CASPT and TransitData 2025

The 16th International Conference on Advanced Systems in Public Transport (CASPT2025) and the 10th International Workshop and Symposium on Research and Applications on the Use of Passive Data from Public Transport (TransitData)

Program and Abstracts

Dates: June 30 to July 4, 2025

Venue: Kyoto University,
Clock Tower Centennial Hall
and Shiran Kaikan
Co-chaired by Jan-Dirk Schmöcker
and Fumitaka Kurauchi

京都大学 KYOTO UNIVERSITY

MAKE NEW STANDARDS. 東海国立大学機構

GIFU UNIVERSITY

GREMO

Organised by Kyoto University, Gifu University and
Global Research Institute for Mobility in Society, Nagoya University

Contents

Sponsored and supported by

Regional Futures Research Center

Institute of Systems Science Research

The Institute of Behavioral Sciences

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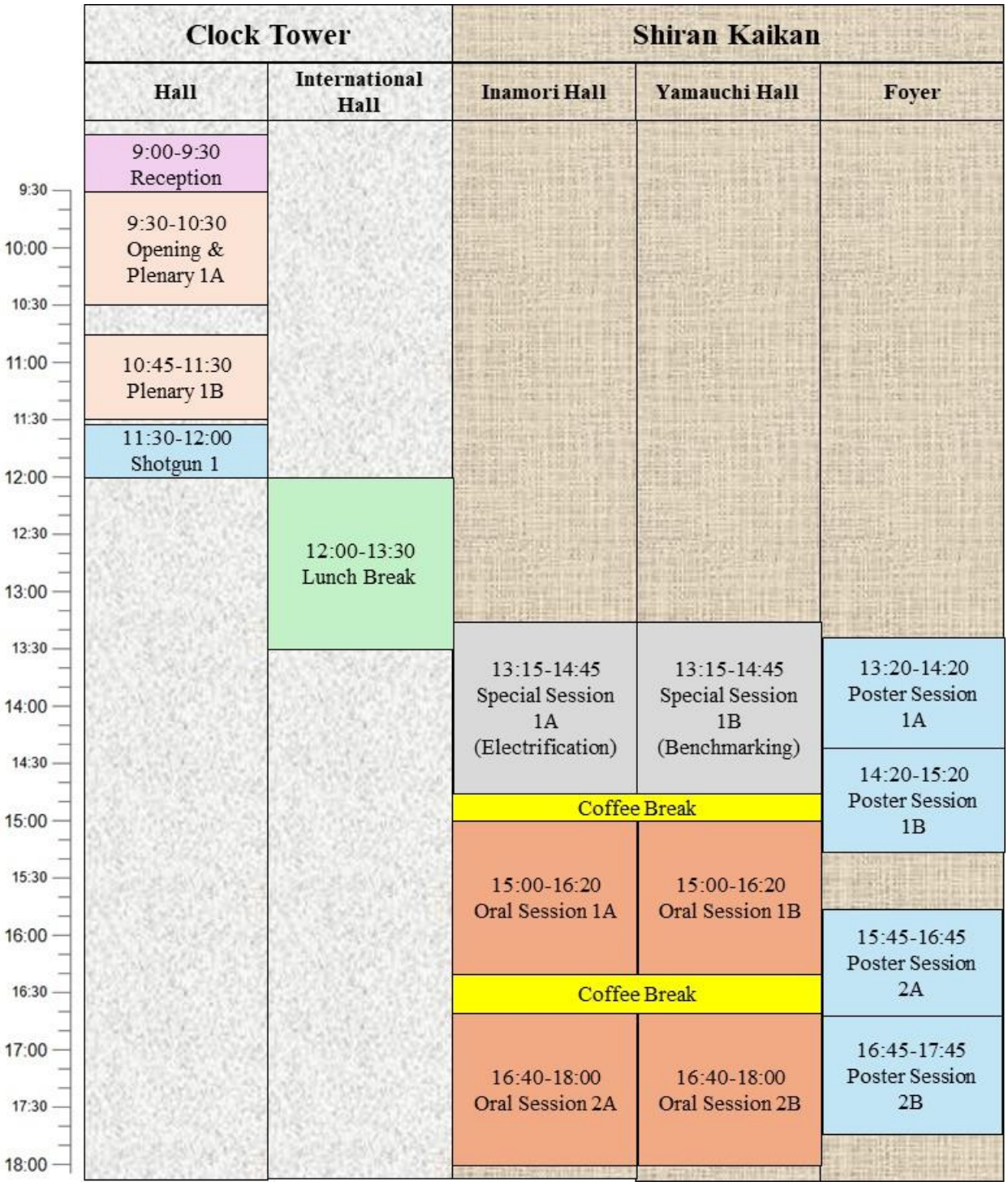
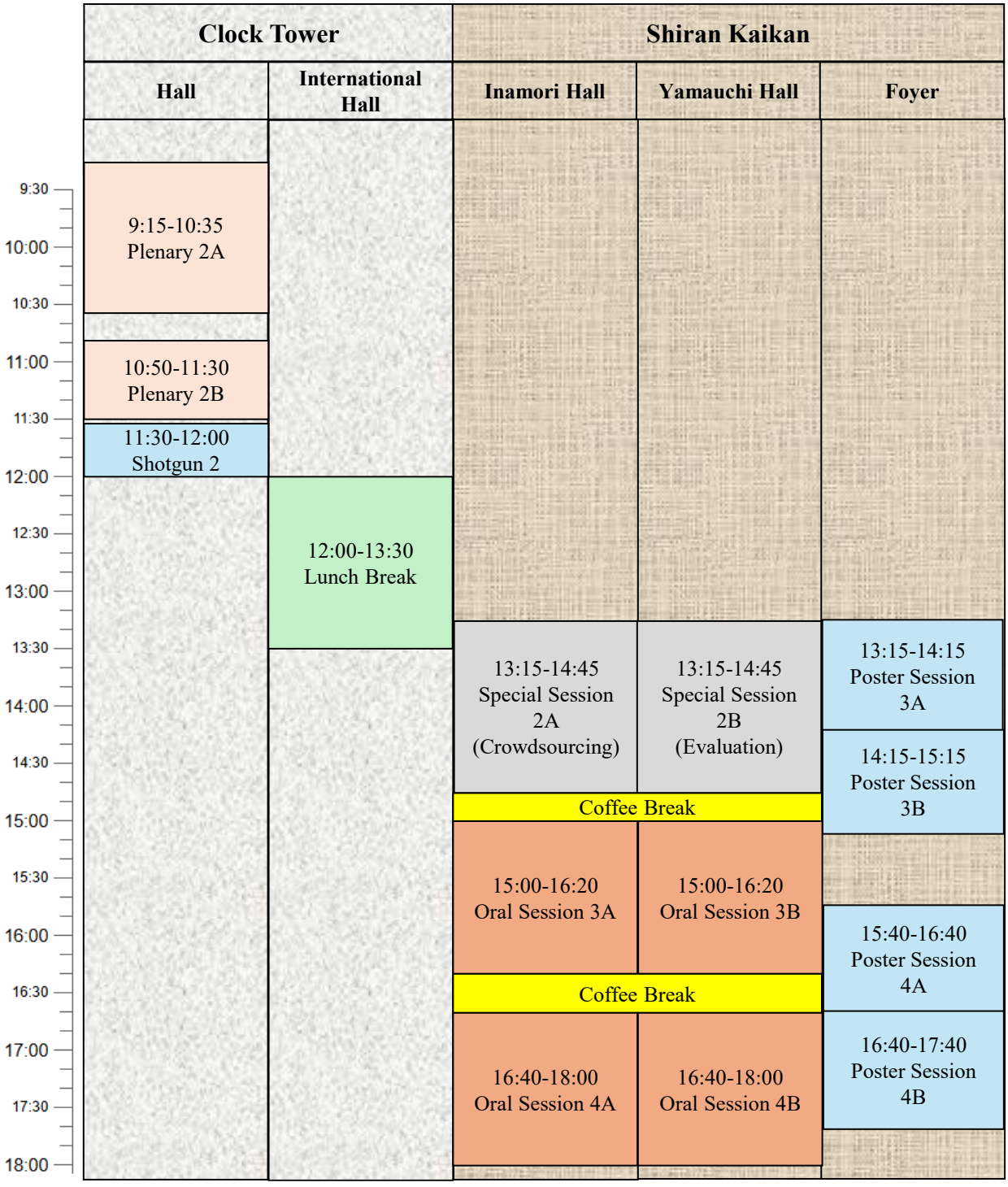
Program at a glance

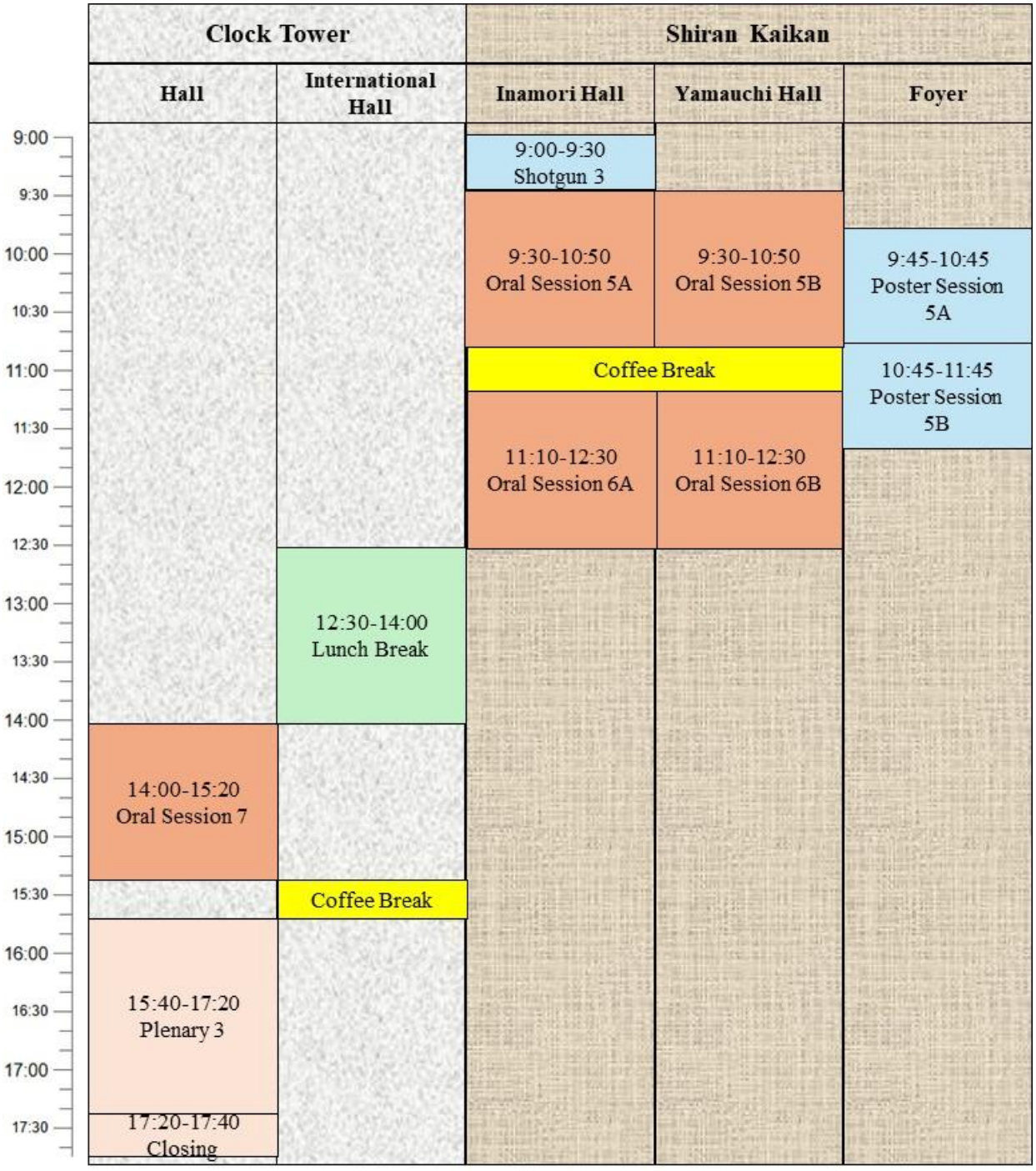
Day 1 (July 1st)



