buildings leads to the concept of dynamic land use, defined in this study as modifications in building form, function, location and speed of change. Dynamic land use could be a way to achieve a smart and compact growth. However, the impact of a widespread application of dynamic land use on transport and accessibility remains unknown, as well as the required policies to respond to those impacts. This study applies scenario planning and transport modelling to explore the implications of dynamic land use for transport and spatial planning, using the city of Eindhoven, Netherlands, as case study. Results show that dynamic land use impacts are dominant on car and bike shares. Central areas are suitable for dynamic land use, as car congestion remains stable while bike share and accessibility increase. Policies could encourage dynamic land use and cycling in central areas, and upgrade road infrastructure in non-central areas.

The Impact of Residential and Work Dissonance on Commute Mode Choice in Dual-earner Households—Evidence from a Small Chinese City

Yang Hu (Utrecht University)
Anae Sobhani (Utrecht University)
Dick Ettema (Utrecht University)

Abstract. Attitudes-induced self-selection is an important issue in land use–travel interaction research. Self-selection occurs when people choose their residential location based on their wants, needs, attitudes, and preferences. However, due to constraints on the location choice, people cannot always self-select their preferred built environment (BE). In addition, the varying attitudes of the different members of a household lead to a match or mismatch between attitudes and the BE, a matter that has received only limited attention. Using data collected in the small Chinese city of Ganyu, this research explored how consonance and dissonance between travel attitudes and the BE occur differently for male and female spouses in dual-earner households, as well as how that consonance and dissonance influence their commute mode choice. We found that about half the respondents in our samples do not live or work in their preferred BE, and consonance and dissonance occur differently for female and male spouses. In particular, male spouses do not tend to self-select their preferred residential BE more than their partners do, although they do tend to work in their preferred BE more than their partners do. In addition, the commute mode choice of respondents is related not to where they live but to where they work, especially in the case of male spouses.

Does a Residential Relocation Enable Satisfactory Travel?

Jonas De Vos (University College London)
Kostas Mouratidis (Norwegian University of Life Sciences)
Long Cheng (Ghent University)
Md. Kamruzzaman (Monash University)

Abstract. Transport-related residential self-selection indicates that people try to live in a neighbourhood in line with their travel preferences and needs. Although studies have found that travel attitudes are mostly aligned with the urban form characteristics of the residential location, no studies have explored whether people are actually able to travel in a preferred way after having relocated. In this study we analyse whether people are able to travel with a preferred mode after relocating and how this affects their travel satisfaction. Results from 1,650 recently relocated residents in the city of Ghent (Belgium) indicate that most people were able to change their travel behaviour in congruence with their travel attitudes. The study found that a decrease in travel duration, distance, car use, and public transport use, and an increase in walking and cycling increased travel satisfaction. This is particularly true when changes in travel behaviour interacted with travel attitudes. Results show that when walking and cycling levels change in line with travel attitudes, travel satisfaction increases. Travel behaviour changes in line with travel attitudes did not always result in high levels of satisfaction (improvements) since we also found that those who reduced travel durations and have a positive attitudes towards travel in general (or vice versa) have high levels of travel satisfaction (improvements). The findings indicate that built environment interventions have the potential to contribute to satisfying travel and thereby to improve subjective well-being of residents.

The Need for Coordinated Planning of Urban Change and Urban Management in the Vicinity of Metro Infrastructure, a case study of Los Angeles Metro

Nathan Darroch (University of Aberdeen)
Shine Ling (LA Metro)

Abstract. As populations continue to urbanise, cities are densifying, globally. To enable the rapid mass movement of people through those densifying urban environments, cities have introduced and continue to construct urban metro systems. The presence of metro systems creates presence, property, and protection interfaces with their environment. These need to be managed effectively during periods of urban change and urban management . Through research of the authors' to date, they have identified that there is little academic consideration of how or why those interfaces are managed.

To stimulate discussion of these topics, this paper presents a discussion of how, when, when, where and why the Los Angeles Metro (LA Metro) Development Review Team work to ensure the safe continued presence and operation of the LA Metro. An argument for why more discussion and benchmarking of interface management, globally, is also provided.

Through this paper, the authors' hope to stimulate greater consideration, discussion and collaboration between urban stakeholders, railway-based infrastructure managers, urban and transport planners, academics, and policy makers, to ensure the continued sustainable presence and operation of metro infrastructure and its environment across the world.

Infrastructure is not Enough: Interactions between the Environment, Socioeconomic Disadvantage and Cycling Participation in England

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Robin Lovelace (University of Leeds)
Eva Heinen (University of Leeds)
Richard P Mann (University of Leeds)

Abstract. Cycling can be particularly beneficial for socioeconomically disadvantaged populations for two main reasons. First, cycling enables access to opportunities that may be unaffordable by other modes. Second, cycling increases physical activity levels and, consequently, improves health. In this context, we analyse the extent to which socioeconomic disadvantage impacts cycling participation and cycling duration for both leisure and utility cycling. Then, we examine whether socioeconomic inequalities in cycling participation can be explained by the environment in which disadvantaged populations live. The study population includes 167,178 individuals, residing in 2,931 areas, and 326 Local Authorities. Data on individual factors were drawn from the Active Lives Survey and data on environmental factors from several sources. Descriptive statistics and multilevel regression models were estimated. We found that the likelihood of cycling is lower among people living in deprived areas than among people living in non-deprived areas. This difference is significant for leisure, but also for utility cycling when controlling for individual and environmental factors. However, cyclists living in deprived areas are more likely to cycle longer per week than cyclists living in non-deprived areas, particularly for utility cycling. We also found that cycling infrastructure and greater levels of cyclability is higher in deprived areas than in non-deprived areas. This suggests that infrastructure and cyclability are not enough to increase cycling levels among disadvantaged populations. Further research on other barriers to cycling among disadvantaged populations is required.

Do New Urban and Suburban Cycling Facilities Encourage More Bicycling? Results from a Case-Controlled Study in Toronto, Canada

Raktim Mitra (Ryerson University)
Avet Khachatryan (University of Toronto)
Paul Hess (University of Toronto)

Abstract. Municipalities continue to invest in cycling facilities to reduce car dependence and improve road-user safety, but the mode substitution related benefits are difficult to isolate. This paper presents the findings from a household survey conducted in 17 neighbourhoods in Toronto region, Canada, some with a recently built cycling facility and some without. Results indicate higher odds of an increase in bicycling on streets with a new cycling facility. People who were already commuting by bicycle at least once a week are likely to bicycle more frequently after new facilities are built. Bicycling uptake was more obvious in streets with a new cycle track, and less so for bicycle lanes. Both urban and suburban cycling facilities were associated with the odds of increased bicycling on the street, but not with potential commute mode substitution, compared to neighbourhoods without a facility. Findings offer insights into expected outcomes of bicycle network expansion policy/projects.

Children's Local Accessibility: Measuring Access to Parks via Walking and Cycling in Quebec City using Open Data

Arianne Robillard (Polytechnique Montreal)
Genevieve Boisjoly (Polytechnique Montreal)
Owen Waygood (Polytechnique Montreal)

Abstract. Accessibility indicators are gaining traction in research and planning as they provide a joint understanding of how transport networks and land use patterns enable individuals to reach a variety of destinations. Local accessibility is especially beneficial for children who increasingly rely on their parents for their everyday trips, possibly to the detriment of their health and well-being. Children do not have the same capacities to travel as adults and their local independent mobility is generally constrained to active modes such as walking and cycling. Yet, there does not appear to be much work done in terms of developing children-specific accessibility indicators. This study sets out to propose present a methodology to specifically assess accessibility to parks by walking and by cycling for children, using open data. The method is applied to Quebec City, Canada and considers the distribution of the population across the territory using the finest spatial unit available, the residential lot. The equity of accessibility to parks within that population is then considered through population and income measures. The results are of interest to researchers and planners aiming at refining accessibility indicators to support children's independent mobility, while taking equity into consideration.

Subway Expansion, Jobs Accessibility Improvements and Home Value Appreciation in Four Global Cities: Considering both Local and Network Effects

Adriano Borges Costa (Massachusetts Institute of Technology)
Camila Ramos (Massachusetts Institute of Technology)
Siqi Zheng (Massachusetts Institute of Technology)

Abstract. We explore the potential of incorporating accessibility analysis in studying the impact of subway expansions on the real estate market. We first demonstrate that using increases in accessibility to firms as a continuous treatment variable instead of its binary alternative, the station-dummy approach, yields better goodness-of-fit in a quasi-experimental econometric analysis. We show that the dummy

treatment variable consistently reported overestimated coefficients of impact for new subway stations. Furthermore, accessibility measures allow the exploration of impacts beyond the local effects around new subway stations, shedding light on network impact that has been largely overlooked in the literature. To provide greater external validity to our results, we apply the same analysis to the cities of Santiago (Chile), São Paulo (Brazil), Singapore, and Barcelona (Spain) and explore the common results. We argue that the integration of urban economics and transportation analysis can bring innovation to the empirical approach commonly adopted in the literature, and the use of accessibility measures in causal empirical studies on transportation impacts can produce more robust and comprehensive results and capture the nuanced spatial heterogeneity effects.

Half-(Head)Way There: Comparing Two Methods to Account for Waiting Time in Public Transit Sketch Planning

Anson Stewart (Massachusetts Institute of Technology)
Andrew Byrd (Conveyal LLC)

Abstract. In previous articles, we have described new multi-modal sketch planning methods based on cumulative opportunities accessibility indicators that account for variability and uncertainty in public transit travel times. In this paper we establish some convergence characteristics of one such method, yielding guidelines for the minimum number of randomized schedules. This parameter has implications for result stability, analysis turnaround time, and computation costs.

We also confirm that there are spatially varying differences in travel time and accessibility results from our method relative to a conventional half-headway method. The conventional method appears to understate the benefits of transit in certain locations, particularly those served by multiple lines. Researchers and planning practitioners may therefore find our method preferable when comparing transit scenarios where routes are specified in terms of headways, rather than complete schedules with exact departure times for each trip.

Spatial Segmentation of Mode Choice Behavior: A Latent Class Approach based on Accessibility and the Built Environment

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Kelly Clifton (Portland State University)
Ricardo Hurtubia (Pontificia Universidad Católica de Chile)

Abstract. Land-use policies that reduce car dependency have traditionally relied on analysis of travel behavior data for the calculation of the relationship between the built environment and mode choice. The traditional approach employs a model specification that assumes to behave the same regardless of the spatial context. Evidence has shown that travelers respond differently to the spatial circumstances, but still, there is a gap identifying the magnitude of bias of not considering a differentiated response on the urban areas and the approach to spatially segment and identify these different behaviors. This research seeks to overcome these limitations by integrating travel and environmental data in a simultaneous estimation process for spatial segmentation and mode choice. The approach uses a latent class within the framework of discrete choice models that segments the region into spatial classes base on environmental attributes and estimates a set of mode choices coefficients for each class in a case study for Portland, Oregon. The results reveal a significant improvement from the model without latent classes, with a clear differentiation of the travelers' preferences. The new method found that the error due to not considering the spatial segmentation is considerable and that should be addressed in the analysis of this type. Finally, the simultaneous method for the segmentation and choice models successfully identifies the different classes and has a much better fit than the non-class model suggesting potential for future uses.

