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**BEHAVIORAL URBAN INFORMATICS, LOGISTICS, & TRANSPORT LAB (BUILT@NYU)**  
C2SMARTER University Transportation Center, New York University

--- 2023 Research Brief ---

If last year (2022) served as a transition period (a number of graduated PhD students, pending C2SMART Center renewal, etc.), this year is marked with a number of “firsts”, renewals, new horizons and forays. I continue to be among the top 2% of scientists worldwide in the subfield of Transportation & Logistics (cumulative through 2022).

**1) Two new centers**

The year began with a renewal of our C2SMART Center (now dubbed [C2SMARTER](#) with a new focus in Equitably Reducing Congestion) for \$2M/year over 5 years, as well as the new regional SEMPACT UTC led by CCNY, of which NYU is a member with Kaan Ozbay and me as co-PIs.

**2) First sabbatical**

It also included a major milestone, my first half-year sabbatical, where I spent two months visiting TU Delft (thanks to [Shadi Sharif Azadeh](#) and [Oded Cats](#) for hosting, and to [Serge Hoogendoorn](#) for accommodating!). It was a very productive trip where I had an opportunity to exchange research notes with colleagues across multiple universities and countries, much thanks to colleagues for the invitations and fascinating discussions:

- EPFL ([Michel Bierlaire](#), as external dissertation committee member for his PhD student [Selin Atac](#))
- University of Luxembourg ([Francesco Viti](#), [Richard Connors](#)) and LISER ([Tai-yu Ma](#))
- TU Munich ([Constantinos Antoniou](#), [Klaus Bogenberger](#), [Rolf Moeckel](#))
- TU Dresden ([Travis Waller](#), [Michael Krieg](#))
- University of Liège ([Mario Cools](#), [Cinzia Cirillo](#) (*visiting*))
- TU Delft ([Lori Tavasszy](#), [Bart van Arem](#), [Bilge Atasoy](#), [Yousef Maknoon](#), [Gonçalo Homem de Almeida Correia](#), [Irene Martínez](#); [Hani Mahmassani](#), [M. Grazia Speranza](#) (*via workshop*))

During the sabbatical, I worked with my students to formalize the software licensing for our lab’s research products, under which we now have several tools and original data sets (see New Research Products below). We expect to expand much further on this effort next year.

**3) First student obtaining faculty position**

My former student [Gyugeun Yoon](#) started as an assistant professor at Seoul National University. Needless to say, it is a proud teacher moment.

**4) New executive board membership**

At the Annual MATSim User Meeting in fall 2023, I was announced as one of the six executive board members for the [MATSim Association](#), the only one from North America. I expect the role to take further shape next year.

**5) New editorial role**

At the end of the year I accepted an invitation to serve as an Associate Editor for the INFORMS journal [Service Science](#). Looking forward to working with the journal’s editorial board and staff.

**6) NYU reception restarted at TRB**

We once again have a NYU/C2SMARTER reception planned for TRB after three years. Link to RSVP can be found [here](#).

**Grants activities**

Our lab completed three grants from C2SMART and one funded by MOIA. We continued working on the two projects with NYSERDA: one with CALSTART on mobility hubs in the capital region which is almost wrapped up, and one with Dollaride as part of a [\\$10M Clean Transit Access Program](#). Under C2SMARTER, we started two new grants, with one as a lead PI involved in helping the FDNY improve their emergency response times through traffic digital twin development, and as a co-PI to NCAT working with City of Arlington, Texas, and Replica, to better



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understand demand for microtransit trips to help assess revenue management strategies to better compete against automobile. A third new project was started under SEMPACT to develop a public statewide synthetic population for NYS that uses state of the art AI methods to better accommodate equity.