Day 2 (July 2nd)



Day 4 (July 4th)



Welcome Message

On behalf of the organizing committee, it is our great pleasure to welcome you to the **16th Conference on Advanced Systems for Public Transport (CASPT)** and the **10th Conference on TransitData**, held here in Kyoto, Japan.

Both conference series have established a long-standing tradition of bringing together researchers, practitioners, and decision-makers who are shaping the future of public transport systems around the world. This year's joint edition continues that tradition, offering a vibrant platform for the exchange of innovative ideas, rigorous research, and practical solutions to the complex challenges facing public transport today.

The large number of paper submissions and participants is a testament to the continuing, if not growing, recognition of public transportation as a cornerstone of sustainable and livable cities. As urban environments and mobility needs continue to evolve, so too must our systems—driven by innovation and new opportunities made possible by technological advancements.

We are delighted to host such a diverse and international group of participants. We hope this conference not only offers valuable insights and stimulating discussions, but also fosters friendships, meaningful connections and long-term collaborations. We trust it will inspire new ideas to address the shared challenges that cities and transit systems face worldwide.

Finally, we extend our heartfelt thanks to all authors, speakers, reviewers, and sponsors for their contributions—and to you, the participants, for being part of this important event.

Warmest regards,

Jan-Dirk Schmöcker, Fumitaka Kurauchi and the whole Organizing Committee

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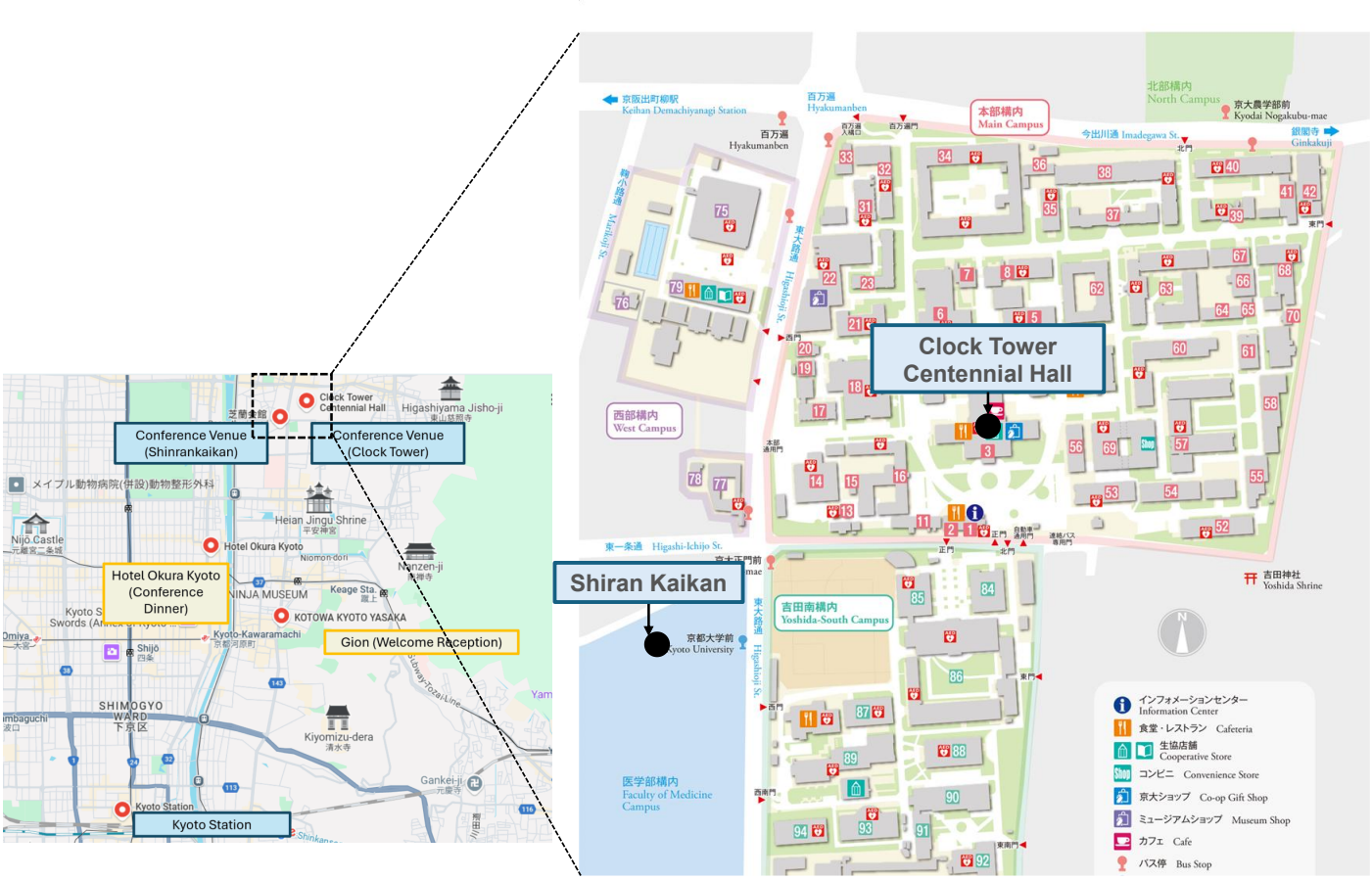
Maps and Venues

The conference will be held at the main campus of Kyoto University. The Yoshida campus is located in the center of the city. Morning sessions on Tuesday and Wednesday, the afternoon sessions on Friday and lunch on all three days will be served in the Clock Tower Centennial Hall. Afternoon parallel sessions on Tuesday and Wednesday and morning sessions on Friday will be held in Shirankaikan. A simplified map and the location of each conference venue are shown below.



Memory of Yuval Hadas

In Loving Memory of
Professor Yuval Hadas
(04.02.1967–16.02.2024)

We, the colleagues of Professor Yuval Hadas from Israel and around the world, are honored to endorse the following three eulogies in his memory: from his workplace university, his graduating university, and an international colleague.

Professor Hadas, who passed away on February 16, 2024, was a pioneering leader and innovator in public transportation research and practice. His extensive contributions spanned multiple disciplines, leaving an enduring legacy in academia, industry, and the broader community.

Yuval organized the prestigious CASPT 2022 international conference in Tel Aviv, a testament to his academic vision and leadership. His groundbreaking work in logistics, smart transportation systems, and cutting-edge technologies transformed the field and inspired countless students, colleagues, and collaborators around the globe. **His impact will be remembered for generations to come.**

Excerpts from the Eulogy by Prof. Tal Avinadav,
Head of the Department of Management, Bar-Ilan University, February 18, 2024

I extend my deepest condolences to the Hadas family for their tremendous loss. You have endured a difficult period, full of trials, hopes, and prayers. We all waited and prayed together for Yuval to recover and return to us, but sadly, we lost this battle, and our department has lost a dear and beloved colleague.

From our first conversation, it was clear that Yuval was not only deeply knowledgeable in logistics, a field he had worked in as an army officer, but also a young lecturer brimming with motivation and enthusiasm. I was impressed by his dedication, love for logistics, and ability to connect academic knowledge to practical transportation challenges. Yuval became head of the undergraduate logistics program and later led the master's program in supply chain management and logistics, excelling in both. He was also deputy head of the department for five years, contributing tirelessly.

Yuval expertise in smart transportation, GIS, and innovative technologies brought international recognition. He collaborated globally, received prestigious grants, and was an active editorial board member for leading journals. His work was widely recognized through prestigious grants, including a personal ISF and multiple awards from the Israel Smart Transportation Center. He served as an editor for *Transportation Research Part E* and actively contributed to key transportation committees internationally, cementing his reputation as a thought leader.

Yuval's absence leaves a significant void. He was not only a distinguished scholar and teacher but also a good-hearted person, a true friend, and a devoted husband and father. We will always remember his smile, energy, and integrity. **May his memory be a blessing.**

Excerpts from the Eulogy by Prof. Avi Ceder (Technion) at the TransitData Conference in London, July 2, 2024

It is with profound sadness that I open this memorial session for Yuval Hadas, who passed away far too soon at the age of 57. His untimely loss is deeply felt. Yuval was the driving force behind the last joint CASPT and TransitData conference, where his leadership and tireless efforts ensured its success. He managed many responsibilities, including coordination with transport ministers from Chile and Israel, a testament to his dedication and ability.