Assessment of Disparities in Spatial Accessibility to Vaccination Sites in Florida

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Mark Horner (Florida State University)
Eren Ozguven (Florida State University)

Abstract. Community-wide vaccination and equal spatial access to vaccination sites would be the most effective way to abrogate the COVID-19 pandemic. Given that the number of COVID-19 vaccines is limited in the early stage of vaccine distribution, age-based prioritization may be brought into question since differences in income levels and races/ethnicities among older populations are ignored. In this vein, this paper assessed disparities in population-weighted spatial accessibility to vaccination sites with consideration of older populations' income levels and races/ethnicities at the state and the county levels in Florida. To evaluate the disparities, this paper compared spatial accessibility between the older populations with different income levels within the same race/ethnicity and between different racial/ethnic older populations within the same income level. This was achieved by using ratios of spatial accessibility between population groups and the Kruskal-Wallis test at the state level and by visualizing maps identifying counties with disparities based on ratios at the county level. The findings of this study were that any state level disparities were not founded but the county level disparities were identified. In addition, older populations below poverty had lower access compared to older populations above poverty, and levels of spatial access between different racial/ethnic older populations differed by counties. We thus conclude that policymakers should take into account older populations' income levels and races/ethnicities for vaccine prioritization and some counties should be paid attention to reduce county level disparities.

Self-selection Debate in the Built Environment-travel Behavior Connection: A Review of Theories and Empirical Research on Causality

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Gian-Claudia Sciara (The University of Texas at Austin)

Abstract. The influence of the built environment (BE) on travel behavior (TB) and the role of residential self-selection in mediating that influence have long been debated in the literature. Previous studies address self-selection by controlling for travel related attitudes, assuming that people choose residential location according to their travel preferences. In this paper, we discuss theoretical underpinnings of that assumption; we draw on the social psychology literature to consider how attitudes and preferences themselves are shaped by contextual influences and how cognitive-behavioral processes play important roles in attitude formation and changes over time. We call attention to three dynamics that lead us to question the travel attitude-based control of self-selection. First, there is potential for incongruence between travel attitudes and residential choice. Travel attitudes that play no role in residential location choice would hardly constitute any bias to mediate the influence of BE on TB. Second, the BE influences travel attitudes through cognitive-behavioral processes such as social network, new information, direct and indirect behavioral experiences. Third, individuals' residential preferences are influenced by long-term lifestyle, prior location experience, and constrained by supply, availability and composition of the built environment of wider city/region. We therefore see a bi-directional relationship between the BE and residential preferences. The paper presents a conceptual framework that illustrates multiple causalities involved in the built environment and travel behavior interactions. Finally, the policy implications are discussed.

Explore Regional Variation in the Effects of Built Environment on Driving with High Resolution U.S. Nationwide Data

Liming Wang (Portland State University)

Abstract. There have now been numerous studies on the relationship between built environment and travel behavior over the last a few decades. Past studies have mostly focused on producing point estimates of model coefficients and ended up with a wide range of estimates for the elasticity of the built environment on travel behavior, including household's Vehicle Miles Travelled (VMT). With few exceptions, previous studies use data from a single region or a small number of regions, and thus are not able to sufficiently investigate the regional variation in elasticities. A few recent papers that address the heterogeneity of elasticities among different population groups and neighborhood types, for example, Salon (2015); Voulgaris (2016), but they ignore the regional variation that likely exists. In this paper, I use the 2009 U.S. National Household Travel Survey and high resolution built environment measures from the Smart Location Database to investigate the regional variation in the effects of built environment on household VMT.

Chasing the City that Cannot Stop: Exploring Transportation and Urban Co-development in São Paulo's History

Adriano Borges Costa (MIT)
Chris Zegras (Massachusetts Institute of Technology)
Ciro Biderman (FGV)

Abstract. We present a historical analysis of transportation and urban development in São Paulo (Brazil), attempting to discern Granger causal effects using historical land-use and transportation data from 1881 to 2013. Our results align with the hypothesis commonly stated in the literature about the relevance of road transportation in São Paulo's peripheral urban expansion during the twentieth century. We find, however, more complex relationships, and changes in them, over time. Over the entire 130 years, we find that urban expansion and roads pushed and pulled each other, in a somewhat "orderly" way. Mass transit infrastructure is not linked to urban expansion. On the other hand, while roads are not linked to densification, we find that mass transit infrastructure did lead to building densification; although densification did not lead to additional public transit supply. Overall, we find that the city sprawled outward, but not subsequently upward. Distinguishing those 130 years into distinct periods, adds further insights. Examining São Paulo's "streetcar era" (up to 1929) verifies the "orderliness" for roads and urbanization found over the entire period. We also find "orderliness" in the case of streetcars – evidence of joint development consistent with "streetcar suburbs." Streetcars also led to building densification during this early period. The subsequent decades, up until 1974, marked a period of massive roadway development and increased population and industrialization. During this period, mass transit infrastructure investments were virtually non-existent and road transportation essentially chased urban expansion, not vice versa. Finally, the last four decades, when São Paulo's modern mass transit system was developed, reveals a return to "orderly" patterns of road expansion and urbanization but no evidence of mass transit infrastructure's effects on urbanization or densification. The analysis illustrates how transportation investment choices have important consequences for urban growth, exerting long-lasting influences on its urban form.

New Mobilities

Traffic-Land Use Compatibility and Street Design Impacts of Automated Driving in Vienna, Austria

Emilia Bruck (TU Wien)
Aggelos Soteropoulos (TU Wien)

Abstract. The potential rise of automated vehicles (AVs) may significantly impact future traffic volumes, which in turn affect urban street designs and adjacent land use. While integrated assessments of potential traffic and land use changes due to AVs have mostly been concerned with issues of location choice and changing settlement patterns, assessments of how AVs may influence the quality of streets depending on the requirements of adjacent land uses remain scarce. This paper presents an integrated assessment of AVs' traffic and urban effects at the neighbourhood level for the city of Vienna. It provides a methodology to assess whether changing traffic volumes are compatible with the land use functions of a given neighbourhood, to approximate street space requirements of shared automated shuttles, and to visualize possible trajectories of spatial transformation by considering city goals and policies. The results show that the opportunities to convert street space and the risks of environmental harm due to AVs will vary across neighbourhoods and street typologies. It is crucial for policymakers and planners to consider contextual differences of this type in order to gain better insight into the spatial requirements and consequences of AVs. The assessment aims to inform the evaluation of current street designs, the management of increasingly diverse demands for street space, and the pro-active implementation of traffic and urban design policies in light of automated driving.

A Solution to the Chicken-Egg Dilemma of Electric Mobility for Indian Cities

Ruchi Singhal (Sardar Vallabhbhai National Institute of Technology)
Chetan R. Patel (Sardar Vallabhbhai National Institute of Technology)

Abstract. By the diffusion of electric vehicles, there is an improvement in air quality as emissions are shifted from dispersed sources (fossil-fuel vehicles) to concentrated sources (electricity generation plants) and from these concentrated sources carbon-capturing can be done. To decrease the observable emission levels, there is a need to increase the market share of electric vehicles. Since electric vehicles are infrastructure dependent technology, and their penetration faces the problem of lacking recharging infrastructure, thus there is a dilemma of chicken-egg in the penetration of EVs and their charging infrastructure for the decision-makers. To solve this dilemma, the study suggests a co-diffusion strategy for deployment of electric vehicles and charging infrastructure.

This article also examines e-mobility scenario of 3 Indian cities and identifies the issues and challenges of EVs and makes policy recommendation to encounter the top barriers, which will help policymakers in the successful implementation of e-mobility in India

Impact of Micro-mobility on the Urban Form: a Systematic Review of International Literature

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Dena Kasraian (Eindhoven University of Technology)
Pieter van Wesemael (Eindhoven University of Technology)

Abstract. In recent years, innovations in business models and technology have brought out new mobility systems, including shared and electric micro-mobility. A rapidly expanding strand of literature mirrors the

micro-mobility's exponential growth and popularity. While many studies analyze micro-mobility from operations, management and user perspectives, fewer works investigate the relation of micro-mobility with the urban form. Like other transportation modes, micro-mobility has an impact on the urban form and a potential to reshape its physical characteristics and usage. This paper provides a systematic review of existing conceptual and empirical studies, and those exploring the implications of micro-mobility (i.e., bike-sharing schemes and e-bikes/scooters) for urban form. The impacts on urban form are investigated at the levels of node (e.g. the emergence of docking stations and parking stops), link (e.g. the street-level conflicts with walking/cycling/vehicle lanes) and network (e.g. stimulating infrastructure network creation and catchment area shifts). The findings are relevant for urban and transport planners, designers, researchers, policy makers and public authorities. They contribute to the much-needed evidence base for effective design and policy recommendations to accommodate micro-mobility in the existing and developing built environment, to achieve a safe, lively and inclusive built environment in general and public space in specific.

Dockless Bike-sharing's Impact on Mode Substitution and Influential Factors: Evidence from Beijing, China

Zheyan Chen (Utrecht University)
Dea van Lierop (Utrecht University)
Dick Ettema (Utrecht University)

Abstract. As a newly emerged bike-sharing system, dockless bike-sharing has the potential to reconstruct urban mobility by substituting for car use, public transit, or active modes. However, there is scant empirical research exploring the extent to which dockless bike-sharing replaces other travel modes for different travel purposes. We know little about how individuals' personal characteristics and neighborhood environment features influence their mode substitution choices. Using survey data collected from residents in Beijing and geodata of land use and public transit, we conducted four multinomial logistic models to explore the potential mode substitution behavior influenced by dockless bike-sharing for four travel purposes: work or education commuting, sports and leisure, grocery shopping and recreational activities such as shopping, eating and drinking. The results indicated that the majority of respondents would turn to walking or public transit in the absence of dockless bike-sharing systems. In addition, our analysis of travel attitude pointed out that dockless bike-sharing attracts not only bicycle lovers but also users with varying mode preferences. The positive association between the length of bicycle paths and the likelihood of turning to public transit or motorized vehicles also revealed the possibility that dockless bike-sharing could draw users from public transit and motorized vehicles.

A Bayesian Belief Network Approach to Examine the Long-term Impacts of COVID-19 on Travel Attitudes and Preferences

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Muhammad Ahsanul Habib (Dalhousie university)

Abstract. COVID-19 has significantly affected our daily travel behavior. It is necessary to understand the complex reactions COVID-19 may continue to have on our transport and land-use systems. This research examines how peoples' long-term travel choices may change due to the pandemic. For this, it first conducts a questionnaire survey among the working professionals in Halifax, Canada to get data on their socio-demographic conditions, and their travel choices and preferences once the pandemic threat is reduced. Bayesian belief network approach is adopted in this study to mathematically understand the relationship between different socio-economic and travel factors on individuals' choices of 'residential relocation near workplace', 'work from home' preference and 'vehicle purchase intention' in post-

COVID times. Results indicate that a very few percentages of people want to purchase new vehicle (2%), want to relocate near workplace (7%) but a high percentage want to work from home (57%). Negative correlation is found between residential mobility and work from home which indicates that people wishing to relocate near workplace are less likely to telecommute. The outcomes of this study will offer transport and land-use planners insights on post-COVID travel habits and help them reconfigure policies focusing on sustainable travel behavior.