- NYCDOT Off-Hour Deliveries (NYCDOT, Lead Arcadis) (*notified of award*)
- An AI-reinforced traffic digital twin for testing emergency vehicle interventions, co-PIs: K. Ozbay, J. Gao (C2SMARTER, with \$56,000 in-kind cost share from FDNY) (*ongoing*)
- Multimodal trip chain planner for disadvantaged travelers to incentivize transit usage, co-PIs: V. Pandey, H. Park (C2SMARTER, WITH \$35,000 in-kind cost share from Replica and City of Arlington, Texas) (*ongoing*)
- Developing a NY statewide synthetic dataset and measures for equity analysis of mobility technology and policy deployments, co-PIs: K. Ozbay, J. Gao (SEMPACT) (*ongoing*)
- PON 4743 Clean Neighborhoods Challenge: *Clean Transit Access Program* (NYSERDA, lead Dollaride) (*ongoing*)
- Capital Region Mobility Hubs (NYSERDA, lead CALSTART, SP:20-1155) (*ongoing*)
- Quantifying and visualizing city truck route network efficiency using a virtual test bed (C2SMART, with \$300K in-kind cost share from NYC DOT) (*completed*)
- One-to-Many Simulator Interface with Virtual Test Bed for Equitable Tech Transfer (C2SMART) (*completed*)
- NY Statewide Behavioral Equity Impact Decision Support Tool with Replica (C2SMART) (*completed*)
- Development and evaluation of an electric-charging-constrained, non-myopic, dynamic routing algorithm with synchronized transfers (MOIA/Volkswagen) (*completed*)

BUILT participated in two summer research programs once again: the Summer Undergraduate Research Program at NYU, and the [ARISE program](#), which supports high school students interested in STEM research.

Research briefs from 2015 – 2022 can be found [here](#).

### Research Highlights

Our research agenda this year is divided into three main efforts: (1) MaaS systems evaluation, (2) Freight systems analysis, and (3) simulation/AI. Along with these efforts, we have revamped our Research Products to go beyond prototypes to working non-commercial licensed software and original data. Key findings are presented.

#### *MaaS evaluation*

Bingqing Liu continues building on her **Mobility-as-a-Service platform equilibrium model**. She is developing a stochastic behavioral variant in which coalitions of travelers and operators choose a network path to use. This changes the stability conditions away from the conventional deterministic complementary slackness conditions to one based off coalitional logit optimality conditions. This work is in collaboration with David Watling at U. Leeds. Bingqing further completed an algorithm for a multimodal stochastic user equilibrium model with explicitly specified flow/capacity relations to empirically model multimodal systems with dynamic capacities. The algorithms are scalable and inverse optimization models are also developed to infer the model parameters from data, making this work highly practical for implementation.

While Bingqing works on the supply side, Xiyuan Ren continues to study **agent-based mixed logit model for evaluating individual-level heterogeneity** in choice behavior (what Joffre Swait calls “[individual parameter logit](#)”). We estimated mode choice models for different population segments across with deterministic parameters for every Census block group pair in New York State (NYS), based on aggregate market share data. This method based on inverse optimization is highly replicable, as we are now applying it to the City of Arlington to help study microtransit preferences under different fare pricing schemes. The data is also being used to study electric vehicle adoption, equity analysis in mobility service adoption across NYS, and quantifying impacts of a new Interborough Express light rail line in NYC.

Bronx Science HS student Marco Giordano (who will be joining Columbia next year) worked with me on **e-scooter service region and fleet design** with elastic demand. We developed a scalable mixed integer programming model to study different budget level deployments of e-scooters in Manhattan.



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**Freight systems**

We produced several datasets related to freight: residential parcel delivery vehicle kilometers traveled in NYC, and commodity generation by zone in NYC. These data can be used to study various freight-related policy questions. For example, the commodity generation is being used by Haggai Davis to synthesize a population of truck tours to serve the demand, which will then feed into an updated MATSim-NYC simulation. The parcel delivery data can be used to understand the role of parcel deliveries on greenhouse gas emissions and justify different delivery strategies like cargo bikes and microhubs. Hai continues working on the deliveries side, looking at robotic deliveries and also studying energy delivery within an electric MaaS environment. Meanwhile, Haggai is taking the tour output data to study electric truck adoption policies.

**Simulation/AI**

Farnoosh and Hai are leading the effort to upgrade MATSim-NYC with more equitable zones and synthetic trucks. In addition, Farnoosh completed her work with MOIA on evaluating ridepooling with transfers, and has embarked on a new project with FDNY to study the use of AI models combined with simulation to help inform intervention strategies to reduce response times.

**Looking Ahead**

Next year we expect to see more contributions in electric mobility (both passenger and freight) and on simulation-based AI modeling tools. With the success of the new centers and completion of recent projects, we hope to solidify our research outputs into more formal offerings that can be shared more widely with the world.

Sincerely,

Joseph Chow, Ph.D., P.E.