On a personal note, Yuval was my second PhD student and a trailblazer in transportation research. His pioneering work on synchronized transfers, published in *Transportation Research Part C*, introduced the innovative concept that public transport vehicles could reliably meet at any feasible road point, not just at designated stops. He incorporated reliability parameters and operational tactics such as holding, skip-stop strategies, speed adjustments, short-turns, and shortcuts. His optimization model, validated through simulation, showcased his methodical and inventive approach.

Yuval's ability to think beyond conventions was one of his greatest strengths. He often said, "Logic is a systematic way of arriving at the wrong conclusion with confidence," a reflection of his creative mindset. He was also the first to define the "quality of transfer," categorizing types such as street-cross, sidewalk, and non-walk transfers, while developing these ideas within a multi-agent framework. In recent years, Yuval extended his expertise to autonomous vehicles and drones, demonstrating his adaptability and forward-thinking vision.

Those who knew Yuval will always remember his humility, warmth, and friendship. His groundbreaking contributions to transportation research and his exceptional character leave a lasting legacy. **May his memory and his remarkable achievements continue to inspire us.**

Excerpts from the Eulogy by Prof. Riccardo Rossi (EWGT Coordinator) at the 26th EWGT Annual Conference (Lund, September 4, 2024)

We first met Prof. Yuval Hadas in January 2013 at the Transportation Research Board Meeting in Washington D.C., where he proposed spending a period at the University of Padova as part of the Eden project. From the outset, it was clear this collaboration would be both fruitful and enriching. It marked the beginning of a long partnership and friendship, with exchanges between Yuval at our university and us at Bar-Ilan, collaborating on shared research interests.

I fondly recall the nickname Prof. Tova Rosembloom gave Yuval during one of our meetings: "an integrator." Indeed, Yuval had a unique ability to bring together ideas, projects, and people with unforgettable vitality and passion. Yuval was a key member of the EURO Working Group on Transportation (EWGT), contributing his expertise and enthusiasm to become one of the group's leading figures. He played pivotal roles in organizing the EURO Winter Institute in Bressanone in 2017 and the EURO Mini Conference on Freight Transportation and Logistics in Padova in 2018.

He also served on the board of the Doctoral School of Civil, Environmental, and Architectural

Engineering in our department, where he mentored doctoral students, and as a member of the editorial board of *Transportation Research Procedia*, helping establish the journal. Yuval's scholarly contributions included numerous papers and the co-edited volume *Advanced Concepts, Methodologies, and Technologies for Transportation and Logistics* published in 2017. To honor his legacy, the 26th EWGT Meeting awarded a prize for the best work on public transport optimization, a fitting tribute to Yuval's invaluable contributions to the field.

It is truly difficult to capture the scope of Yuval's energy, passion for transport, and the potential of the ideas we shared. His legacy is immense, and **his strength and vitality will remain an enduring inspiration.**

In closing, these eulogies reflect the meaningful contributions of Professor Yuval Hadas to public transportation research and academia. His visionary work, dedication, and kind spirit left a lasting impression on colleagues and students worldwide. Yuval's influence extends beyond his accomplishments, inspiring many through his example. **May his memory and work continue to inspire us all.**

Endorsers (listed alphabetically by last name)

The following colleagues, friends, and collaborators endorse this letter and honor the memory of Professor Yuval Hadas:

Dr. Mahdi Amiripour, AT, Auckland, NZ
Prof. Tal Avinadav, Bar-Ilan Uni., Israel
Prof. Erel Avineri, Afeka Academic College, Israel
Prof. Jaume Barcelo, Polytech. Uni. of Catalonia, Spain
Prof. Shlomo Bekhor, Technion, Israel
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Prof. Avi Tillman, Bar-Ilan Uni., Israel
Prof. Tomer Toledo, Technion, Israel
Prof. Kazuya Tomiyama, Kitami Inst. of Techno. Japan
Dr. Dimitry Tzadikovich, Bar-Ilan Uni., Israel
Prof. Avinash Unnikrishnan, The UAB, Alabama, USA
Prof. Nobuhiro Uno, Kyoto Uni., Japan
Dr. Michael Vaknin, Bar-Ilan Uni., Israel
Dr. Guy Wachtel, Ariel University, Israel
Dr. Michal Weber, Bar-Ilan Uni, Israel
Prof. Sara Westreich, Bar-Ilan Uni., Israel
Prof. Doug Wilson, Uni. of Auckland, NZ
Prof. Nigel Wilson, MIT, USA
Dr. Shuki Wolfus, Bar-Ilan Uni., Israel,
Prof. Eyal Yaniv, Bar-Ilan Uni., Israel
Prof. Jacek Zak, Poznan Uni. of Technology, Poland

Detailed Program

Tuesday, July 1st

09:30-10:30 Session K1A: Opening & Plenary 1A

09:30 Welcome greetings

09:45 *Hong K. Lo*

Sustainable management strategies for a mixed fleet of electric and diesel buses under driving range uncertainty

10:45-11:30 Session K1B: Plenary 1B *(Clock Tower Centennial Hall)*

10:45 *Nie Marco*

Is fare-free transit just?

11:30-12:00 Shotgun presentations *(Clock Tower Centennial Hall)*

12:00-13:30 Lunch *(Clock Tower 2nd Floor)*

13:15-14:45 Session S1A: Electrification (*Shirankaikan Imamori Hall*, Chair: *Ludger Heide*)

13:15 *Sara Momen*, *Soren Paul Burghardt*, *Kuldeep Kavta* and *Shadi Sharif Azadeh*

Behavioral Impact of Battery Range and Unlock Fees on Shared E-Moped Usage

13:35 *Luyun Zhao*, *Shiyu Shen* and *Zhan Zhao*

Multi-Period Electrification of Large-Scale Bus Network via Deep Reinforcement Learning

13:55 *Robert Janus*, *Natalia Kliewer*, *Lucas Mertens* and *Mick Molitor*

Extended Simultaneous Optimization of Charging Station Locations and Electric Vehicle Scheduling for a Changing Mixed Bus Fleet

14:15 *Jie Ma*, *Xiaokuan Zhao*, *Yu Li*, *Le Zhang*, *Weihua Gu* and *Chi Xie*

Integrated Replacement Planning and Scheduling for Multi-terminal Electric Bus Systems

13:15-14:45 Session S1B: Benchmarking (*Shirankaikan Yamauchi Hall,* Chair: *Daniel Graham*)

13:15 *Daniel Graham*

Model-Based Adjustment for Conditional Benchmarking of Mass Transit Systems

13:35 *Anupriya Anupriya* and *Daniel Graham*

Benchmarking Urban Rail Transit Operations Using Synthetic Units

13:55 *Anastasios Skoufas*, *Matej Cebecauer*, *Wilco Burghout*, *Erik Jenelius* and *Oded Cats*

Ex-Post Assessment of Public Transportation on-Board Crowding Induced by New Urban Developments

14:15 *Shagun Mittal*, *Rajat Verma* and *Satish Ukkusuri*

Understanding Income-Based Inequalities in Public Transit in Data-Poor Environments

13:15-14:15 Session P1A: Optimization and Environmental Assessment *(Shirankaikan Foyer)*

1A-1 *Michelle Ochsner, Sarah Greenham, Daniel del Barrio Álvarez and Hironori Kato*
On Track to Climate Resilience? Insights from Japanese Railways

1A-2 *Barbara T.H. Yen*, *Chia-Jung Yeh*, *Yu-Chiun Chiou*, *Chin-Chih Liao*, *Chin-Tung Tsai*, *Jin-Yuan Wang* and *Pai-Chu Lee*
Public Transport Promotion Effect Measurement: Monthly Pass (Tpass) Case Study in Taiwan

1A-3 *Zhiya Su*, *Joseph Chow* and *Hong Lo*
Dynamic Shuttle Bus Frequency Control for Stochastic Metro Disruption

1A-4 *Yumeng Fang*, *Tai-Yu Ma* and *Francesco Viti*
A Hybrid Large Neighborhood Algorithm for the Integrated Dial-a-Ride Problem

1A-5 *Chiang Fu*, *Barbara T.H. Yen*, *Ching-Ming Lai*, *Hsin-Tung Tu* and *Pai-Chu Lee*
HOW SUSTAINABLE POLICY INFLUENCES THE GREEN VEHICLE DECISION: A META-ANALYSIS

1A-6 *James C Chu*, *Yi-Wei Sung*, *Yi-Chen Chou*, *Kuang-Che Lo* and *Chao-Hua Wu*
Optimizing Integrated Passenger-Freight Transportation with Configurable Vehicles

1A-7 *Nishtha Rawat* and *Amit Agarwal*
Integration of Dimensionality Reduction and Metaheuristic Optimization for Spatiotemporal Clustering

1A-8 *Shih-Hung Yang* and *Tzu-Chang Lee*
Exploring the Impact of Urban Greenness and Shading Levels on Cycling Routes by Using Street View Imagery Data

1A-9 *William Andersson*, *Florian Fuchs*, *Zahra Ansarilari* and *Francesco Corman*
Stochastic Transit Network Design

1A-10 *Xiaokuan Zhao*, *Weihua Gu*, *Zhicheng Jin*, *Jie Ma* and *Chi Xie*
Energy Consumption Evaluation of Electric Buses and Hydrogen Buses Using Real Data

1A-11 *Kartikyan*, *Pramesh Kumar* and *Karthik K. Srinivasan*
Joint Optimization of Transit Service Frequency and Fare with Passenger Assignment

1A-12 *Yung-Hsiang Cheng* and *Ying-Chieh Kuo*
Uncertainty on Users' Behavior Intention: Evidence from Electric Moped Scooter Sharing

1A-13 *Diana Quintanar* and *Omar Ibarra*
Integrated Timetabling and Vehicle Scheduling and Electric Fleet Procurement for a Sustainable Transit System

1A-14 *Luis A. Guzman*, *Santiago Gomez*, *Olga Lucía Sarmiento* and *Carlos Moncada*
Boosting Welfare for the Poor: the Role of Public Transport Subsidies

1A-15 *Satoshi Sugiura*, *Fumitaka Kurauchi*, *Kam-Fung Cheung*, *Michael Bell* and *D. Glenn Geers*
Bus Lane Design Problem with Steiner Trees and Road Congestion

1A-16 *Ziyi Qin*, *Daisuke Fukuda* and *Mayo Mieno*

Explore the Impact of Green Slow Mobility Introduction: a Social Capital Perspective

1A-17 *Oriol Marquet*, *Monika Maciejewska* and *Oriol Roig-Costa*
Intermodality, Disrupted: Evaluating the Impacts of Banning E-Scooters on Public Transport Use in Barcelona