A Deeper Investigation into the Role of the Built Environment in the Use of Ridehailing for Non-Work Travel

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David Bunch (University of California, Davis)
Susan Handy (University of California, Davis)
Giovanni Circella (University of California, Davis)

Abstract. Ridehailing has become a main-stream mobility option in many cities around the world. Many factors can influence an individual's decision to use ridehailing over other modes, and the growing need of policy makers to make built-environment and regulatory decisions related to ridehailing requires an increased understanding of these. This study develops a model that estimates how the built environment affects the decision to choose ridehailing for making non-work trips, while carefully accounting for a variety of confounding effects that could potentially bias the results (if ignored or improperly incorporated). These include: total number of trips, supply differences between urban and non-urban areas, residential choice (urban versus non-urban), and household choice of whether to own a vehicle. We use individual-level data from a California travel survey that includes detailed attitude measurements to estimate an integrated choice and latent variable (ICLV) model to properly specify these effects. We include accessibility measures used elsewhere (e.g., Walkscore) plus measures developed for this study. Our analysis estimates the effect of these measures on ridehailing mode share, and how they differ between urban and non-urban areas. We also confirm that failure to take into account, e.g., latent preferences for residential location can lead to biased results. This analysis results in two major findings: 1. individuals living in vibrant and walkable neighborhoods replace other modes (possibly active modes) with ridehailing, 2. previous studies may have overestimated the complementary or supplementary relationships between public transit and ridehailing by ignoring confounding effects.

Do E-scooters Fill Mobility Gaps Before and During COVID-19? A Spatiotemporal Analysis using Open Big Data

Xiang Yan (University of Florida)
Wencui Yang (University of Florida)
Xilei Zhao (University of Florida)

Abstract. The growing popularity of e-scooters and their rapid expansion across urban streets has attracted widespread attention. A major policy question is whether e-scooters substitute existing mobility options or fill the service gaps left by them. This study addresses this question by analyzing the spatiotemporal patterns of e-scooter service availability and use in Washington DC, focusing on their spatial relationships with public transit and bikesharing. Results from an analysis of three open big datasets suggest that e-scooters have both competing and complementary effects on transit and bikesharing services. The supply of e-scooters significantly overlaps with the service areas of transit and bikesharing, and we classify a majority of e-scooter trips as substitutes to transit and bikesharing uses. A travel-time-based analysis further reveals that when choosing e-scooters over transit, travelers pay a price premium and save some travel time. The price premium is greater during the COVID-19 pandemic but the associated travel-time savings are smaller. This implies that public health considerations rather than time-cost tradeoffs are the main driver for many to choose e-scooters over transit during COVID. In addition, we find that e-scooters complement bikesharing and transit by providing services to underserved neighborhoods. A sizeable proportion (about 10 percent) of e-scooter trips are taken to connect with the rail services. Future research may combine the big-data-based analysis presented here with traditional methods to further shed light on the interactions between e-scooter services, bikesharing, and public transit.

Exploring the Implications Travel Behavior During COVID-19 for Transit: Potential for Ridesharing and Carsharing

William Riggs (University of San Francisco)
Bruce Appleyard (San Diego State University)

Abstract. The COVID-19 epidemic has had unprecedented impacts on travel patterns in the US. This study evaluates changes to travel after shelter in place mandates. It finds that despite a potential reduction in gross vehicle miles travel, travel for secondary trips for recreation, shopping and errands may have increased. 26% of travelers may take trips that they otherwise would not have taken when working from home—many conducted via driving or carpooling and some via transit. This offers policy opportunities to consider how these trips can be captured in more sustainable modes than driving alone, and how transit might evolve after the pandemic to meet these travel needs.

Congested Sidewalks: The Effects of the Built Environment on E-Scooter Parking Compliance

Rob Hemphill (Portland State University)
John MacArthur (Portland State University)
Phil Longenecker (Portland State University)
Lillie Nie (University of Southern California)
Garima Desari (University of California, Santa Cruz)
Abbey Ibarra (California State Polytechnic University-Pomona)
Jennifer Dill (Portland State University)

Abstract. With the proliferation of electric scooters (e-scooters) in cities across the world, concerns continue to arise about their parking spots on sidewalks and other public spaces. Research has looked at e-

scooter parking compliance and compared compliance to other mobility devices, but research has not yet examined the impacts of the built environment on parking compliance. Utilizing a field observation dataset in the City of Portland, Oregon and novel GIS data, we attempt to understand the spatial distribution of e-scooter parking and the impact of built features on parking compliance, offering recommendations for policymakers and future research. The results of our study showed that 76% of e-scooters observed failed at least one of the City of Portland's parking compliance requirements; 59% failed on at least two criteria. However, compliance varies spatially and by violation type, indicating that parking compliance (or non-compliance) is dependent on features of the built environment. Parking compliance is significantly higher on blocks with designated e-scooter parking than blocks without designated e-scooter parking (X2 = 15.35, p < 0.001, V = 0.16). A statistically significant relationship was observed between the amount of legally parkable area on a city block and parking compliance. Parking compliance increases with larger percentages of legally-parkable area (t = 4.4, p<0.0001). This finding can help policymakers prioritize dedicated e-scooter parking for blocks with limited legally-parkable area.

Keeping up with the Car-dashians: A Retrospective Look at Private Mobility Holdings in the Shared Mobility Era

Rounaq Basu (Massachusetts Institute of Technology)
Joseph Ferreira (Massachusetts Institute of Technology)

Abstract. Concerns about the adverse impacts of rising automobile ownership on society have motivated cities to explore strategies envisioning a car-lite future. Such explorations need to consider the possible impact of shared mobility services on reducing private vehicle holdings. We argue that traditional transport datasets are inadequate for this research direction, and present a retrospective survey that is theoretically grounded as a mobility biography. By administering this survey in Singapore, we hope to explore the dynamics of the decision to purchase vehicles, while integrating it with other urban long-term choices such as residential and job location changes, economic events, and changes in household composition. This study provides a descriptive summary of findings related to five research questions. We find that multi-generational households with higher wealth status, as proxied by dwelling ownership and income, are more likely to buy or trade cars, which is often accompanied by the addition of a new member to the household. Attitudinal desires for certain vehicle models or brands, and economic life-cycle events such as job promotions, are the most likely reasons for purchasing cars. Our findings for recent car-buyers and car-traders also contradict the popular hypothesis that frequent users of shared mobility services are less likely to own cars. Attitudinal explorations show how cars are perceived as a social status symbol, but also highlight the positive outlook of car-owning households towards shared mobility. Stated preference responses point to the possibility of reducing car ownership, if the service qualities of shared mobility and public transit are improved in addition to providing integrated and reliable connections closer to homes and workplaces. Acknowledging the preliminary reports in this study, we hope to use this valuable data source to further our understanding of the dynamics of the vehicle ownership decision.

Street Livability, Health, and Humanity in a Future of Transportation Innovation, Disruption, and Automation

Bruce Appleyard (San Diego State University)
William Riggs (University of San Francisco)

Abstract. Transport innovation, disruption and automation provide the potential to dramatically change travel and our urban landscapes over the coming years. This transformation could increase safety and

efficiency, alongside accessibility for many populations. Yet this promise is not without limitations. This paper focuses on the attributes of disruptive transportation that could either help or hinder street, and overall, urban livability, sustainability, and equity. It provides an overview of the literature and practice, and discusses the benefits and challenges of new and disruptive mobility, focusing primarily on autonomous vehicles (AVs) and Mobility as a Service (MaaS). This leads to a roadmap to guide industry, planners, engineers, and policy-makers toward achieving livable cities and neighborhoods in parallel with these innovations. The roadmap illustrates potential challenges in maintaining human-centered transport. Planners and engineers will need a multi-pronged set of goals for 1) vehicle sharing; 2) prioritizing human travel and experiences via the design and programming of our streets, street networks and vehicle design; and 3) proactively manage and guide land use with the intent of shortening trip distances and curbing sprawl.

Automated Vehicles and Active Travel - A Qualitative Dutch-Australian Comparison.

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Stephen Greaves (The University of Sydney)
Michiel Bliemer (The University of Sydney)
Dea van Lierop (Utrecht University)
Dick Ettema (Utrecht University)

Abstract. This research uses a qualitative approach to explore attitudes towards Automated Vehicles (AVs), with a focus on the implications for Active Travel (walking and cycling) and land use. As attitudes are expected to be shaped by locally experienced environments (including infrastructure, traffic flows, and legislation), we consider two contrasting urban road environments: car-centric and bicycle-centric. Semi-structured interviews were conducted in which a heterogeneous sample of people living in metropolitan areas in (car-centric) Australia and (bicycle-centric) the Netherlands were asked to state their views about AVs, also in relation to active travel. We observed that participants in both locales were concerned that AVs would create a dehumanised world run by machines and that they would feel isolated and unable to communicate with the vehicles to negotiate priority. Australian participants were concerned that other people would hold up AV traffic, whereas Dutch participants expressed a willingness to hold up AV traffic themselves, by asserting their right to use the street on foot. Australian participants were cautiously-optimistic that AVs could create a safer environment for cycling. Dutch participants were unconcerned with the impact of road-bound AVs on cycling (due to a widely available separated bicycle path network), however, they were concerned about sharing bicycle paths with automated micro-freight vehicles.

Mobility Manager: Finding a Role for Community Transport in a MaaS Future

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Corinne Mulley (The University of Sydney)
Geoffrey Clifton (The University of Sydney)
Miguel Loyola (The University of Sydney)
Ben Whitehorn (Randwick Waverley Community Transport)

Abstract. Community Transport provides access to health, leisure and employment activities for the frail-aged and younger people living with a disability. Traditional service provision by volunteers and grant supported organisations created large geographical differences in the quality and availability of services. The sector faces emerging disruption from person-centred funding models, Transport Network Companies and the emergence of Mobility as a Service (MaaS).

This paper looks at whether there is a role for Community Transport to play as a 'mobility manager' on behalf of clients, encompassing the management of person centred funding streams, provision of travel training and planning plus multi-modal booking and broking services.

A survey and series of focus groups of existing Australian users look at the travel needs and attitudes towards the mobility manager concept. Stakeholder interviews examine the viability of the concept and the capacity of the sector to act in this role. It is suggested that the mobility manager concept provides a route to increase the financial viability of existing operators, promoting modal integration and better transport outcomes for vulnerable members of the community. This may allow MaaS to expand beyond mainstream users (Mass-MaaS) to ensure a mobility future for the transport disadvantaged ('MaaS of the gaps').

Factors Affecting the Adoption Intention of Electric Vehicles: The Roles of Objective, Perceived and Prospective Accessibility

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Shuli Luo (The Chinese University of Hong Kong)
Ka Kit Sun (The Chinese University of Hong Kong)

Abstract. In the era of new mobility, promoting Electric Vehicle (EV) usage is considered a promising policy to incorporate in the government agenda. While accessibility as a general concept has been recognised as an important factor affecting user's EV adoption intention, there is a dearth of studies discussing how accessibility determines EV adoption intention. This study uses a novel set of accessibility measures relevant to public EV charging facilities – objective, perceived and prospective accessibility – and investigates how and to what extent these measures affect the EV adoption intention of individuals. The data are primarily based on a recent questionnaire survey of driving license holders in Hong Kong, including both EV owners and non EV owners. The results show that objective accessibility – the number of (population weighted) standard chargers publicly available within five minutes' walking distance of an individual's residential district – is highly significant in influencing an individual's EV purchase intention. Additionally, subjective accessibility, as measured by four Likert-scale questions, is highly significant as well. Moreover, prospective accessibility also significantly influences non EV owner adoption intention. We also find that environmental consciousness and prior experience with EV have significant effects. This study provides a valuable reference for the importance of accessibility of public EV chargers on customer EV adoption intention in the context of a high density Asian city. Based on the findings, we provide a number of policy recommendations that integrate accessibility planning strategies into e-mobility promotion in cities that aspire to promote e-mobility.