[Institute Associate Professor, Department of Civil & Urban Engineering](#)

[Deputy Director, C2SMART University Transportation Center](#)

[BUILT@NYU](mailto:BUILT@NYU)

New York University Tandon School of Engineering

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**BUILT Lab members active in 2023**

**PhD student researchers**

[Jesse Fu](#), [Bingqing Chloe Liu](#), [Haggai Davis, III](#), [Farnoosh Namdarpour](#), [Hai Marshall Yang](#), [Xiyuan Ryan Ren](#), [Hannah Bonestroo](#)

**MS student researchers**

[Hector Landes](#), [Chetan Sharma](#), [Hongying Wu](#)

**HS student researcher**

Marco Giordano

**New Research Products in 2023**

**Journal publications:**

- 1) **Rath, S., Chow, J.Y.J.**, 2024. A deep real options policy for sequential service region design and timing. *Computers and Operations Research* 161, 106458.



- 2) **Yang, H., Landes, H., Chow, J.Y.J.**, 2023. A large-scale analytical residential parcel delivery model evaluating greenhouse gas emissions, COVID-19 impact, and cargo bikes. *IJTST*, in press, doi: 10.1016/j.ijst.2023.08.002.
- 3) **Fu, Z., Chow, J.Y.J.**, 2023. Dial-a-ride problem with modular platooning and en-route transfers. *Transportation Research Part C* 152, 104191.
- 4) **Pantelidis, T., Chow, J. Y. J.**, Cats, O., 2023. Mobility operator fleet-sharing contract design to risk-pool against network disruptions, *Transportmetrica A*, in press, doi: 10.1080/23249935.2023.2210229.
- 5) **Rath, S., Liu, B., Yoon, G., Chow, J.Y.J.**, 2023. Microtransit deployment portfolio management using simulation-based scenario data upscaling, *Transportation Research Part A*, 169, 103584.

**Peer-reviewed conference proceedings and presentations**

- 6) **Davis, H., III, Landes, H., Namdarpour, F., Yang, H., Chow, J.Y.J.**, Ozbay, K., 2024. Truck tour synthesis for multiagent simulations from public data. Proc. 103rd Annual Meeting of the TRB, Washington, DC.
- 7) **Liu, B., Watling, D., Chow, J.Y.J.**, 2024. Stackelberg pricing in Mobility-as-a-Service platforms with stochastic coalitional matching. Proc. 103rd Annual Meeting of the TRB, Washington, DC.
- 8) **Namdarpour, F., Liu, B.**, Kuenhel, N., Zwick, F., **Chow, J.Y.J.**, 2024. On non-myopic internal transfers in large-scale ride-pooling systems. Proc. 103rd Annual Meeting of the TRB, Washington, DC.
- 9) **Sharma, C., Chow, J.Y.J.**, 2024. Reducing U.S. transit costs: an empirical review and comparative case study of Portland, Manchester rail systems. Proc. 103rd Annual Meeting of the TRB, Washington, DC.
- 10) **Ren, X., Chow, J.Y.J.**, 2024. Choice-based service region assortment problem with statewide synthetic data: towards equitable transportation design. Proc. 103rd Annual Meeting of the TRB, Washington, DC.
- 11) **Fu, Z., Chow, J.Y.J.**, 2024. Modular platoon-based vehicle-to-vehicle electric charging problem. Proc. 103rd Annual Meeting of the TRB, Washington, DC.
- 12) **Ren, X., Chow, J.Y.J.**, 2024. Group level agent-based mixed logit for nonparametric estimation of k-modal taste heterogeneity with a ubiquitous data set. Proc. 103rd Annual Meeting of the TRB, Washington, DC.
- 13) **Yang, H., Du, Y., Le, T.V., Chow, J.Y.J.**, 2024. Analytical model for large-scale design of sidewalk delivery robot systems. Proc. 103rd Annual Meeting of the TRB, Washington, DC.
- 14) **Giordano, M., Chow, J.Y.J.**, 2024. An e-scooter service region and fleet allocation design problem with elastic demand. Proc. 103rd Annual Meeting of the TRB, Washington, DC.
- 15) **Yang, H., Du, Y., Le, T.V., Chow, J.Y.J.**, 2023. Analytical model for large-scale design of sidewalk delivery robot systems. INFORMS Annual Meeting, Phoenix, AZ.
- 16) **Ren, X., Chow, J.Y.J.**, 2023. Choice-based service region assortment problem: equitable design with statewide synthetic data. In: Proc. IEEE ITSC, Bilbao, Spain.
- 17) **Yang, H., Chow, J.Y.J.**, 2023. A large-scale analytical residential parcel delivery model with cargo bike substitution. 12th Intl Conference on City Logistics, Bordeaux, France.