1A-18 *Vikram Singh* and *Amit Agarwal*
Monitoring Air Pollution Exposure of Public Bus Drivers in Delhi

1A-19 *Rashmi Choudhary* and *Amit Agarwal*
Shift from Private Mode to Public Transit with Provision of Air Pollution Information

1A-20 *Leena Ahmed*, *Matthias Ehrgott*, *Judith Y. T. Wang* and *Ahmed Kheiri*
Walking School Bus Planning – PART I: Multi-Objective Routing Optimisation with Open Source Data

14:15-15:15 Session P1B: Passenger Behavior *(Shirankaikan Foyer)*

1B-1 *R.C.P. Wong*, *W. L.Y. Wan*, *W.Y. Szeto* and *Nazam Ali*
Revolutionizing Elderly Mobility Through Autonomous Demand-Responsive Transport Services

1B-2 *Jan Lordieck* and *Francesco Corman*
How Much Do They Know? Timetable Awareness and Waiting Time of Public Transport Passengers

1B-3 *Christopher Tacker-Mischenko*, *Cheok Kit Lei*, *Yu-Ting Hsu* and *Yung-Cheng Lai*
Exploring Passenger Backtracking Behavior in Taipei Metro Using Smart Card Transaction Data

1B-4 *Mio Hosoe* and *Masashi Kuwano*
Change in Bus Route Search Trends Before and During Covid-19 Pandemic

1B-5 *Patricio Miño*, *Sebastián Raveau* and *Delgado Felipe*
Mode Choice Behaviour for Public Transport Airport Ground Egress

1B-6 *Jaeyeong Lee*, *Hyunseung Kim* and *Minsu Won*
An Algorithm for Extracting Access Trips at Railway Stations from Mobility Data and Analyzing Travel Patterns

1B-7 *Wei-Lun Tsai* and *Ching-Fu Chen*
Investigating the Heterogeneity of MaaS Adoption Intention: Evidence from Taiwan

1B-8 *Santiago Cardona*, *Jaime Soza-Parra*, *Sebastián Raveau* and *Dick Ettema*
The Role of Transport Exclusion and Aerial Cable Cars in Shaping Commuting Choices in Steep Cities

1B-9 *Marianthi Kallidoni*, *Jesper Bláfoss Ingvardson* and *Otto Anker Nielsen*
Public Transport Passenger Perceptions: Analysing Train Station Attributes in Denmark

1B-10 *Aditya Pitale*, *Shubhajit Sadhukhan* and *Manoranjan Parida*

Impact of Proposed Regional Rapid Transit System on Intercity Travel Mode Share

1B-11 *Matthew Liu*, *Kari Watkins* and *Susan Cayar*
Rural Microtransit Service to Replace Fixed Route Service: A California Case Study

1B-12 *Shu-Wei Liang*, *Chin-Shan Lu* and *K.I. Wong*
Passengers' Perceptions of the Acceptance of Autonomous Ferry

1B-13 *Oren Nahum*, *Avishai Ceder* and *Neema Nassir*
User-Centric Transfer Attributes for Path Selection and Bottleneck Detection in Public Transport Network

1B-14 *Kejun Du*, *Enoch Lee*, *Qiru Ma* and *Hong Lo*
Identification, Categorization and Rationalization of Metro Passenger Rerouting Choices Under Metro Disruptions

1B-15 *Monika Maciejewska*
The Real Cost of Women's Daily Mobility in the Context of Public Transport Scarcity in Cuba

1B-16 *Xin Chen*, *Ying Lu* and *Mark Hickman*
Investigating Customers' Inertial and Variety-Seeking Tendencies in Bundle Choices in a Mobility as a Service (Maas) Trial

1B-17 *Achille Fonzone* and *Lucy Downey*
Likelihood of Choosing Automated Buses: a Discrete Choice Experiment

1B-18 *Hanghun Jo* and *Sungtaek Choi*
What Drives Public Transport Satisfaction? Comparing Metropolitan and Provincial Areas

1B-19 *Howard Wong*, *Sophie Levi-Kallin*, *David Arquati* and *Joseph Fenwick*
Segmenting the Activity Frequency and Regularity to Study Public Transport Usage

14:45-15:00 Coffee Break

15:00-16:20 Session O1A: Optimization (*Shirankaikan Imamori Hall,* Chair: *James Chu*)

15:00 *Qiande He*, *Wai Yuen Szeto* and *Yi Wang*
A Modified Genetic Algorithm for Solving the Joint Regular Bus Route Design, Express Bus Service Design, and Frequency Setting Problem

15:20 *Zhiya Su*, *Enoch Lee*, *Hong K. Lo* and *Joseph Y.J. Chow*
Resilient Bus Services Design Under Correlated Stochastic Metro System Disruption

15:40 *Ali Akbar Sadat Asl*, *Hugues Delmaire*, *Antoine Legrain* and *François Soumis*
A Real-Time Multi-Modal Transport System: Balancing Perspectives on Users, Operators, Sustainability, and System-Wide Efficiency

16:00 *Markus Reuther* and *Torsten Klug*
A Hungarian Heuristic for the Rolling Stock Rotation Problem

15:00-16:20 Session O1B: Scheduling (*Shirankaikan Yamauchi Hall,* Chair: *Taku Fujiyama*)

15:00 *Nattanon Luangboroboon*, *Marcella Samà*, *Andrea D'Ariano* and *Taku Fujiyama*
Train Platforming Problem from the Viewpoint of Passenger Flow Management

15:20 *Chuhan Yin*, *Zhiyuan Lin*, *Ronghui Liu*, *Zixian Zhang* and *Jin Liu*
Train Unit Scheduling Considering Two Capacity Levels Derived from Multiple Demand Sources

15:40 *Neema Nassir*, *Andres Fielbaum*, *Sapan Tiwari* and *Avishai Ceder*
Optimal Vehicle Scheduling for Network-Based Modular Autonomous Public Transport Systems

16:00 *Valentina Cacchiani* and *Andrea Bettinelli*
Extending a Mixed Integer Linear Programming Formulation for Train Rescheduling with New Real-Life Objectives and Constraints

15:40-16:40 Session P2A: Emerging Mobility *(Shirankaikan Foyer)*

2A-1 *Prawira Fajarindra Belgiawan*, *Cintia Nurliyana*, *Indira Ayu Adzhani*, *Meldi Romadhani*, *I Gusti Ayu Andani*, *Muhammad Fakhrul Rozi Ashadi*, *Hasbian Fauzy Perdhana*, *Henndy Ginting* and *Mustika Sufiati Purwanegara*
User Preferences and Attitudes Toward Urban Air Mobility as a Feeder for High-Speed Rail

2A-2 *Watetu Mbugua*, *Dorine Duives*, *Jan Anne Annema* and *Niels van Oort*
Integrated Bike-Sharing Systems and Public Transport: Societal Costs and Benefits

2A-3 *Fatemeh Torabi Kachousangi*, *Yashar Araghi*, *Niels van Oort*, *Sascha Hoogendoorn-Lanser* and *Serge Hoogendoorn*
Examining Shared Mobility Adoption in Two Settings: Insights in User Preferences for First/ Last Mile Connections and Urban Trips

2A-4 *Nejc Geržinič*, *Mark van Hagen*, *Hussein Al-Tamimi*, *Dorine Duives* and *Niels van Oort*
Shared Micromobility: the Last Mile Solution for Train Stations?

2A-5 *Zhuowei Wang*, *Jiangbo Yu*, *An Wang*, *Yiyang Peng*, *Hongxing Yang* and *Anthony Chen*
Lifecycle Economic Feasibility of Zero-Emission Buses in Hong Kong: a System Dynamics Approach

2A-6 *Muchlis Muchlisin*, *Jaime Soza-Parra* and *Dick Ettema*
Who Are the Happiest Ride-Hailing Riders? Exploring Determinants of Ride-Hailing Travel Satisfaction Across Income Levels in Yogyakarta, Indonesia

2A-7 *Chung Cheng Lu*, *Yu Shyun Chien*, *Lei Jie Wang* and *Yu Kai Huang*
An Electric Bus Scheduling Problem for a Mixed Fleet of Electric and Diesel Buses

2A-8 *Wenxiang Li*, *Xingguang Zhang* and *Weiwei Liu*
Collaborative Prediction of Bike-Sharing Demand Around Subway Stations Based on Deep Spatio-Temporal Neural Networks

2A-9 *Cheng Zhang*, *Min-Ci Sun* and *Luca Quadrifoglio*

A Peer-to-Peer Ridesharing Model Incorporating Value of Time

2A-10 *Nidhi Kathait* and *Amit Agarwal*
Comparative Service Quality Evaluation of Bicycle-Sharing and E-Bike Sharing System: a Case Study of Delhi, India

2A-11 *Vahed Barzegari Bafghi* and *Mehdi Nourinejad*
Comprehensive Optimization of Charging Infrastructure Placement and Scheduling for Electric Buses Under Dynamic Electricity Pricing

2A-12 *Junhyeon Kweon* and *Sugie Lee*
Dynamic Interactions Between E-Scooters and Subway: Focusing on First-Mile and Last-Mile Trips in Seoul, Korea

2A-13 *Chaione Kim* and *Junghwa Kim*
Integrating Shared Autonomous Vehicles into Public Transit: Optimizing Pick-up and Drop-off Locations Using Taxi Data

2A-14 *Zhuoye Zhang*, *Zhichen Liu*, *Yafeng Yin*, *Daniel Vignon* and *Fangni Zhang*
Differentiated Order Allocation to Electrify Ride-Sourcing System

16:20-16:40 Coffee Break (*Shirankaikan Foyer)*,

16:40-18:00 Session O2A: Network (*Shirankaikan Imamori Hall*, Chair: *Yafeng Yin*)

16:40 *Chee Yung Lo and Daisuke Fukuda*
Development of a Semi-Dynamic Link-Based Transit Assignment Model

17:00 *Maarten Wens, Jeroen Verstraete and Pieter Vansteenwegen*
Solving the Passenger Assignment Problem with Frequency and Time Scheduling

17:20 *Hiroe Ando and Francesco Corman*
Eigenvalue Analysis of Multilayer Networks for Topological Equality in Multimodal Transport System

17:40 *Hiroshi Shimamoto*
Impact of Level of Service Public Transportation on Ridesharing Penetration -a Mathematical Model Analysis-

16:40-18:00 Session O2B: Operation (*Shirankaikan Yamauchi Hall,* Chair: *Niels van Oort*)