Public Transport

Marginal Emission Factors for Public Transit: Effects of Urban Scale and Density

Alexander Bigazzi (The University of British Columbia)

Abstract. The emissions intensity of different modes of travel is typically examined and compared using average emission factors (AEF). However, marginal emission factors (MEF), i.e., how emissions change with a change in travel volume, are more important for understanding the environmental effects of mode choices and mode shift strategies. AEF for public transit systems are lower in larger, denser cities where transit service provision can be more efficient – but do MEF vary with urban scale and density in the same way? The objective of this study is to determine the relationship between fundamental urban scale

characteristics (population, area, density) and marginal emission factors for public transit. MEF and AEF are estimated and compared for transit systems across the U.S. using regression analysis on Federal Transit Administration panel data aggregated to 376 urban areas over 27 years. Results show that both MEF and AEF vary substantially across cities and decrease with urban population, area, density, and transit system extent – but AEF are around 50% more sensitive to urban scale than MEF. MEF for bus transit is also more sensitive to urban scale than for rail transit. The distinction between MEF and AEF is especially important for bus transit in smaller, less dense cities, which tend to have lower ridership and higher AEF. Marginal analysis shows that public transit is a more sustainable choice than private auto travel and mode shift should be encouraged, even in small cities where average emissions from travel by bus may be higher than for travel in private vehicles.

Exploring the Interrelation Between Rapid Transit and Gentrification in Metro Vancouver: Different Modes, Different Outcomes

Jordan Rea (University of Alberta)
Emily Grise (University of Alberta)
Bogdan Kapatsila (University of Alberta)

Abstract. As cities across the world embrace the benefits of rapid transit technology and invest in the expansion of existing infrastructure or plan for the introduction of new lines, the difference in outcomes that bus rapid transit (BRT) and rail rapid transit (RRT) brings remains unclear. This study aims to bridge that gap and understand if there is a distinction in externalities that result from BRT and LRT projects, especially their influence on gentrification, by exploring effects of both modes in the same metropolitan region – Metro Vancouver, as well as advance the knowledge on the impacts BRT stations have on the sociodemographic composition of adjacent neighbourhoods. This study uses three BRT and three RRT lines that were in service for all or part of the 20 years spanning 1996 through 2016 to assess the rates of in- and out-movement of households by income in Census Tracts (CTs) within 800 metres (½-mile) of a given rapid line. We consider rising concentrations of higher-income households, coupled with declining shares of lower-income households, to signal gentrification is occurring. This study found that the share of higher-income households rose over time in tandem with a decline in lower-income households adjacent to all study RRT lines. The trend is less uniform for study BRT corridors, while there was some indication of gentrification adjacent to the 99 B-Line (the most heavily patronized bus route in Vancouver). This research adds a unique perspective to the debate cities and transport agencies are experiencing between different transport technologies. In addition to lower costs and quick construction timelines, bundled with greater flexibility to modify routing, BRT may also provide high-quality transport to a region without disrupting the social fabric of communities.

Access During Crisis: Applying Accessibility Metrics to Public Transport Systems During the COVID-19 Pandemic from an Equity Perspective

James DeWeese (McGill University)
Kevin Manaugh (McGill University)
Ahmed El-Geneidy (McGill University)

Abstract. Accessibility—the ease of reaching desired destinations—has enjoyed increasing recognition as a valuable metric of land-use and transport-system interactions. Accessibility's unifying focus and the accompanying shift from a mobility-centric agenda have led to its adoption as a key performance measure for long-range planning and scenario development. The proliferation of publicly available data and easy-to-use free and open-source software tools mean that practitioners and policymakers can now generate accessibility measures more quickly and conveniently, allowing for these metrics to be applied to a

broader range of situations. In this study, we show how accessibility could be used as a rapid diagnostic tool to assess the potential impacts of public-transport service adjustments during a public-health crisis. We examine accessibility changes to a range of job and activity types resulting from the service alterations the greater Montreal region's public-transport operators made in response to COVID-19. Using publicly available data and free software, we find that accessibility to many jobs and opportunities classified as essential declined more severely than jobs and opportunities that were deemed nonessential. We also find that the public-transport service changes that took place between May 2019 and May 2020 in Montreal significantly reduced the number of health-sector workers who could reach some area hospitals within 45 minutes by transit at key shift-change times. Findings based on accessibility generally cannot determine the extent to which any particular traveler or destination might be specifically affected, but they are useful to quickly pinpoint potential problems that may require additional study. Although this paper focuses on using accessibility to analyze public-transport operators' responses to a unique health crisis, it may also be of interest to practitioners wishing to incorporate equity analysis into their planning processes more generally as it suggests a quick and straightforward method to assess accessibility by public transport for defined groups.

Influences on Transit Ridership and Transit Accessibility in US Urban Areas

Louis Merlin (Florida Atlantic University)
Matan Singer (University of Michigan)
Jonathan Levine (University of Michigan)

Abstract. The success of transit systems, traditionally gauged through ridership metrics, must also be assessed via transit accessibility because accessibility to destinations indicates the quality of service that transit provides. Using a structural equation modeling approach, we explain transit accessibility and transit ridership in 2017 for 50 large urbanized areas in the United States as dual outcomes dependent upon population size, urban form, and transit service provision. Also, we examine transit accessibility as a factor that influences transit ridership. We find that transit service provision strongly influences both transit ridership per capita and job accessibility provided by transit and that transit accessibility, in turn, offers a moderate boost on transit ridership. Population density results in higher transit accessibility directly by making destinations easier to reach and indirectly by increasing the amount of transit services provided. Other built environment and transit service variables were examined but did not improve the models' explanatory power. Disaggregating the effects of fixed-guideway (i.e., rail) and non-fixed guideway transit (i.e., buses in mixed traffic), we find that fixed-guideway transit has a more substantial effect on transit accessibility, while non-fixed guideway transit has a larger effect on transit ridership.

Build Transit and Will They Park and Ride? Modeling Motorcycle Parking Behavior Change during Metro System Expansion in Taipei, Taiwan

Bing-Yu Chiu (University of Pennsylvania)

Abstract. Can increasing the supply of public transit in cities with high motorcycle use contribute to reductions in motorcyclists' trip length, and thus support lowering transportation-induced greenhouse gas emissions and traffic accidents? To answer this question, this study examined recent motorcycle parking behavior in Taipei, Taiwan that has similar transportation characteristics (time of adopting mass rapid transit and current motorcycle modal share) as some other large Asian cities such as Bangkok and Kuala Lumpur. In fact, the Asia Pacific region houses 60% of the global population and more than 50% of the world's motorcycles. Between 2008 and 2019, the Taipei Metro mass rapid transit system increased its operating kilometers by 55 kilometers, a 73% increase. In the same period, Taipei had an increased rate of motorcycle ownership, experienced modest population growth, and a decline in motorcycle vehicle kilometers traveled (VKT) among its motorcyclists. Using a dataset supplied by the Taipei City

Government, this study monitored increases in parked motorcycles as a proxy for motorcycle trips to measure whether this factor (additional parked motorcycles clustering around new metro stations) could explain the drop in VKT. The results confirmed the clustering yet suggested that other determinants could also have been influential. Nonetheless, the significance of this research lies in its identification of the correlation between increasing mass rapid transit and behavior change of motorcyclists that could explain decreasing motorcycle VKT.

Connecting to Health and Education: Assessing the Accessibility Provided by Public Transport in Major African Cities

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Tamara Kerzhner (UC Berkeley)
Eulalie Saisset (Mines ParisTech & Paris School of Economics)
Xavier Espinet Alegre (World Bank)

Abstract. Transport matters for health and education outcomes by ensuring physical access to health facilities and schools. Using spatial modeling techniques and routable public transport service data, and adopting a consistent definition of the area that constitutes the "city", this study assesses the extent to which existing fixed route public transport systems ensure accessibility to advanced healthcare and education opportunities in ten large African cities. It finds that, on average, connectivity to schools, especially at the primary level, is considerably better than to advanced healthcare facilities across all of the cities. However, most of the trip duration is actually taken on foot rather than in the public transport vehicle. Moreover, there are significant pockets of "accessibility poverty" – travel times above an acceptable level – indicating inequality in access within the cities, and poor populations, on average, incur higher travel times than the city populations overall. Proximity of public transport to people's homes matters, but only to some extent (more so for access to healthcare than to education), possibly due to the way public transport service providers – many of whom operate informally – allocate their routes across the urban space as well as due to the overall low travel speeds and frequencies of the public transport vehicles. The low technical performance and sparsity of some of the public transport systems also means that the "value added" provided by public transport vis-à-vis walking is low in most cities. While some accessibility challenges persist across all ten cities, different approaches in prioritizing policy interventions are likely needed depending on the specific accessibility landscape. These range from more limited, targeted interventions to address individual accessibility poverty pockets in cities like Douala, Conakry, Nairobi, Kampala, and Kigali, to larger scale transport and health infrastructure investments in Harare, Ouagadougou, Bamako, and Dar es Salaam.

Investigating the Ridership Impact of New LRT and Arterial BRT Lines in the Twin Cities

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Eric Lind (Metro Transit)
Candace Brakewood (University of Tennessee)
Gregory Erhardt (University of Kentucky)
Kari Watkins (Georgia Institute of Technology)

Abstract. Cities in the United States and across the world are investing in high-capacity modes with enhanced reliability, including light-rail (LRT) and arterial Bus Rapid Transit (BRT), to regain ridership. However, the impact of replacing high-frequency bus service with these modes is not well understood. This paper investigates the ridership effect of implementing LRT and arterial BRT on corridors that were already well served by local bus routes. Using data from Metro Transit in Minneapolis/St. Paul between 2012 and 2017, overall ridership and frequency on the corridors are evaluated to distinguish between trips

that were newly generated from trips that were drawn from the local bus routes running in the same corridor. Fixed-effects models are fitted to estimate how much of the new ridership can be attributed to the high-capacity modes and to the reliability improvements they provide while controlling for covariates. The Green LRT Line generated 86% more ridership and the arterial BRT Line A generated 12% more ridership than if the transit agency had relied on local bus. These results demonstrate the potential ridership impacts of replacing and supplementing existing bus service with reliable high-capacity modes.

Exploring the Interaction Effect of Poverty Concentration and Transit Service on Highway Traffic during the COVID-19 Lockdown

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Jason Cao (University of Minnesota)

Abstract. During the COVID-19 lockdown, transit agencies need to respond to the decline in travel but also maintain essential mobility of low-income people. However, there are few lessons to learn from. Using highway traffic data in the Twin Cities, this study applies a generalized additive model to explore the relationships among the share of low-income population, transit service, and highway traffic during the week right after the stay-at-home order. Our results substantiated that transportation impacts are spread unevenly across different income groups and low-income people are less able to reduce travel, leading to equity concerns. Moreover, transit supply influences highway traffic differently in the areas with different shares of low-income people. Our study suggests that transportation agencies should provide more affordable travel options for the areas of concentrated poverty during the lockdown time. In addition, transit agencies should manage transit supply strategically depending on the share of low-income people to better meet people's mobility needs.

What the Heck is a Choice Rider? A Theoretical Framework and Empirical Model

Erick Guerra (University of Pennsylvania)

Abstract. As local, state, and federal agencies begin investing substantial resources into subsidizing transit in the 1960s and 70s, public documents argue that transit agencies should focus on attracting choice riders instead of dependent riders, who have no alternatives and use transit regardless of service quality. After six decades, the definitions, uses, and implications of the terms choice and dependent rider have remained consistent in the academic and professional literature. These definitions, however, lack a strong theoretical grounding or empirical evidence. Using travel diary data from the Philadelphia region, I estimate discrete choice models to identify choice riders, who I define as those who have close to a 50% probability of choosing between a car or transit for a given trip. The Philadelphia region, which has a diverse range of transit users and transit services, is an ideal place to develop and fit an empirical model of choice ridership. Attributes assumed to be associated with dependent riders, such as a lack of a car, low income, and being a racial or ethnic minority, are much more prevalent among choice riders than the general metropolitan population. Choice riders are also diverse, with a mix of racial backgrounds, income levels, educational attainment, and access to private cars. Transit dependency, by contrast, is rare. The lowest and highest income residents generally only choose transit when service quality is high, and transit is cost- and time-competitive with the car.