**Research reports:**

- 18) [One-to-Many Simulator Interface With Virtual Test Bed for Equitable Tech Transfer](#), PI: J. Y.J. Chow, Co-PI: X.G. Ban; Sponsor: C2SMART
- 19) [NY Statewide Behavioral Equity Impact Decision Support Tool with Replica](#), PI: J.Y.J. Chow; Sponsor: C2SMART.
- 20) [Quantifying and Visualizing City Truck Route Network Efficiency Using a Virtual Testbed: Models for an Urban Freight and Parcel Delivery Virtual Testbed in NYC](#), PI: J.Y.J. Chow, Co-PI: K. Ozbay; Sponsor: C2SMART

**Dissertations and Theses completed:**

- 21) **Fu, Z.**, 2023. [Operation Design for Modular and Electric Microtransit](#). PhD dissertation, New York University.

**Working papers:**

- 22) **Liu, B., & Chow, J. Y. J.** (2023). On-demand Mobility-as-a-Service platform assignment games with guaranteed stable outcomes. [arXiv preprint arXiv:2305.00818](#).
- 23) **Yoon, G., & Chow, J. Y. J.** (2023). A sequential transit network design algorithm with optimal learning under correlated beliefs. [arXiv preprint arXiv:2305.09452](#).



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- 24) Liu, Q., Chow, J.Y.J., 2023. A generalized network level disruption strategy selection model for urban public transport systems. [arXiv preprint arXiv:2305.04324](https://arxiv.org/abs/2305.04324).

**Invited Talks:**

- 25) “Advances in assessing large-scale urban freight, from cargo bikes to robotic deliveries”, FMRI x WTS FAU, October 25, 2023.
- 26) “Transit network design with learning”, KAIST-NYU AI Seminars, October 12, 2023.
- 27) “Integrating individual parameter choice models with equitable mobility systems design”, 2nd Google Research Workshop on Sustainable Urban Mobility: Simulation and Optimization, June 7, 2023.
- 28) Panelist, “Recent advances connecting emerging modes to travel behavior”, NREL Workshop: Envisioning Tomorrow's Sustainable Mobility Systems, May 9, 2023.
- 29) “Inverse optimization applications in data-constrained freight systems”, TU Delft Freight Lab, Apr 11, 2023.
- 30) Keynote speaker, TU Delft Transport Institute Workshop: Dynamic and real-time decisions for emerging transport systems. TU Delft, Apr 4-5, 2023.
- 31) "Overview of MaaS systems planning methodological research", TU Dresden, Mar 29, 2023.
- 32) "Overview of MaaS systems planning methodological research", TU Munich, Mar 27, 2023.
- 33) "Mobility-on-Demand Technology Deployment under Two Data-Availability Extremes", TU Delft SPTL & SUM Labs, Mar 24, 2023.
- 34) "Advances in Static and Dynamic Pickup and Delivery Problems", TU Delft M3E, Mar 23, 2023.
- 35) “BUILT Lab Research Overview”, U. Luxembourg, Mar 3, 2023.

**Non-commercial licensed software:**

- 36) [EVQUARIUM](#): a tool for quantifying the equilibrium access and queuing delay for a given mix of fixed charging station locations; users can run this tool to compare different location and mix of charging technology alternatives
- 37) [NOMAD-RPS](#): a simulation environment and dispatch optimization for a fleet of ridepooling vehicles that can be tuned to fit different operations

**Proprietary open access data:**

- 38) [Equitable zone districts for NYC](#): aggregated districts based on reducing the zonal margin of error in the American Community Survey data for more equitable transportation planning applications (like synthetic populations)
- 39) [Mode choice model parameters and probabilities for NY State](#): from 2019 base year Replica, we created a set of mode choice parameters for every Census block group to block group pair, divided into four mutually exclusive population segments (low income employed, non-low income employed, seniors, students). A user can refer to this data to find mode choice models for every block group pair in the state.
- 40) [Commodity generation in NYC for 2019](#): using the FTG method produced by Holguin-Veras’ group, we generated commodity volumes by zone within NYC in 2019 that was used to distribute to tours; users can extract by different production and attractions by commodity
- 41) [Parcel delivery vehicle-kilometers traveled spatial distribution in NYC](#): The unobserved VKT from residential parcel deliveries was estimated using macroscopic models, which outputted this data. Users can