16:40 *Rhian Paterson*, *Saeid Saidi* and *Lina Kattan*
Revisiting Bus Dwell Time Estimation with Stochastic Stopping Trends and Policy Adherence

17:00 *Jiali Zhou*
Impacts of Unplanned Service Disruptions on Passenger Travel Behavior: a Cluster-Based Analysis

17:20 *Jilin Song*, *Amer Shalaby* and *Merve Bodur*
Real-Time Assignment of Extraboard Transit Operators

17:40 *Marketa Jirmanova*, *Vojtech Novotny*, *Michal Matowicki* and *Ching-Fu Chen*
Evaluating and Prioritizing Public Transit Infrastructure Using Man-Hours Savings: a Case Study of New York City and Kaohsiung Bus Operations

16:40-17:40 Session P2B: Prediction and Estimation *(Shirankaikan Foyer)*

2B-1 *Bingxun Wang*, *Zhibin Jiang* and *Wei Liu*
Predicting Individual next Trip in Metro Networks Using a Transformer-Based Deep Learning Model

2B-2 *Nazam Ali*, *Djamila Ouelhadj*, *Seda Sucu Sagmanli*, *Nima Dadashzadeh* and *Graham Fletcher*
A Comparative Study of Different Explainable Machine Learning Techniques for Mode Choice Prediction of Mobility-as-a-Service Users

2B-3 *Mohammad Maleki*, *Scott Rayburg* and *Stephen Glackin*
Predictors of Crowdshipping Participation in Public Transport Systems: a Mixed-Methods Analysis with Managerial Insights

2B-4 *Kwangho Baek* and *Alireza Khani*
A Discrete Choice Model with Segmentation and Embedding via AI-Learning (DCM-SEAL) for Transit Mode Choice and Planning

2B-5 *Sebastián Contreras*, *Jacqueline Arriagada* and *Eduardo Graells-Garrido*
Bus Arrival Time Prediction at Bus Stops for Multiple Cities

2B-6 *Melvin Huang*, *Martin Trépanier* and *Amaury Philippe*
Improvement to Destination Estimation in AFC Systems

2B-7 *Laura Knappik*, *Lorena S. Reyes-Rubiano* and *Sven Müller*
Optimizing Passengers' Boarding and Alighting Operations in Urban Mass Transit

2B-8 *Tak Chun Marcus Chan* and *Kari Watkins*
Transit Ridership Prediction for Student-Centric Communities

2B-9 *Javad Esmailpour* and *Saeid Saidi*
Assessment of Transit OD Scaling Methods Under Varying AFC Penetration Rates

2B-10 *Christos Gkartzonikas*, *Paraskevas Nikolaou* and *Loukas Dimitriou*
Estimating Spatial Spillover Effects in Public Transportation Network Changes

2B-11 *Xinyu Wang* and *Andrés Fielbaum*
RL-Based Anticipatory Matching in on-Demand Ridepooling

2B-12 *Constantin von Beck*, *Valeria Jana Schwanitz* and *August Wierling*
A Regression Model for Estimating Rural Traffic Volumes in Vestland County, Norway

2B-13 *Taewoo Kim* and *Joonho Ko*
Understanding User Reusability on Bike Sharing System: Using RFM Model on Rental Data

2B-14 *Seungbin Im, Inseong Lee, Ria Roida Minarta, Joonho Ko*
Developing a Bus Speed Prediction Model for Exclusive Median Bus Lanes: Considering

Autonomous Driving Constraints

2B-15 *Yining Di*, *Jie Zeng*, *Zheng Zhu*, *Hao Wen*, *Puyan Zhao*, *Qipeng Chen* and *Hai Yang*
Dual-Hierarchical Dynamic Graph Neural Network for Multi-Modal Demand Prediction

2B-16 *Alaa Itani*, *Amer Shalaby* and *Khandker Nurul Habib*
Exploring Trip Cancellation Behaviour of on-Demand Transit Riders

Wednesday, July 2nd

09:15-10:30 Session K2A: Plenary 2A (*Clock Tower Centennial Hall)*

09:15 *Akihito Ito*

Intercity High-Speed Rail : From the Tokaido Shinkansen to the Linear Chuo Shinkansen

09:55 *Kiyohito Utsunomiya*

Railways as Urban Transportation: Japanese Experience and Future Challenges

10:45-11:30 Session K2B: Plenary 2B (*Clock Tower Centennial Hall)*

10:45 *Shigeru Morichi*

Japan's TOD and its proposals to Asia

11:30-12:00 Shotgun presentations (*Clock Tower Centennial Hall)*

12:00-13:30 Lunch (*Clock Tower 2nd Floor)*

13:15-14:45 Session S2A: Special Session (Crowdsourcing) (*Shirankaikan Imamori Hall,* Chair: *Kari Watkins*)

13:15 *Laura Kolcheva*, *Antoine Legrain* and *Martin Trépanier*

Network-Wide Transfer Synchronization Strategies in a Public Bus System with Real-Time AVL and Smart Card Data

13:35 *Rabi Mishalani*, *Mark Mccord* and *Diego Ribeiro de Oliveira Galdino*

Using APC Data to Investigate Changes in City-Wide Transit Origin-Destination Flows Resulting from Exogenous Events: Application to the Covid-19 Pandemic

13:55 *Chris Yung*, *Charalampos Sipetas* and *Claudio Roncoli*

A Machine Learning Framework for Public Transport Ridership Estimation Using Multi-Source Data Fusion with Low-Cost Bluetooth Data

14:15 *Teethat Vongvanich, Jan-Dirk Schmöcker, Wenzhe Sun, Francesco Viti and Federico Bigi*

Estimating Station User Activity and Origin-Destination Flows Using Crowdsourced Data

13:15-14:45 Session S2B: Special Session (Evaluation) (*Shirankaikan Yamauchi Hall,* Chair: *Takayuki Morikawa*)

13:15 *Jérémy Gelb*, *Hamzeh Alizadeh* and *Ludwig Desjardins*

Towards Fair Transit: a Toolbox for Equity Diagnostics in Spatial Accessibility

13:35 *Itsuki Sato*, *Kiyoshi Takami* and *Giancarlos Parady*

Evaluation of Public Transport Accessibility Under Delay Conditions: a Case Study of a Japanese Regional City

13:55 *Gen Hayauchi*, *Kensaku Yoshida* and *Takayuki Morikawa*

Towards a Livability Index by Public Transport (Lipt): Conceptual Framework and Tool Prototyping

14:05 *Yurie Toyama* and *Ryo Ariyoshi*

The Role of Family Ride-Giving in Supporting Children's Mobility in Japan

14:15 *Ryo Ariyoshi and Tomoichi Ebata*

Quantification Method for Resident Contact Opportunities Generated by Public Transport

13:15-14:15 Session P3A: Policy *(Shirankaikan Foyer)*

3A-1 *Gülin Göksu Başaran*, *Jesper Bláfoss Ingvardson* and *Otto Anker Nielsen*

Where the Station Ends and Surroundings Begin: a Holistic Gender Perspective on Perceived Safety in Public Transport

3A-2 *Mohammad Ansari Esfeh*, *Diego Da Silva*, *Amer Shalaby* and *Eric Miller*

Metro System Vulnerability: Understanding Factors Affecting the Severity of Disruptive Events

3A-3 *Marko Kapetanović* and *Niels van Oort*

Multi-Criteria Evaluation of Propulsion Alternatives for a City Bus Fleet Renewal: a Dutch Case Study

3A-4 *Hyundo Kang* and *Tomio Miwa*

Node-Place Model with Accessibility Based on Potential Factors and Clustering: TOD Typology for Chukyo Metropolitan Area, Japan

3A-5 *Raashid Altaf*, *Kshitij Srivastava* and *Pravesh Biyani*

The Road Less Congested: a Policy-Driven Approach to Alleviating Congestion Through Last-Mile and Public Transit Integration

3A-6 *Filippos Alogdianakis*, *Christos Gkartzonikas* and *Loukas Dimitriou*

The Interplay of Demand for Public Transportation, Shared Micro-Mobility and Land Use Patterns

3A-7 *Andres Medaglia*, *Luis A. Guzman* and *Olga Lucía Sarmiento*

Extended Transit Opportunity Index for Large-Scale Public Transport Systems

3A-8 *Jaimy Fischer*, *Brenn Anderson-Gregson*, *Steven Farber*, *Ignacio Tiznado-Aitken*, *Antonio Páez*, *Meghan Winters*, *Ben Woodward* and *Alex Smith*

The Mobilizing Justice's Transportation Equity Dashboard: an Online Platform for Transit Accessibility and Equity Analysis in Canada

3A-9 *Taejun Kim* and *Junghwa Kim*

Analyzing Transit Hub Types Considering Metro User Trip Patterns and Station Area Environment

3A-10 *Jiahao Wang* and *Amer Shalaby*

IROAM: Integrated Route Operation and Anomaly Monitor

3A-11 *Tatsuki Nakanishi* and *Yukimasa Matsumoto*

Identifying Areas Suitable for Introducing Transfer-Based DRT Based on User Mobility Evaluation

3A-12 *Achille Fonzone* and *Lucy Downey*

Public Perceptions Towards Transport Policy and Investment

3A-13 *Michael Leong*, *Anson Stewart* and *Jinhua Zhao*
Rethinking Transit-Oriented Development: a Post-Pandemic Strategy to Revitalize Transit Ridership?