Transitway Investment and Nearby Commercial Gentrification

Noah Wexler (University of Minnesota)
Yingling Fan (University of Minnesota)

Abstract. Transitway-investment often has an unintended negative consequence of commercial gentrification --- the process by which land-use changes devalue some land and increase value for others, leading to business turnover that particularly affects small firms. Using cross sectional data on over 24,000 business-year observations, we examine how the construction and opening of the Green Line Light Rail Transit in Minneapolis and St. Paul affected sales volume and employment at nearby businesses. Using pre-and-post construction local polynomial regressions, we find that firms within about 750 meters of a new transit station are negatively affected by transit station opening, and integrate this distance threshold into event study difference-in-differences models that allow us to estimate how treatment effects change over time. We find that single location firms' sales volumes begin to experience a 13% reduction (compared to untreated firms) about two years after LRT becomes operational but are unaffected during construction. By contrast firms with multiple locations do not experience significant sales volume effects. Employment at both types of firms was unaffected. We test the robustness of models and explore potential explanations for results.

COVID-19, Travel Behavior Change, and Timing the Launch of a Shared Use Mobility Program

Susan Pike (University of California, Davis)

Abstract. The COVID-19 pandemic has impacted the patterns of daily life and altered transportation systems the world over. As the threat of the pandemic begins to subside and in person activities begin to resume, the patterns and behaviors that have been adopted during this time will be disrupted. This disruption could cause individuals and households to re-examine their pre-COVID travel patterns, and may represent an opportunity to encourage increases, as compared to pre-COVID use, in the use of sustainable modes of transportation. This study explores expectations about transportation choices once the pandemic begins to subside. Survey data was collected in July 2020 to explore changes made in travel behavior resulting from the pandemic and to evaluate participants expected travel behavior, "Once COVID-19 is no longer a threat." The survey also investigates the potential interest in shared use mobility programs that would connect residents to regional rail. The majority of participants indicated they expect to return to their pre-COVID-19 usual commute mode. However, because many also reported that they have an interest in the shared-use mobility programs planned by the City, there is an opportunity for these programs to facilitate the increased use of the train as the pandemic subsides and travel increases.

Examining the Urban-Rural Differences on the Non-linear Relationships Between the Social and Built Environment and Public Transport Use Among Older Adults

Lanjing Wang (Shanghai Jiao Tong University)
Jiani Wu (Shanghai Jiao Tong University)
Wenxiao Wang (Shanghai Jiao Tong University)
Yi Zhang (Shanghai Jiao Tong University)

Abstract. Currently the gap between urban and rural development and quality of life still exists objectively. The rapid growth of the aging population in China puts forward a series of new requirements for the large occupancy public transport system. However, few studies have investigated the differences between urban and rural older people's use of public transportation, and diverse influencing factors. Based

on the data of Zhongshan, a medium-sized city in southern China, this paper explores the non-linear effects of personal, attitudinal, household, social, and built environment attributes on public transport use among the urban and rural elderly by using the XGBoost model, and draw some conclusions. For example, the travel frequency of rural elderly is lower than urban elderly; Motorcycle ownership is strongly interrelated with public transport use of rural elderly, while bicycle and electric bike ownership, walking preference are more significant for urban elderly. The built environment attributes have the greatest impact on the urban and rural elderly, but the degree is slightly different, and the relationship is non-linear. For instance, greenspace is crucial for both and has a threshold effect in the city, while the main greening in rural areas is farmland and natural vegetation, and the high greening ratio has no significant motivation. The findings will provide an effective theoretical basis and reference for the development and research of public transportation in the process of urban integration.

Investigating a Point-to-Point Bus Service System Ridership and Terminal Characteristics in Metro Manila

Francis Lorenz Abinales (De La Salle University)
Jose Emmanuel Dela Torre (De La Salle University)
Adrian Limqueco (De La Salle University)
Cyro Hector Sanchez (De La Salle University)
Paolo Ian Lucero (De La Salle University)

Abstract. The Premium Point-to-Point Bus Service or more commonly known as P2P was created to help alleviate the traffic congestion along one of the most traversed roads connecting the north and south in Metro Manila: the Epifanio delos Santos Avenue or simply EDSA. P2P's main objective is to encourage the shift of private car users to public transport by providing less bus stops and increasing the quality of convenience of the service. After years of operation of the P2P system, it was observed that most people who shifted to P2P are already public transport users. To look further into the ridership characteristics of the implemented P2P system, this research would focus on analyzing each P2P station in relation to the surrounding land use characteristics. There are P2P stations with significantly higher ridership than other terminals. Specifically, this paper investigated the impacts of variables which could be a significant factor on ridership of P2P located in Metro Manila. Correlations between variables were performed using SPSS and were analyzed using backward multi-linear regression. Five variables were found to be significantly associated with P2P ridership at the 95% confidence level: residential, administrative, number of parking slots, number of four-way intersections, and population density. Commercial, green space, industrial, transportation connectivity, fare, and the dummy variables "mall" and "makeshift" were found to be insignificant to P2P ridership.

Dissertation Award Nominees

Redefining the Value of Accessibility: Toward a Better Understanding of How Accessibility Shapes Household Residential Location and Travel Choices

Xiang Yan (Urban and Regional Planning, University of Michigan) (currently at University of Florida)

A growing number of scholars have suggested that transportation and land-use planning should focus on promoting accessibility rather than mobility (Handy, 2005; Martens, 2016; Levine et al., 2019). Mobility describes how fast people can travel, whereas accessibility describes how convenient a transportation and land-use system allows people to reach essential destinations. The call for a shift from mobility-based to accessibility-based planning is also gaining momentum in the U.S. national policy arena, as policymakers advocate for promoting access and equity in transportation decision-making (Short, 2019). However,

efforts to promote accessibility-based planning face many obstacles, such as confusion about accessibility concepts, constraints due to governance structure, legacy institutional barriers, and professional norms (Geurs & Van Wee, 2004; Handy, 2020; Levine et al., 2019). My dissertation addresses an important but largely overlooked conceptual impediment to accessibility-based planning: the assumption that equates the benefits of accessibility to travel cost savings (TCS).

Starting from this assumption, many researchers have interpreted the absence of TCS such as savings in commuting cost and reductions in vehicle miles traveled (VMT) as evidence undermining the rationale for accessibility-promoting strategies such as job-housing balance and transit-oriented development. I challenge these interpretations by suggesting that accessibility improvements can result in not only TCS but also destination-utility gains, which means the individual satisfaction from interacting with or choosing desirable destinations. The absence of TCS from accessibility-promoting policies can be explained by accessibility gains manifesting as destination-utility gains (van Wee, 2011). I further argue that evaluating accessibility-promoting land-use and transportation strategies by whether they accrue travel-cost savings amounts to a vast underestimate of the positive impacts of these policies, which impedes both policy reform and the utility of the accessibility concept in research.

I empirically test these arguments with research into the influence of destination-utility gains on residential location choice and trip frequency; and an evaluation of the relative importance of walkability, transit accessibility, and auto accessibility on residential location choice. I design an innovative empirical strategy to isolate the independent effects of destination-utility gains from travel-cost savings on household residential location and travel decisions. To strengthen the generalizability of the findings and to explore differences in regional contexts, I conduct the empirical analysis for three distinctive U.S. metropolitan regions (Atlanta, Puget Sound, and Southeast Michigan). I demonstrate the importance of destination-utility gains to individuals and households in three related papers.

In the first paper, I trace the origin of the TCS-based view of accessibility to classic urban economic theories and review its application in residential location studies. To test the hypothesis that individuals value accessibility beyond the benefit of travel-cost savings, I examine whether transit accessibility remains a significant predictor of residential location choice after I control for all possible travel-cost savings associated with it. The results do not support a TCS-based view of accessibility benefits. Considering that only a small fraction of Americans regularly use transit, I conclude that it is mainly the option value of transit access that attracts people to transit-accessible neighborhoods.

Building on the idea that people value accessibility beyond the benefit of TCS, the second paper critiques the common practice of using a reduction in VMT as the main empirical measure to represent the transportation benefits of accessibility-enhancing compact-development strategies. I argue that VMT-reduction measures blur the impact that compact development has on the utility that people receive from their environment. This is because compactness can shape personal VMT in opposite directions: a desire for TCS can make people reduce their VMT, but people can end up traveling more if they make more trips or travel to more remote destinations to gain greater destination utility. Empirical analysis of trip frequency data in Puget Sound and Southeast Michigan supports my hypothesis by suggesting that compact development has countervailing effects on driving. Therefore, VMT-reduction measures underrepresent the transportation benefits of compact development.

The third paper empirically evaluates the relative importance of walkability, transit accessibility, and auto accessibility in residential location choice across three U.S. regions (Puget Sound, Southeast Michigan, and Atlanta). I find that transit accessibility is a more important determinant of residential location choice than walkability and auto accessibility. The results further suggest that households' preferred behavior can be different from their actual choices because of housing supply constraints. This implies that if housing supply changes, estimates of accessibility preferences may change accordingly. This finding

challenges the standard practice of land-use and transportation modeling, which forecasts future land-use patterns based on the presumed stability of historical or present estimates of accessibility preferences.

My research advances the theoretical understanding of how accessibility shapes household residential-location and travel choices by highlighting the importance of destination-utility gains that have been largely ignored by the existing literature. The research findings suggest that planners and policymakers should broaden the empirical criteria used to evaluate accessibility-promoting land-use and transportation strategies such as transit-oriented development. In other words, analysts should measure both the travel-cost savings and destination-utility gains that can potentially arise from accessibility improvements. Advocates of accessibility-based planning can garner wider support by bring into public discussions the various forms of destination utility gains, such as activity participation, gains from destination diversity, and knowledge spillover from enhanced personal interactions.

Public Transit Innovations, Equity, and Blind Spots: Examining Benefits and Unintended Consequences from Investments in BRT and Urban Gondolas in Three Cities in the Global South

Manuel Santana Palacios (UC Berkeley)

Cities in the global South are often characterized by being grossly unequal, and a historical lack of efficient public transit is often cited as a barrier to mobility and access to urban opportunities for the urban poor. However, decision makers are now addressing the deleterious effects of decades of disinvestment in public transit infrastructure by pouring vast public resources into transit innovations, such as Bus Rapid Transit systems and urban gondolas. These investments, often promoted as pro-poor, are expected to improve the quality of life of economically disadvantaged population groups. As cities in the global South expand and continue to invest large amounts of scarce public resources into capital-intensive public transit infrastructure projects, it is imperative to understand whether and under which conditions such investments accomplish what they promise. Employing multi- and interdisciplinary research approaches, this dissertation investigates whether investments in BRT and gondolas reduce mobility and accessibility inequalities. It challenges commonly held beliefs about the distributive effects of transit innovation to make visible planning blind spots. This dissertation also provides crucial methodological and policy recommendations for advancing towards a more inclusive urban future.