3A-14 *Tomohiro Yakura*, *Yasuhiro Shiomi* and *Ngoc An Minh*
To What Extent Can Online Activities Complement Mobility Needs in an Aging Society? a Generalized Cost-Based Accessibility Analysis

14:15-15:15 Session P3B: Service and Operation *(Shirankaikan Foyer)*

3B-1 *Fan Yujie*, *Liang Yunyi* and *Wu Zhizhou*
A Study of the Reasonable Service Scope for Metro Transit Connections Considering Demand Response Bus

3B-2 *Thiago Carvalho* and *Ahmed El-Geneidy*
Measuring the Impacts of a New Bus Rapid Transit (BRT) Service on Running Time and Schedule Deviation in Montréal Canada

3B-3 *Hung-Yi Hsueh*, *Tai-Ting Chen* and *Chia-Chun Tai*
Optimized Mass Rapid Transit Operation Model to Maximize Station Transportation Efficiency and Commercial Benefits

3B-4 *Yinfei Feng*, *Tao Liu* and *Yong Yin*
Virtual Coupling and Decoupling Operation of Autonomous Rail Rapid Transit Lines Connecting with a High-Speed Railway Station

3B-5 *Qingyun Tian*, *Yun Hui Lin*, *Yitong Yu*, *Kaidi Yang* and *David Z W Wang*
Operation Design of Last-Mile Transit Service with Modular Vehicles

3B-6 *Kelvin Lee, Yu Jiang and Avishai Ceder*
Public Transit Limited-Stop Service: Alternative Paths Using Deep Reinforcement Learning Approach

3B-7 *Marco Innao*
Run Time Allowances in Rail Planning and Travel Time Estimation: International Perspectives and Practices

3B-8 *Jia Hui Zhu*, *Dennis Huisman* and *Twan Dollevoet*
Rolling Horizon Stochastic Programming Approach for Real-Time Rolling Stock Rescheduling

3B-9 *Howard Wong* and *Ed Manley*
Evaluating the Impact of Metro Expansion on Public Transport Demand at Od-Level Using Longitudinal Data and Multilevel Modelling

3B-10 *Jing Teng*, *Chenlu Zhu* and *Enhui Chen*
Evaluation of Demand Responsive Transit: a Multidimensional Review of Theories, Methods, and Performance Indicators

3B-11 *Jing Heng Chen*, *Chia Chung Chen* and *Yung Chen Lai*

Light Rail Line Capacity Analysis Considering C-Type Right-of-Way

3B-12 *Jing Teng*, *Tong Wu* and *Enhui Chen*

Identifying the Relationship Between Travel Demand and Spatial Patterns in Areas with Limited Public Transport Access to Transportation Hubs: a Case Study of Shanghai

3B-13 *Marco Petrelli*

A Methodology for the Definition of the Supply Level of the Public Transport Services

3B-14 *Yaochen Ma*, *Xiaoyan Wang*, *Hongbo Ye* and *Hai Yang*

Train Scheduling with Virtual Coupling and Stop-Skipping in Metro Systems

3B-15 *Qin Zhang* and *Zhou Xu*

Incorporating Freight Assignment and Platform Allocation in High-Speed Railway Timetabling

3B-16 *Zaixu Yang*, *Jun Zhao* and *Qiyuan Peng*

Analysis of Railway Traffic Flow Under Train Group Operation Based on Fundamental Diagram

3B-17 *Karla Isabel Cervantes-Sanmiguel*, *Ricardo Giesen* and *Omar Jorge Ibarra Rojas*

Multi-Objective Optimization Model for Sustainable Planning of Bus Fleet Replacement

3B-18 *Maha Ahmad* and *Kari Watkins*

Designing a Survey to Test Service Improvements on Regional Rail Ridership Impacts

15:00-16:20 Session O3A: Emerging Mobility (*Shirankaikan Imamori Hall,* Chair: *Hai Yang*)

15:00 *Zhihua Jin, Gregory Erhardt and Rolf Moeckel*

How Much Should This Ride Cost? Pricing Transportation Network Company Trips to Complement and Not Compete with Transit

15:20 *Riki Kawase, Elnaz Emami and Mohsen Ramezani*

Fleet Sizing, Dynamic Pricing, and Parking Recommendations in Dockless Bike-Sharing Systems Under Demand Uncertainty

15:40 *Bing Liu, Christopher Szymula and Nikola Besinovic*

Integrating Air and Rail Services with Rerouting Strategy

16:00 *Zhicheng Jin, Weihua Gu, Xiaokuan Zhao and Huizhao Tu*

Complement or Substitution: a Spatial Investigation over TNC-PT Relationships in Shanghai

15:00-16:20 Session O3B: Time Table (*Shirankaikan Yamauchi Hall,* Chair: *Martin Trépanier*)

15:00 *Florian Fuchs*, *Viera Klasovitá* and *Francesco Corman*

Line Planning with Resilience Against Blockages Through Γ-Robustness

15:20 *Hoang Thi Khue Nguyen*, *Paul Bouman* and *Dennis Huisman*

Solving Train Timetabling Adjustment Problems with Integrated Track Assignments

15:40 *Renate J.H. van der Knaap*, *Niels van Oort* and *Rob Goverde*

Balancing Flexibility and Predictability: Evaluating the Impact of Multi-Period Timetabling

on Railway Demand

16:00 *Yu Li*, *Weihua Gu*, *Ronghui Liu*, *Weitiao Wu* and *Li Zhen*
Joint Robust Optimization of Bus Timetabling and Vehicle Scheduling with Dynamic Holding Strategies

15:20-15:40 Coffee Break *(Shirankaikan Foyer)*

15:40-16:40 Session P4A: Simulation *(Shirankaikan Foyer)*

4A-1 *Deo Chimba*
Evaluating Green Extension and Red Truncation Strategies in Transit Signal Priority Systems

4A-2 *Tianqi Wang*, *Weihan Xu* and *Xin Li*
Do We Still Need the Dedicated Bus Lane in Connected Environment?

4A-3 *Muslina Syahril*, *Widyarini Weningtyas* and *Taufiq Suryo Nugroho*
The Effect of Skip-Stops Service on BRT Scheduling Based on Smart Card Data (Case Study: Transjakarta Bus Corridor 13)

4A-4 *Federico Bigi*, *Yumeng Fang* and *Francesco Viti*
Evaluating Dynamic-Responsive Transport at Equilibrium Within an Agent-Based Simulation Environment

4A-5 *Max Coey*, *John Moody* and *Devin Wilkins*
Improvements for Capacity and Reliability at Passenger Railway Terminals: a Simulation-Based Case Study of Boston'S South Station

4A-6 *Manik Mondal*, *Yushi Ishijima*, *Hideki Yaginuma* and *Shintaro Terabe*
Activity Data Generative Model Integrating Ai for Enhanced Travel Behaviour Analysis

4A-7 *Ming-Yu Tu*, *Chen-Wei Huang* and *Yung-Cheng Lai*
Simulation Model for Capacity Analysis of Intermediate Turn-Back Stations in High-Speed Rail Systems with Path Consideration

4A-8 *Sarah Wise*, *Fuko Nakai*, *Wendi Han* and *Hitomi Nakanishi*
Going off the Rails: an Agent-Based Simulation of Evacuation in Areas with Mass Transit

4A-9 *Dolgorsuren Gombojav* and *Mend-Amar Majig*
Revenue Leakage in Urban Transit: a Case Study of Ulaanbaatar's Fare Payment System

4A-10 *Xuan Li*, *Jiho Yeo* and *Sugie Lee*
Scenario-Based Prediction Models for Public Bike Systems Using Temporal Fusion Transformers

4A-11 *Ludger Heide*, *Shuyao Guo*, *Dietmar Göhlich* and *Yang Song*
Assessment of Electrification Strategies Using a Micro-and Macroscopic Simulation Approach: a Case Study for the Kyoto Bus Network

4A-12 *Tarek Chouaki*, *Sebastian Hörl* and *Yann Briand*
A Decision-Support Tool for Inclusive Cooperative Connected Automated Mobility

Solutions: from Simulation Research to Operational Implications

4A-13 *Andreas Keler*, *Yang Song*, *Ali Gul Qureshi* and *Jan-Dirk Schmöcker*
Simulation of Adaptive Signal Control on Bus Energy Consumption

4A-14 *Nakhyeon Choi*, *Andreas Keler* and *Jan-Dirk Schmöcker*
Microsimulation of Passenger Incentives to Reduce Dwell Times

4A-15 *Yang Song*, *Andreas Keler*, *Jan-Dirk Schmöcker*, *Ali Gul Qureshi* and *Wenzhe Sun*
Modeling and Simulating Energy Consumption of Electric Buses in Kyoto Using Sumo

4A-16 *Zhipu Chen*, *Yunyi Liang*, *Cheng Lyu* and *Constantinos Antoniou*
Graph Multi-Agent Reinforcement Learning for Distributed Control of Traffic Signals and Connected Autonomous Vehicles

16:20-16:40 Coffee Break *(Shirankaikan Foyer)*

16:40-18:00 Session O4A: Dynamic and Evolution (*Shiranakaikan Imamori Hall,* Chair: *Marco Nie*)

16:40 *Yanhao Li*, *Xin Li*, *Huaiyue Li* and *Yun Yuan*
Evolutionary Game Analysis on Carbon Generalized System of Preferences Policy for Public Transportations

17:00 *Richard Connors*, *Haruko Nakao*, *Francesco Viti* and *Tai-Yu Ma*
Tackling the Problem of Ride-Time Volatility in Demand Responsive Transport

17:20 *Chao Yang*, *Wentao Dong* and *Chengcheng Yu*
MBSE-Net: Multi-View Attributed Graph Model for Individual-Level Multimodal Transit Behavior Status Evolution Prediction

17:40 *Watcharapong Wongkaew*, *Kongtup Wanichjaroenporn* and *Pongsun Bunditsakulchai*
Spatiotemporal Dynamics of Land Use and Ridership: a Geographically Weighted Regression Analysis of Bangkok's Mrt Blue Line

16:40-18:00 Session O4B: Fares and Pricing (Chair: Anthony Chen)

16:40 *Ying Lu*, *Mark Hickman* and *Xin Chen*
Exploring the Heterogeneity in Subscription and Travel Behaviours of MaaS Users: a Segmentation Approach and Thematic Analysis

17:00 *Wenzhe Sun*, *Zifeng Wang*, *Yihe Zhou*, *Jan-Dirk Schmöcker* and *Jing Zhao*
Pricing Premium-Class Seats in Transit Fares

17:20 *Wei Wei*, *Muqing Du*, *Yu Gu*, *Anthony Chen* and *Zhong Wu*
Collaborative Pricing of Public Transit and E-Hailing Service Considering Travellers' Loyalty

17:40 *Yihe Zhou*, *Jan-Dirk Schmöcker* and *Wenzhe Sun*
Optimal Transit Fares with Delay Insurance Considering Required Incentives to Alternative Service Providers

16:40-17:40 Session P4B: Transit Data Analysis *(Shirankaikan Yamauchi Hall)*

4B-1 *Ka Kee Alfred Chu*, *Bruno Allard* and *Guillaume Bisaillon*
Modelling the Potential Impacts of a New Tap-in Tap-out Scheme with Smart Card Transaction Data

4B-2 *Noriyasu Tsumita*, *Vichiensan Varameth* and *Atsushi Fukuda*
Enhancing Urban Accessibility with Railway Network Development: a Comparative Scenario Analysis in Bangkok

4B-3 *Shu-Hao Chang*, *Kuan-Yao Wang* and *S.K. Jason Chang*
Modeling Bus ADAS Warning Occurrences and Traffic Environment with Machine Learning

4B-4 *Pei-Fen Kuo*, *Cai-Yu Yang*, *Ching-Fu Chen* and *Chung-Wei Shen*
Who's Riding and Where: Key Insights from Kaohsiung's Maas Program

4B-5 *Sunghoon Jang*, *Meng Guo* and *Shin-Hyung Cho*
Assessing Alternative Acceptance in Tour-Based Travel Behavior Using Integrated Active and Passive Public Transit Data

4B-6 *Momoka Ozono* and *Shintaro Terabe*
Estimating Bus Passenger Counts Using Wi-Fi Packet Sensors: a Background Noise Cancellation Approach

4B-7 *Jonas Jostmann*, *Tong Mo*, *Haoyan Wang* and *Zhenliang Ma*
Open Source Digital Twin Platform for Public Transport: a Case Study in Stockholm

4B-8 *Bastian Henríquez*, *Jacqueline Arriagada* and *Alejandro Tirachini*
Evidence of the Impact of Real-Time Information on Passenger Satisfaction Across Varying Public Transport Quality in 13 Chilean Cities

4B-9 *Yihang Huang*, *Qian Fu*, *David Jaroszweski* and *Lee Chapman*
Impact of Weather on Bus Ridership: Evidence and Insights from Smart Card Data in West Midlands, UK

4B-10 *Minsu Kim*, *Jiho Yeo* and *Sugie Lee*
Building Realistic GTFS Data Using Smart Card and Bus Information Data

4B-11 *Motohiko Shiraiwa* and *Ryosuke Abe*
Impact of Road-Based Public Transportation Frequency on People's Activity Levels Using GPS Tracking Data

4B-12 *Theeranai Pullarp*, *Hyungsub Jee*, *Jan-Dirk Schmöcker*, *Sean Barbeau* and *Kari Watkins*
Understanding Transit Information Inquiry Patterns Through Long-Term Crowd-Sourced Trajectory Data

4B-13 *Diego Da Silva*, *Mayuri Annerose Morais* and *Raphael Camargo*
Strategies for Implementing Open Data Technology in Public Transportation: a Case Study in Porto Alegre, Brazil

4B-14 *Eunah Hong*, *Taeseok Kang* and *Junghwa Kim*
Identifying Potential Long-Term Users in on-Demand Services Using DBSCAN Clustering

4B-15 *Anne Mercier*, *Loïc Bodart* and *Christian Clerc*
Clustering Run Time Anomalies in Public Transit Data Using AI: a Case Study with the Transit Operator of Geneva

4B-16 *Georges Sfeir*, *Filipe Rodrigues*, *Ravi Seshadri* and *Carlos Lima Azevedo*
Choice Sets and Smart Card Data in Public Transport Route Choice Models: Generated Vs. Empirical Sets

4B-17 *Xavier Blessy David*, *Varun Varghese*, *Makoto Chikaraishi* and *Akimasa Fujiwara*
A Novel Crowding Contribution Index Using Automated Fare Collection Data from Delhi, India

4B-18 *Paul Bouman*
Towards Convenient Software for Event-Activity Network Based Data Visualization

Friday, July 4th

09:00-09:30 Shotgun presentations *(Shirankaikan Yamauchi Hall)*

09:30-10:50 Session O5A: Multimodal and Mode Choice (*Shirankaikan Imamori Hall*, Chair: *Jing Zhao*)

09:30 *Sebastián Raveau*, *Jaime Soza-Parra* and *Angel Cantillo*
Behavioural Modelling of Public Transport Users: Understanding Fare Payers and Evaders Mode and Route Choices

09:50 *Youxin Lin*, *Judith Y.T. Wang*, *Chris Nash* and *Zhiyuan Lin*
Evaluating Network Integration of Rail and Long Distance Bus Based on an Extended Node-Place Model

10:10 *Kang Wang*, *Jan-Dirk Schmöcker* and *Simon Hu*
Carbon Credit-Based Incentive Model for Multimodal Transport System

10:30 *Max T.M. Ng*, *Hani S. Mahmassani*, *Draco Tong*, *Omer Verbas* and *Taner Cokyasar*
Joint Optimization of Multimodal Transit Frequency and Shared Autonomous Vehicle Fleet Size with Hybrid Metaheuristic and Nonlinear Programming

09:30-10:50 Session O5B: Bus Demand and Priority Measures (*Shirankaikan Yamauchi Hall*, Chair: *Achille Fonzone*)

09:30 *Anupriya Anupriya*, *Emma McCoy* and *Daniel Graham*
Urban Rail Transit and Sustainable Urbanisation

09:50 *Rupam Fedujwar* and *Amit Agarwal*
Impact of Urban Form and Socio-Demographic on Transit Boarding: a Case Study of Indore, India

10:10 *Tingsen Xian*, *John Nelson* and *Emily Moylan*
Design Evaluation of Bus Cross-Traffic Turn Priority Box

10:30 *Hugo Silva* and *Felipe Gonzalez*
Efficiency of Bus Priority Infrastructure

09:50-10:50 Session P5A: Network Design, Reliability and Vulnerability *(Shirankaikan Foyer)*

5A-1 *Wen Meng*, *Tao Liu*, *Jian Gao* and *Yin Su*
Deployment Planning for a Modular Autonomous Vehicle-Based Shuttle Transit System

5A-2 *Yujie Huang* and *Zhipeng Zhang*
Impact of Adverse Weather on Weekday Peak-Hour Metro Ridership Dynamics: a Case Study of Shanghai

5A-3 *Mingrui Liu*, *Wai Yuen Szeto* and *Sujun Sun*
Bus Network Design with the Integration of Limited-Stop and Autonomous Bus Services

5A-4 *Molin Zhao* and *Baonan Gu*
Potential Corridor Search Method for Rail Transit Network Design

5A-5 *Li Zhen*, *Weihua Gu*, *Minyu Shen*, *Yu Li* and *Zhixian Tang*
Optimal Trunk-Feeder Transit Network Design Under Heterogeneous Demand

5A-6 *Congying Han*, *Jing Teng*, *Congjian Liu* and *Tao Wang*
Bi-Level Optimization Model for Customized Tourist Bus Routes and Ticket Pricing in Tidal Tourist Traffic: a Case Study of Chongming Island, Shanghai

5A-7 *Thiago Carvalho* and *Ahmed El-Geneidy*
Measuring the Impacts of a Major Metro Disruption in Montreal, Canada on Riders' Satisfaction and Willingness to Recommend the Service to Others

5A-8 *Robin Gaborit*, *Evelien van der Hurk*, *Yu Jiang*, *Konstantinos Zografos*, *Ahmed Kheiri* and *Otto A. Nielsen*
A Model for Passenger Oriented Integrated Frequency Setting, Timetabling, and Vehicle Scheduling

5A-9 *Zhi Li*, *Ning Zhang* and *Xu Dong Guo*
A Public Transportation Network Optimization Method Based on Reinforcement Learning

5A-10 *Mina Nasab* and *Rajan Batta*
Optimization Approach for Emergency Evacuation Using Public Transit

5A-11 *Xin Li*, *Sai Zhang*, *Huaiyue Li* and *Yun Yuan*
Robust Collaborative Timetabling and Bus Interlining Optimization Under Travel Time Uncertainty

5A-12 *Liya Ma*, *Yao Chen* and *Xujie Feng*
Emergency Bus Route Optimization for Passenger Evacuation in Response to Metro Disruptions

5A-13 *Xinyu Liu*, *Jing Zhao* and *Xiaoguang Yang*
Transit Route Network Planning from the Societal Perspective: a Particle Swarm Optimization Based Algorithm

5A-14 *Juho Lee*, *Sion Kim*, *Ryujeong Lee*, *Ilho Jeong*, *Minje Choi* and *Seungjae Lee*
Temporal Cascading-Failure Dynamics in Seoul's Coupled Urban Transit Network Under Event-Induced Disruptions

5A-15 *Enoch Lee*, *Manzi Li* and *Yue Huai*
Co-Modality in Transit: a Stochastic Elastic Framework for Integrating Freight and Passenger Services

5A-16 *Tygo Nijsten*, *Aliki Pouliasi* and *Michael Sederlin*
Bus Rapid Transit Network Design: Planning Routes and Upgrading Stops Among Multiple Municipalities

5A-17 *Filippos Alogdianakis* and *Loukas Dimitriou*
Designing Joint Fixed and Flexible Public Transit Networks for the X-Minute City

5A-18 *Yuxuan Wang*, *Catherine Morency* and *Martin Trépanier*
Examining Transit Reliability Using an Origin-Destination Reliability Matrix

5A-19 *Aman Sharma* and *N Nezamuddin*
Resilient Electric Bus System Design Considering Power Grid Disruptions

5A-20 *Seyedehsima Madani*, *Kris Braekers* and *Imre Keseru*
Optimising the Design of a Hybrid Urban Mobility System

5A-21 *Zain Ul Abedin*
Trade-Offs Between Coverage and Ridership Maximization in Transit Network Design: an Empirical Analysis

5A-22 *Julia Bickel*, *Maxim Meijers* and *Niels van Oort*
Evaluating Transfer Reliability in Public Transport Route Choices Based on Smartcard Data

5A-23 *Yijing Dai*, *Rong Cheng*, *Tao Liu* and *Yu Jiang*
Route Optimization for Demand-Responsive Connector Service with Multi-Passenger Requests and Route Travel Time Constraint

5A-24 *Yuhan Tang*, *John Attanucci*, *Jinhua Zhao* and *Haris Koutsopoulos*
Fine-Tuning Bus Running and Cycle Times by More Carefully Addressing the Tradeoffs Among Passenger Delays, Reliability, and Operating Costs

10:50-11:10 Coffee Break *(Shirankaikan Foyer)*

10:50-11:50 Session P5B: Transit Modeling *(Shirankaikan Foyer)*

5B-1 *Lin Lin*, *Orlando Rivera Letelier*, *Xinyu Wang* and *Andrés Fielbaum*
Scheduling an Electrified Public Transport Ferry System via a MILP

5B-2 *Chuhan Yin*, *Zhiyuan Lin* and *David Watling*
A Hybrid Heuristic Approach for Integrated Railway Train Unit and Driver Scheduling