Despite the increasing prevalence of social justice in contemporary transport planning scholarship and the steady growth of investments in public transit, there is surprisingly little empirical evidence detailing how the benefits of recent public transit infrastructure investments are distributed. Moreover, research on equity and transport often fails to connect empirical analyses with different principles of fairness that have driven transport policy decisions for decades. In terms of urban and regional planning, scholarship seldom attempts to link questions of transport justice with land development patterns, and there is little empirical evidence showcasing how transit investments disrupt the pre-existing private and often informal transit services upon which the urban poor in the global South often depend. Following a three-paper format which examines three recent investments in public transit infrastructure in three different cities in the global South, this dissertation addresses these gaps.

The first paper, co-authored with my colleague Lisa Rayle, critically questions whether BRT closes gaps in commute times between economically disadvantaged and non-disadvantaged users in Cape Town, South Africa, and Barranquilla, Colombia. Drawing from a retrospective intercept survey administered after BRT deployment, we estimate changes in commute times for different population groups. Our comparative and descriptive statistical analyses indicate that while BRT narrowed the gap in commute

times in Cape Town between economically disadvantaged and non-disadvantaged groups, BRT in Barranquilla did not. Triangulation with secondary data indicates that the diverging results are explained by each city's pre-BRT transit performance and urban form. One critical lesson is that BRT route configuration, urban extent,and pre-existing arterial road infrastructure dictate the degree to which BRT can reduce gaps in commute times.

For the second paper, I travel to the urban fringe of Bogotá, Colombia, to continue my investigation of the distributional effects of recent transport investments in the global South. I examine how increases in job accessibility enabled by Bogota's first urban gondola, TransMiCable, are distributed across space and population groups. I used a quasi-counterfactual research design with before-and-after comparative and descriptive analyses that capitalize on GTFS data and employment data imputed from the 2019 Bogota's travel survey. I demonstrate that while TransMiCable enabled a notable increase in job accessibility for one of the most disadvantaged population groups living near the project station areas, positive effects spill over to low- and middle-class neighborhoods in other parts of this urban region. These localized and far-reaching effects are explained by the spatial distribution of employment and the seamless connectivity of TransMiCable and the city's BRT system. I also quantify the extent to which TransMiCable reduces regional accessibility gaps and conclude by reflecting on how different methodological choices can influence how findings are interpreted in light of contrasting principles of fairness.

In the third paper, I approach Bogota's TransMiCable as a point of access into the informal transport sector to better understand how this market adapted to the urban gondola and overall implications for transport justice. I collected 31 interviews with community leaders and informal transit providers, field observations, informal transit GPS traces, and satellite images showcasing land development patterns before and after TransMiCable opened to the public. Drawing from this empirical evidence, I demonstrate that the social embeddedness character of the informal transport sector—including local connections between community members, informal transport providers, and local authorities—can enable and disable rapid adaptation to increases in access to urban opportunities enabled by improvements in the transit network. Furthermore, I suggest that the growth of the informal transport sector seems to be, in part, a consequence of the state's investment in TransMiCable. This paper closes by reflecting on multiple and interconnected unintended consequences of deploying TransMiCable. I contest the outcomes of this investment through different lenses and reflect on the need for land use planning and transport policies which promote more inclusive planning practices.

By investigating the subject of transport justice in three distinct papers using a mixture of research methods, this dissertation offers new insights that contribute to transport scholarship, plannigna and policymaking. The first paper harnesses the power of comparison to uncover how urban form and other local conditions dictate the extent to which BRT can deliver more equitable commute time savings in particular contexts. The second paper capitalizes on urban data analytic tools to understand the role of network connectivity and the spatial distribution of jobs in enabling dissimilar effects from public transit investments on job accessibility and links political philosophy to methodological choices and data interpretation. The third paper borrows methods from the digital humanities to uncover market and non-market forces that drive the adaptation of the informal transport sector to investments in public transit in a context of rapid urbanization. Together these methods and empirical evidence allow us to reflect more intentionally on the importance of delivering public transit interventions that are more sensitive to land uses and economic forces driving such occupation patterns, physical and social networks, and the implications of methodological choices on transport policy decisions.

Disparities in Access to Walking and Cycling Infrastructure, and the Relationship Between Infrastructure Investment and Gentrification

Lindsay Braun (UNC Chapel Hill) (currently at UIUC)

Abstract. Background and Research Questions Cities across the U.S. are increasingly investing in programs, policies, and infrastructure to support active transportation (walking and cycling). Some have suggested that these investments could address health disparities observed by race, ethnicity, and socioeconomic status (SES), as walking and cycling are physically active and relatively low-cost travel modes. Despite this potential, there is emerging evidence that active transportation investments have been inequitably distributed across communities of varying sociodemographic composition. For instance, cycling advocates have argued that low-income communities of color have disproportionately low access to safe, convenient infrastructure such as bike lanes. At the same time, active transportation projects have recently faced opposition from traditionally underserved communities in several U.S. cities, due largely to concerns about gentrification. Contributing to this tension is the general lack of empirical data about both sides of this relationship—about the existence and extent of disparities in access to walking and cycling infrastructure, and about the potentially simultaneous relationship between infrastructure investment and gentrification. I address this gap by examining the following research questions: 1. How are different sociodemographic groups distributed across space with respect to walkable built environments? 2. Is access to bike lanes associated with area-level sociodemographic characteristics in a cross-sectional sample of 22 large U.S. cities? 3. Are bike lane investments associated with area-level sociodemographic change (gentrification) over a 25-year period in three large U.S. cities? Access to Walkable Built Environments First, I examined how sociodemographic groups are distributed across neighborhoods of varying walkability in Birmingham, Chicago, Minneapolis, and Oakland, using data from the CARDIA Study (n=2,085 individuals). I conducted this analysis using coarsened exact matching (CEM), a non-parametric matching method that accounts for differences in covariates across "treatment" groups (here, across neighborhood types). To measure walkability, I created an index from indicators of density, street connectivity, and local destinations. I used CEM to match participants who had similar sociodemographic characteristics (race, educational attainment, income, SES) but lived in different neighborhood types (low, medium, high walkability). I found that non-white individuals and those with low SES tended to live in more walkable neighborhoods, but were less likely to be matched (i.e. to be found across the full range of neighborhood types). This could reflect socio-spatial segregation and limits on residential choice. Additionally, I found that estimates of the association between walkability and walking behavior may be biased by up to 15% when sociodemographic characteristics are adjusted for using traditional regression analysis. CEM offers a promising methodological alternative when individuals living in different neighborhood types are systematically and fundamentally different from one another. Access to Bike Lanes

Second, I examined cross-sectional associations between bike lane access and area-level sociodemographic characteristics in 22 large U.S. cities (n=21,846 block groups). Dependent variables included the presence, density, connectivity, and proximity of bike lanes, measured using GIS data from each of the 22 cities. Primary independent variables included race, ethnicity, educational attainment, income, poverty, and SES, measured using the 2011-2015 American Community Survey. I used multilevel mixed-effects regression to estimate associations between these sociodemographic characteristics and each bike lane variable, before and after adjusting for traditional indicators of cycling demand (density, distance to downtown, proportion of residents ages 18-34, cycling mode share). In unadjusted models, disadvantaged block groups (lower SES, higher proportions of minority residents) had significantly lower access to bike lanes. After adjusting for traditional indicators of cycling demand, access to bike lanes was lower in block groups with particular types of disadvantage (lower educational attainment, higher proportions of Hispanic residents, lower SES) but not in those with other types of

disadvantage (higher proportions of black residents, lower income, higher poverty). These results provide some empirical support for advocates' claims of distributional inequalities in bike lane access. Bike Lanes and Gentrification Third, I considered whether changes in the bike lane network were associated with area-level sociodemographic change between 1990 and 2015 in Chicago, Minneapolis, and Oakland (n=2,743 block groups). Dependent variables included the density and connectivity of bike lanes. Primary independent variables included two indicators of sociodemographic change: (1) a gentrification indicator created from measures of income, educational attainment, housing construction, and housing values, and (2) a more general indicator of change in SES. I used multi-level mixed effects regression to estimate associations between changes in each sociodemographic indicator and changes in each bike lane variable, adjusting for covariates that may influence the location of bike lanes (density, distance to employment, proportion of residents ages 18-34, cycling mode share). While the results varied by city, I found evidence that higher increases in bike lane density between 1990 and 2015 tended to occur disproportionately in block groups that were either already advantaged or increasing in advantage (gentrifying) over time. Temporal models suggested that gentrification occurred before or during the same decade as bike lane investment. These findings add empirical support to claims that bike lane investment is positively associated with gentrification. Conclusions These analyses reveal sociodemographic differences in access to environments and infrastructure that support active transportation, often suggesting lower access among disadvantaged populations. Addressing these disparities, however, is complicated by associations between infrastructure investment and sociodemographic change. In light of these findings, planning researchers should more closely consider the distribution of sociodemographic groups across space, treating sociodemographic characteristics with substantive interest rather than as simple control variables to be adjusted for. There is also a need for qualitative research to complement and contextualize the findings of this quantitative analysis. From the perspective of planning practice, efforts to expand active transportation infrastructure should recognize gentrification concerns and consider the social

context of infrastructure investment. Planners should engage members of disadvantaged communities in meaningful dialogue about their needs, preferences, and concerns related to active transportation, remaining open to the possibility that other types of interventions may be more contextually appropriate. Planners should also develop proactive partnerships with affordable housing and anti-displacement advocacy groups, given potential associations between infrastructure investment and gentrification. Through these approaches, planners can work to ensure that the legacy of walking and cycling interventions remains positive,

Travel Behavior of Ridesourcing: A Data-Driven Analysis

Sicheng Wang (Rutgers) (currently at University of South Carolina)

The emerging ridesourcing services provided by Transportation Network Companies are widely and increasingly used across the world. Yet, little is known about the travel behavior and decisions made by those who use ridesourcing. While many travelers are attracted by the convenience and low cost, ridesourcing has raised widespread concerns about its adverse effects on cities and society. Governments and planners are urged to impose regulations on the operation of ridesourcing. However, little data-driven empirical research has been conducted for understanding, planning, and policymaking about this emerging mobility option. This dissertation fills this literature gap by investigating various behavioral issues associated with ridesourcing using large-scale trip data.

I ask three interrelated questions about travel behavior of ridesourcing: (1) What affects the travel demand of ridesourcing trips? (2) What are the factors associated with the decision to share a ridesourcing trip?

And (3) does ridesourcing provide equitable accessibility to people across space and population groups? I conduct three analytical studies to disentangle each of the questions: (1) variation in ridesourcing trip generation, (2) factors associated with the sharing decision, and (3) equity of ridesourcing accessibility. I use ridesourcing trip data in Chengdu, China and Chicago, Illinois in these analytical studies. The neighborhood-level data about these two cities are obtained or web-scraped from various sources.

In the first analysis, Variation in Trip Generation, I characterize the unique spatiotemporal patterns of ridesourcing trips. I examine how ridesourcing trips are associated with the built environment and land use factors, including population density, floor-area ratio, housing prices, road networks, the proximity of transit, land-use mix, and points of interest. I estimate "global" regression and "local" geographically weighted regression models that account for the spatial nonstationarity. The "global" models suggest that population density, local road density, floor-area ratio, housing price, and the proximity to subway entrances have positive associations with ridesourcing trips. The proximity to a transportation hub also has a positive association with ridesourcing trip generation. Some POIs, including retail stores, restaurants, and sports and entertainment services, have greater effects on ridesourcing dropoffs during the afternoon peak and late night. The "local" models offer more nuanced insights into the spatial variation of the associations. The local coefficients of many built environment/land-use variables vary spatially. Moreover, such spatial variations are associated with the built environment and land use as well. For example, the coefficients of ln(population density) have negative associations with road density, subway entrances, and land-use mix entropy. It also has positive associations with housing prices and sports/entertainment POIs. This analysis shows the importance of considering local contexts when creating ridesourcing policies. In the second study, Factors Associated with the Sharing Decision, I investigate the spatiotemporal distribution of sharing TNC trips in Chicago. I find that the willingness to share differs across neighborhoods with different socioeconomic and built environment characteristics. The willingness to share is closely related to price and travel time. I estimate logistic regression and random forest (RF) classifiers to determine the marginal price and time effects on the sharing decision. The logistic models indicate that the probability of agreeing to share is highly sensitive to the changes in price per mile, total price, and trip duration.

The RF model, as a tree-based machine learning approach, has better predictive accuracy than the logistic model. Its results suggest that price per mile is the most important predictor, followed by total price and trip duration. Furthermore, RF models produce partial dependence (PD) plots that present the detailed marginal effect of each predictor. The findings shed light on potential pricing strategies that may increase the willingness to share ridesourcing trips. This analysis also provides insights into the use of shared autonomous vehicles when they are commercially available. One limitation in this dataset is that the price data is rounded to increments of $2.50. I use two data preprocessing methods to address this and demonstrate that the results are relatively robust. The third analytical study, Equity of Ridesourcing Accessibility, provides a comprehensive understanding of ridesourcing accessibility. I measure ridesourcing accessibility by applying gravity-based metrics based on realized TNC trips in Chicago. I use trip durations as the travel impedance factor and estimate the opportunity attractiveness for three types of nonwork destinations: healthcare facilities, restaurants, and groceries. I employ two approaches to estimate attractiveness: an employment-based measure and a POI location-based measure. The bivariate analyses imply that ridesourcing provides less equitable accessibility compared to transit, given its positive relationship with household income and negative relationship with the percentage of minorities. Furthermore, I estimate ordinary least squares (OLS) models to examine the associations between ridesourcing accessibility and demographic and socioeconomic indicators at the census tract level. The results confirm the statistical significance of the effects of household income and the percentage of non-white minorities.

Given the spatial autocorrelation identified in the OLS models, I estimate spatial autoregressive models and spatial error models to further examine the equity of ridesourcing accessibility. In general, the results remain consistent even after controlling for spatial clustering effects. These findings complement previous studies on ridesourcing accessibility, which only account for the service supply in the trip origin areas but ignore the effects of travel cost and opportunities' attractiveness.

These analyses provide evidence and insights on ridesourcing travel behavior related to planning, policymaking, and land use. Overall, the behavioral characteristics of using ridesourcing services appear to vary spatially and temporally. The travel behavior patterns are significantly associated with local contexts. Racial and social disparities in these behaviors are also illustrated. Based on these findings, I discuss policy implications in leveraging travel demand, encouraging shared rides, and improving the accessibility of disadvantaged populations and neighborhoods. Geofenced pickup/dropoff zones could be created for high-demand areas, which could help manage curb space and relieve traffic during peak hours. Policymakers could increase the congestion surcharge for unshared trips and subsidize shared trips. Planners need to allocate more essential services and facilities in low-income and minority neighborhoods. Investments for transit should be maintained, and ridesourcing subsidies could be given to

An Investigation of the Land Change Process in Relation to BRT Stations

Svitlana Pyrohava (Currently University of Queensland)

Bus Rapid Transit (BRT) has emerged in recent decades as a new version of mass transit. High performance, flexibility and affordable cost make it an attractive option among transit alternatives. Nowadays, there is a variety of systems called BRT, from systems with only dedicated bus lanes to systems with completely segregated infrastructure. The price of BRT- system construction is substantially less than rail-based alternatives, meaning that smaller cities can also afford high-volume and frequent service. At the current moment, BRT systems operate on all inhabited continents with many new systems are in design. Such proliferation of a bus-based transport mode with extensive infrastructure poses a question on its potential impact on surrounding land use. The majority of existing studies on BRT and land use consider capitalization of improvements in accessibility into surrounding land values. However, another aspect of land use, a land change, is less investigated. This dissertation, supplied with several periods of detailed cadastral data, provides a comprehensive investigation of the land change process in relation to BRT stations. To understand a theoretical and empirical background behind a process of land use change, this research started with a review of existing works in the field of transport infrastructure and land use studies. As a result, a distinction between the processes of land value change and land use change has been identified. Conclusions were made about the lack of empirical evidence from BRT and land change, particularly, from the disaggregate level of individual land parcels. The next parts of the thesis introduce a case study of the Brisbane BRT system and data collection process. Four types of data were acquired for this study: cadastral parcel data, social-economic data, environmental data, and transportation data. As a result, a unique multilevel dataset has been assembled to reflect details of social-economic and environmental characteristics of land use in Brisbane City in detail. To provide a unified procedure for selection of control groups sites, this study developed a methodology of consecutive stages. The advantage of this methodology is that it may be applied to any study-control group assessment without having a deep knowledge of the local context. The method uses a regression model using transport accessibility to derive a set of social, economic, and environmental characteristics having a major influence across the city. A statistically significant combination of these measures yields clusters of spatial units that have similar profiles to the investigated study area. The results show the difference in the control group clusters between segments of the busway alignment. The analysis of land use changes in the BRT alignment contrasted the land use distribution within several periods from 2007 to 2013 for parcels

within four segments of the BRT alignment. This analysis identified that the majority of land use changes occurred within the residential land use parcels. The Northern and Eastern segments of the alignment have higher rates of high-density land uses. The Southern segment mainly consists of low-density types of land use. Comparison of these results to the corresponding control groups illustrates a similar dynamic of changes, with cases where the ratios of high-density land use in the control groups were even higher than along the BRT alignment. To capture the influence of proximity to BRT stations on intensification of the built environment, selected types of disaggregate, parcel-level changes were modelled. Logistic models for four time periods were specified for three land use changes: Model 1 captures the conversion of a parcel from low residential density to medium-high residential density type; Model 2 captures

the conversion of a parcel classified as a vacant-construction site to medium-high residential density type; and, Model 3 includes both types of conversions. The model results show that straight-line distance-to-BRT was not significant in Model 1, statistically significant for two out of four periods in Model 2 and for two periods of Model 3, with the expected coefficient sign. A dummy variable of proximity showed impact within 0-1200 m of bus station, also with the expected coefficient signs. Finally, an interaction term of distance and the specific busway segment showed a statistically significant but modest effect of BRT presence in specific segments of the alignment. In conclusion, the study did not observe accumulation of development in the eldest segment of the BRT alignment. However, sections of the corridor in the inner urban area showed an increase in higher density changes, but so do the corresponding control group locations. BRT proximity is a statistically significant factor in high density residential land use conversion. However, the conditions of this impact vary according to the specific segment of the BRT alignment and the specific time period of analysis. By addressing research objectives, this thesis contributed to the identification of land change factors in the empirical study of a Western BRT system. As a result, it developed a model of discrete change for land use parcels in the alignment of BRT stations. Also, this work proposes a new methodology for control group selection criteria that addresses the ambiguity of previous research and accounts for the diversity of urban forms. In a process of investigation of land changes, new algorithms have been developed to identify land parcels' taxonomy based on a density criterion and to match cadastral records across temporal variations.

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Genevieve	Boisjoly	Polytechnique Montreal	29
Genevieve	Boisjoly	Polytechnique Montreal	35
Candace	Brakewood	University of Tennessee	48
Lindsay	Braun	UNC Chapel Hill (currently at UIUC)	65
Emilia	Bruck	TU Wien	39
David	Bunch	University of California, Davis	41
Andrew	Byrd	Conveyal LLC	36
Jason	Cao	University of Minnesota	49
Mengqiu	Cao	University of Westminster	7
Jhun Christopher M.	Castro	Civil Engineering Department, De La Salle University, Manila	11
Jyothi	Chava	Florida Atlantic University	25
Yilin	Chen	Georgia Institute of Technology	18

Zheyan	Chen	Utrecht University	40
Long	Cheng	Ghent University	7
Long	Cheng	Ghent University	33
Bing-Yu	Chiu	University of Pennsylvania	47
Giovanni	Circella	University of California, Davis	41
Geoffrey	Clifton	The University of Sydney	8
Geoffrey	Clifton	The University of Sydney	44
Kelly	Clifton	Portland State University	26
Kelly	Clifton	Portland State University	32
Kelly	Clifton	Portland State University	36
Aviv	Cohen-Zada	Technion – Israel Institute of Technology	4
Aviv	Cohen-Zada	Technion-Israel Institute of Technology	5
Adriano Borges	Costa	Massachusetts Institute of Technology	35
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Boer	Cui	McGill University	29
Isabel	Cunha	Faculty of Engineering, University of Porto	5
Kristina	Currans	University of Arizona	26
Carey	Curtis	University of Melbourne / University of Goteborg	6
Nathan	Darroch	University of Aberdeen	34
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Jorge Pinho	De Sousa	Faculdade de Engenharia da Universidade do Porto/ INESCTEC	22
Jonas	De Vos	Bartlett School of Planning, University College London	15
Jonas	De Vos	University College London	16
Jonas	De Vos	University College London	33
Jose Emmanuel	Dela Torre	De La Salle University	51
Garima	Desari	University of California, Santa Cruz	42
James	DeWeese	McGill University	46
Jennifer	Dill	Portland State University	42
Hongwei	Dong	California State University, Fresno	24
David	Durán-Rodas	Technical University of Munich	15
Andrew	Duvall	National Renewable Energy Laboratory	14
Ahmed	El-Geneidy	McGill University	29
Ahmed	El-Geneidy	McGill University	46
Erik	Elldér	University of Goteborg	6
Gregory	Erhardt	University of Kentucky	48
Dick	Ettema	Utrecht University	33
Dick	Ettema	Utrecht University	40
Dick	Ettema	Utrecht University	44
Ayodele	Faiyetole	Federal University of Technology Akure, Nigeria	16
Yingling	Fan	University of Minnesota	50

Steven	Farber	University of Toronto Scarborough	8
Mahmudur	Fatmi	University of British Columbia	31
Nicholas	Ferenchak	University of New Mexico	19
Joseph	Ferreira	Massachusetts Institute of Technology	24
Joseph	Ferreira	Massachusetts Institute of Technology	31
Joseph	Ferreira	Massachusetts Institute of Technology	43
Alexis M.	Fillone	Civil Engineering Department, De La Salle University, Manila	11
Karst	Geurs	University of Twente	6
Mahyar	Ghorbanzadeh	Florida State University	37
Stephen	Greaves	The University of Sydney	8
Stephen	Greaves	The University of Sydney	44
Emily	Grise	University of Alberta	46
Erick	Guerra	University of Pennsylvania	49
Shuocheng	Guo	University of Illinois at Urbana-Champaign	13
Luis A.	Guzman	Universidad de los Andes	21
Muhammad Ahsanul	Habib	Dalhousie university	40
Susan	Handy	University of California, Davis	41
Afsana	Haque	Jahangirnagar University	27
Chester	Harvey	UC Berkeley	13
Sylvia	He	The Chinese University of Hong Kong	45
Eva	Heinen	University of Leeds	34
Rob	Hemphill	Portland State University	42
Gavin	Hermanson	Concordia University	8
Daniel	Herszenhut	IPEA Institute for Applied Economic Research	4
Paul	Hess	University of Toronto	35
Mark	Hickman	University of Queensland	26
Robin	Hickman	UCL	17
Loan	Ho	Institute of Transport and Logistics Studies, University of Sydney	21
Hannah	Hook	Ghent University	15
Mark	Horner	Florida State University	37
Amanda	Howell	University of Oregon	26
Yang	Hu	Utrecht University	33
Prasanna	Humagain	Utah State University	12
Ricardo	Hurtubia	Pontificia Universidad Católica de Chile	20
Ricardo	Hurtubia	Universidad Católica de Chile	36
Abbey	Ibarra	California State Polytechnic University-Pomona	42
Jesper Bláfoss	Ingvardson	Department of Technology, Management and Economics, Technical University of Denmark	22
Miguel	Jaller	University of California, Davis	14
Wu	Jiani	Shanghai Jiao Tong University	19
Md.	Kamruzzaman	Monash University	33
Bogdan	Kapatsila	University of Alberta	46

Dena	Kasraian	Eindhoven University of Technology	22
Dena	Kasraian	Eindhoven University of Technology	39
Jennifer	Kent	The University of Sydney	26
Tamara	Kerzhner	UC Berkeley	48
Avet	Khachatryan	University of Toronto	35
Abu Baker	Khan	Ritsumeikan University	27
Masanobu	Kii	Kagawa University	30
Kyusik	Kim	Florida State University	37
Kara	Kockelman	The University of Texas at Austin	9
Kara	Kockelman	The University of Texas at Austin	18
Eleftheria	Kontou	University of Illinois at Urbana-Champaign	13
Julia	Kotzebue	Department of Geography, University of West Indies	28
Stephan	Krygsman	Stellenbosch University	6
Nico	Kuehnel	Technical University of Munich	29
Nico	Kuehnel	Technical University of Munich	30
Nico	Kuehnel	Technical University of Munich	30
Bahman	Lahoorpoor	University of Sydney	10
Matthias	Langer	Technical University of Munich	15
Wang	Lanjing	Shanghai Jiao Tong University	19
Anders	Larsson	University of Goteborg	6
Abiola S.	Lawal	Georgia Institute of Technology	18
Jooyong	Lee	University of Texas at Austin	18
Sangwan	Lee	Portland State University	24
Jonathan	Levine	University of Michigan	47
David	Levinson	University of Sydney	10
David	Levinson	The University of Sydney	10
David	Levinson	The University of Sydney	10
David M.	Levinson	The University of Sydney	8
Jason	Li	Massachusetts Institute of Technology	31
Lisa	Li	University of Toronto	22
Adrian	Limqueco	De La Salle University	51
Eric	Lind	Metro Transit	9
Shine	Ling	LA Metro	34
Carlos	Llorca	Technical University of Munich	30
Carlos	Llorca	Technical University of Munich	30
Phil	Longenecker	Portland State University	42
Becky	Loo	The University of Hong Kong	7
Robin	Lovelace	University of Leeds	34
Miguel	Loyola	The University of Sydney	44
Karen	Lucas	The University of Manchester	20
Shanna Trichês	Lucchesi	UFRGS	28
Paolo Ian	Lucero	De La Salle University	51

Shuli	Luo	The Chinese University of Hong Kong	45
John	MacArthur	Portland State University	42
Richa	Maheshwari	Luxembourg Institute of Socio-Economic Research	16
Jai	Malik	University of California, Davis	41
Kevin	Manaugh	McGill University	46
Richard P.	Mann	University of Leeds	34
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Karel	Martens	Technion – Israel Institute of Technology	4
Karel	Martens	Technion - Israel Institute of Technology	5
Marcelo Carreiro	Matias	Delft University of Technology	32
Louis	Merlin	Florida Atlantic University	47
Adam	Millard-Ball	UCLA	23
Eric	Miller	University of Toronto	22
Eric J.	Miller	University of Toronto	23
Eric J.	Miller	Department of Civil & Mineral Engineering, University of Toronto	48
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Rolf	Moeckel	Technical University of Munich	29
Rolf	Moeckel	Technical University of Munich	30
Rolf	Moeckel	Technical University of Munich	30
Rolf	Moeckel	Technical University of Munich	32
Mayara Moraes	Monteiro	Faculdade de Engenharia da Universidade do Porto	22
Ana Tsui	Moreno	Technical University of Munich	30
Kostas	Mouratidis	Norwegian University of Life Sciences	33
Corinne	Mulley	The University of Sydney	20
Corinne	Mulley	The University of Sydney	21
Corinne	Mulley	The University of Sydney	44
Juan Carlos	Munoz	Pontificia Universidad Católica de Chile	20
Kai	Nagel	Technische Universität Berlin	30
Kazuki	Nakamura	Meijo University	11
John	Nelson	The University of Sydney	44
Lillie	Nie	University of Southern California	42
Matheus	Oliveira	PET/COPPE/UFRJ Federal University of Rio de Janeiro - Transport Engineering Program	4
Jaime	Orrego-Oñate	Portland State University	36
Muntahith	Orvin	University of British Columbia	31
Shuhei	Oya	Meijo University	11
Eren	Ozguven	Florida State University	37
Elias	Pajares	Technical University of Munich	15
Chetan R.	Patel	Sardar Vallabhbhai National Institute of Technology	39
Zachary	Patterson	Concordia University	8
Javier	Peña	Universidad de los Andes	21

Rafael	Pereira	IPEA Institute for Applied Economic Research	4
Susan	Pike	University of California, Davis	50
Licinio	Portugal	PET/COPPE/UFRJ Federal University of Rio de Janeiro - Transport Engineering Program	4
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Arnab	Rahman	University of Toronto	23
Mashrur	Rahman	The University of Texas at Austin	37
Anu	Ramaswami	Princeton University	18
Camila	Ramos	Massachusetts Institute of Technology	35
Hema	Rayaprolu	University of Sydney	10
Hema	Rayaprolu	The University of Sydney	10
Jordan	Rea	University of Alberta	46
John	Renne	Florida Atlantic University	25
William	Riggs	University of San Francisco	9
William	Riggs	University of San Francisco	12
William	Riggs	University of San Francisco	42
William	Riggs	University of San Francisco	43
Monorom	Rith	School of Civil Engineering and Technology, Sirindhorn International	11
Arianne	Robillard	Polytechnique Montreal	35
Armistead G.	Russell	Georgia Institute of Technology	18
Eulalie	Saisset	Mines ParisTech & Paris School of Economics	48
Cyro Hector	Sanchez	De La Salle University	51
Manuel	Santana Palacios	UC Berkeley	63
Somwrita	Sarkar	The University of Sydney	8
Paulo Eduardo	Scheuer	Universidade Presbiteriana Mackenzie	28
Hayley	Schinkowsky	University of Wisconsin-Milwaukee	18
Robert J.	Schneider	University of Wisconsin-Milwaukee	18
Gian-Claudia	Sciara	The University of Texas at Austin	37
Bernardo	Serra	Institute for Transport Policy & Development – Brazil	29
Amer	Shalaby	University of Toronto	22
Fatima Kabir	Sharna	Dhaka South City Corporation	27
Heather	Shearer	Griffith University	20
Huizhong	Shen	Georgia Institute of Technology	18
Shivani	Shukla	University of San Francisco	12
Cat	Silva	Technical University of Munich	30
Cecília	Silva	Faculty of Engineering, University of Porto	5
Matan	Singer	Technion – Israel Institute of Technology	4
Matan	Singer	Technion - Israel Institute of Technology	5
Matan	Singer	University of Michigan	47
Ruchi	Singhal	Sardar Vallabhbhai National Institute of Technology	39

Patrick	Singleton	Utah State University	12
Fernanda D. P.	Soares	Department of Civil & Mineral Engineering, University of Toronto	9
Anae	Sobhani	Utrecht University	33
Aggelos	Soteropoulos	TU Wien	39
Jonathan	Stanton	San Diego State University	9
Albert	Steiner	Zurich University of Applied Sciences	6
Anson	Stewart	Massachusetts Institute of Technology	36
Todor	Stojanovski	KTH Royal Institute of Technology	16
Aiga	Stokenberga	World Bank	48
Ka Kit	Sun	The Chinese University of Hong Kong	45
Yusak	Susilo	University of Natural Resources and Life Sciences	16
Antony	Swift	Buckinghamshire Council	7
Tao	Tao	University of Minnesota	49
Tom	Thomas	University of Twente	6
Ignacio	Tiznado-Aitken	Pontificia Universidad Católica de Chile	20
Tara	Tolford	University of New Orleans	25
Wang	Tony	Shanghai Jiao Tong University	19
Eugeni Vidal	Tortosa	University of Leeds	34
Evangelos	Vafeiadis	University of Goteborg	6
Veronique	Van Acker	Luxembourg Institute of Socio-Economic Research	15
Veronique	Van Acker	LISER	16
Veronique	Van Acker	Luxembourg Institute of Socio-Economic Research	21
Jacomien	Van der Merwe	Stellenbosch University	6
Dea	van Lierop	Utrecht University	40
Dea	van Lierop	Utrecht University	44
Rob	van Nes	Delft University of Technology	32
Bert	van Wee	Delft University of Technology	32
Pieter	van Wesemael	Eindhoven University of Technology	39
Jamey	Volker	University of California, Davis	25
Lanjing	Wang	Shanghai Jiao Tong University	19
Lanjing	Wang	Shanghai Jiao Tong University	50
Liming	Wang	Portland State University	24
Liming	Wang	Portland State University	38
Sicheng	Wang	Rutgers (currently at U South Carolina)	66
Wenxiao	Wang	Shanghai Jiao Tong University	50
Kari	Watkins	Georgia Institute of Technology	48
Owen	Waygood	Polytechnique Montreal	35
Wang	Wenxiao	Shanghai Jiao Tong University	19
Noah	Wexler	University of Minnesota	50
Ben	Whitehorn	Randwick Waverley Community Transport	44
Alana	Wilson	National Renewable Energy Laboratory	14
Frank	Witlox	Department of Geography, Ghent University	7

Frank	Witlox	Ghent University	15
Frank	Witlox	Ghent University.	16
Hao	Wu	The University of Sydney	8
Hao	Wu	University of Sydney	10
Hao	Wu	The University of Sydney	10
Jiani	Wu	Shanghai Jiao Tong University	19
Jiani	Wu	Shanghai Jiao Tong University	50
Yang	Xi	Travel Modelling Group, University of Toronto Transportation Research Institute	9
Xiang	Yan	University of Florida	42
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Huajie	Yang	City University of Macau	24
Wencui	Yang	University of Florida	42
Barbara T. H.	Yen	National Yang Ming Chiao Tung University	20
Zhang	Yi	Shanghai Jiao Tong University	19
Tomohiko	Yoshida	Ritsuemikan University	27
Patrick	Yutiga	Ryerson University	17
Chris	Zegras	Massachusetts Institute of Technology	38
Liwen	Zhang	Renmin University of China	19
Qin	Zhang	Technical University of Munich	30
Qin	Zhang	Technical University of Munich	32
Xiaohu	Zhang	Massachusetts Institute of Technology	24
Xiuli	Zhang	University of California, Davis	14
Yi	Zhang	Shanghai Jiao Tong University	19
Yi	Zhang	Shanghai Jiao Tong University	50
Yu	Zhang	University of Toronto	23
Yushan	Zhang	Eindhoven University of Technology	39
Xilei	Zhao	University of Florida	42
Siqi	Zheng	Massachusetts Institute of Technology	35
Meng	Zhou	Sun Yat-sen University	31
Dominik	Ziemke	Technische Universität Berlin	29
Dominik	Ziemke	Technische Universität Berlin	30