5B-3 *Jun Gong*, *Wai Yuen Szeto* and *Sin Cheung Ho*
An Enhanced Artificial Bee Colony Algorithm for Multiperiod Asymmetric Transit Frequency Design

5B-4 *Yanjun Liu* and *Huiyuan Lu*
How to Promote the Implementation of Mobility as a Service (Maas) in China: an Analysis Based on a Tripartite Game Analysis

5B-5 *Rubén Jiménez*, *Manuel Fuentes* and *Luis Cadarso*
Refleeting Tail Assignment-Driven Aircraft Routing Model

5B-6 *Shabnam Dabagh*, *Lory Michelle Bresciani Miristice* and *Guido Gentile*
Doubly Constrained Gravity Models for Accessibility Analysis by Public Transport: a Comparative Evaluation of Two Approaches

5B-7 *Nien-Tzu Han*, *Yi-Chen Lin*, *Cheng-Chung Young* and *Yung-Cheng Lai*
Multi-Level Programming Model for Revenue Analysis in Vertically Separated Rail Networks

5B-8 *Tara Saeidi*, *Babak Mehran* and *Ahmed Ashraf*

Rl Guided Genetic Algorithm for Zoning a DRT Service

5B-9 *Nastaran Tork* and *Alireza Khani*
A Last-Mile Delivery Approach Using Public Buses and Bicycle Crowd- Shipping Systems

5B-10 *Homero Larrain*
Optimizing Express Service Design: the 'Go Big or Go Home' Rule

5B-11 *Jinyi Pan*, *Ronghui Liu* and *Zhiyuan Lin*
ADMM-Based Optimization Method for Scheduling Extra Trains on a High-Speed Rail Corridor

5B-12 *Min-Ci Sun* and *Luca Quadrifoglio*
A Multi-Objective Model for Shared-Ride Automated Services to Reduce the Price of Anarchy

5B-13 *Yuto Obata*, *Toshiyuki Nakamura*, *Satoshi Sugiura*, *Masahiro Kuwahara* and *Fumitaka Kurauchi*
Designing Community Transit Network Systems Using Spanning Tree-Based Method

5B-14 *Ming Zhu*, *Yihui Wang*, *Kun Ji* and *Yanzhang Zhao*
Foreign Object Detection and Comparative Analysis at Railway Crossings

5B-15 *Hanna Vasiutina*, *Olha Shulika*, *Michał Bujak*, *Farnoud Ghasemi* and *Rafał Kucharski*
Methodology for Identifying the Most Suitable Urban Area for Implementing on-Demand Feeder Bus Services

5B-16 *Yu-Kai Huang*, *Jun Toyotani*, *Chung-Cheng Lu* and *Jyun-Kai Liang*
Balancing Act: Kyoto's Quest to Manage Overtourism Through Ai-Powered Traffic Distribution

5B-17 *Haoran Zhao* and *Andrés Fielbaum*
A Hybrid Bus Design for Ridership Fluctuation

5B-18 *Dung-Ying Lin* and *Manwo Ng*
A Heuristic for the Driver Scheduling Problem in Passenger Rail Transportation

5B-19 *Jiahao Wang* and *Amer Shalaby*
Transforming Historical Incident Records into Explainable, Experience-Based Decisions: a Knowledge Graph and LLM Approach

5B-20 *Jie Zeng*, *Hongxing Ding*, *Xinwei Li* and *Hai Yang*
A Dynamic System Towards Dual User Equilibria Under the Booking Cum Rationing Scheme

5B-21 *Bisheng He*, *Fengquan Wang*, *Guangyuan Zhang*, *Andrea D'Ariano* and *Qian Ge*
An Optimization Approach for the Bus-Assisted Drone Routing and Charging Problem in the Last-Mile Delivery Systems

Giuseppe Perona and *Marta González*
A Simple Electrical Circuit Model for Public Transit

5B-22 *Noriel Christopher Tiglao* and *Erris Sanciangco*

Machine Learning-Based Planning and Decision-Making for Paratransit Operations in Developing Countries

5B-23 *Prasetyaning Diah Rizky Lestari*, *Ronghui Liu* and *Richard Batley*
Joint Optimisation of Line Planning and Timetabling with a Focus on Economic and Societal Benefit

5B-24 *Tarun Rambha*
Cyclic Vehicle Scheduling Problem

5B-25 *Yu Gu* and *Anthony Chen*
Modeling Adaptive Capacity of Urban Rail Transit Network with Complementary Shuttle Buses

10:50-11:10 Coffee Break *(Shirankaikan Foyer)*

11:10-12:30 Session O6A: Vulnerability and Robustness (*Shirankaikan Imamori Hall*, Chair: *Michael Bell*)

11:10 *Christopher Szymula*, *Bing Liu* and *Nikola Besinovic*
Multimodal Network Vulnerability Assessment Using a Path-Based Disruption Management Model with Timetable Sensitive Passenger Routing

11:30 *Meisam Ghasedi*, *Jinhyung Lee*, *Scott Bell* and *Ehab Diab*
Do We Need to Measure Transit Reliability at the Stop Level? Exploring the Relationship Between Ridership and Stop- and Route-Level Reliability Measures

11:50 *Georgios Laskaris*, *Alexandros Liazos*, *Christina Iliopoulou* and *Konstantinos Kepaptsoglou*
Transit Network Design and Frequency Setting Accounting for Vulnerability

12:10 *Marta Leonina Tessitore*, *Marcella Samà*, *Giorgio Sartor*, *Carlo Mannino* and *Dario Pacciarelli*
Exploiting the Concept of Fragility in Tactical Timetable Planning

11:10-12:30 Session O6B: Travel Demand Forecast (*Shirankaikan Yamauchi Hall,* Chair: *Francesco Corman*)

11:10 *Zhicheng Dai, Dewei Li, Soora Rasouli and Chenyi Yang*
Passenger Flow Distribution Forecasting at Integrated Transport Hub: a Group Evolution Mechanism with Multimodal Transit Data Integration

11:30 *Heqi Wang and Claudio Roncoli*
Multi-Line Short-Term Onboard Passenger Loading Prediction via Relational Multi-Graph Convolutional-Recurrent Networks

11:50 *Enze Liu, Zhiyuan Lin and Shuguang Zhan*
A Mobile Data Driven Reinforcement Learning Framework for Real-Time Demand-Responsive Railway Rescheduling

12:10 *Tara Saeidi and Babak Mehran*
Estimating Elderly Transit Demand Using Boarding Count Data with Policy Implications for DRT Zoning

12:30-14:00 Lunch *(Clock Tower 2nd Floor)*

14:00-15:20 Session O7: Simulation (*Clock Tower Centennial Hall*, Chair: *Amer Shalaby*)

14:00 *Yunlong Wang*, *Minh Kieu*, *Prakash Ranjitkar*, *Yi Wang* and *Avishai Ceder*

A Framework for Continuous Operation of Shared Autonomous Vehicles in Dynamic Public Transport Networks

14:20 *Chaopeng Tan*, *Georgios Laskaris*, *Dingshan Sun*, *Robin Abohariri*, *Marco Rinaldi* and *Hans van Lint*

Dwelling and Speed Advisory Enhanced Max-Pressure Control with Transit Signal Priority

14:40 *Qiru Ma*, *Enoch Lee*, *Kejun Du*, *Hong K. Lo* and *S. W. Ricky Lee*

Modelling Spatiotemporal Platform Passenger Flow: A Macroscopic Simulation-Based Optimization Approach

15:00 *Mustafa Rezazada*, *Neema Nassir*, *Egemen Tanin* and *Avishai Ceder*

Pre-Emptive Modelling of Bus Bunching: Identifying Key Sources of Reliability Issues and Bunching Patterns

15:20-15:40 Coffee Break *(Clock Tower 2nd Floor)*

15:40-17:20 Session K3: Plenary 3 (*Clock Tower Centennial Hall)*

15:40 *Francesco Viti*

Leveraging Mobile Crowdsensing Data for Transit Flow Estimation and Prediction

16:20 *Avishai Ceder*

CASPT History and Future Urban Public Transport Service

17:20-17:40 Session: Closing (*Clock Tower Centennial Hall)*

Abstracts

Keynote Speeches

Marco Nie: Is fare-free transit just?

ABSTRACT: This study examines whether fare-free transit (FFT) aligns with John Rawls's theory of justice. We focus on the difference principle—which calls for allocating resources to benefit the most disadvantaged travelers—and contrast it with a utilitarian approach that aims to maximize overall utility. FFT is of course not free. Without farebox revenue, transit agencies must either reduce services or secure alternative funding through local taxes and fees. Thus, our analysis integrates both financial and operational decisions, while capturing the interplay between traffic congestion, travelers' income levels, and mode choices. Moreover, we extend our analysis to evaluate a reduced-fare scheme for disadvantaged travelers, comparing its welfare gains and operational efficiency with those of a fully fare-free design. Drawing on a case study based on empirical data from Chicago, we explore the practical compromises required to reconcile the diverse interests and ideologies that shape transit design.

Hong Lo: Sustainable management strategies for a mixed fleet of electric and diesel buses under driving range uncertainty

ABSTRACT: In transit-oriented metropolis, emissions from heavy-duty diesel vehicles, mostly buses, may constitute up to 80-90% of roadside emissions. It is difficult to address the air quality problem without addressing the emissions from buses. Electric buses (EB) are often considered as an important part of the solution, albeit EB deployment encounters major obstacles, such as limited driving range, scarcity of charging facility, and of course, vehicle cost. How to route and schedule EB under range and recharging constraints is a key problem to be tackled. Moreover, the EB driving range is subject to uncertainty, which may vary with congestion, passenger loading, etc. This presentation will investigate the interplay among three stakeholders in the development of sustainable mixed-bus fleet management strategies: operator, passengers, and government. Such an understanding will facilitate the development of bus fleet management strategies and subsidy policies for ensuring their financial viability, maintaining passenger travel convenience, and reducing emissions. We will use Hong Kong case studies to show practicality and highlight the trade-offs between electric bus deployment and strategic charging infrastructure.

Shigeru Morichi: Japan's TOD and its Proposals to Asia

ABSTRACT: TOD in Japan began in 1910 with Ichizo Kobayashi of Hankyu Railways, and became a business model for subsequent private railways. It has not only developed areas around stations, but has also realized railway-oriented urban structures. It has also focused on long-term urban development over 20 years, rather than on short-term profits for railway companies, and has earned more profits not only from new developments but also from redevelopment projects. However, many decision makers in Asia consider TOD to be development around stations, and believe that short-term profits from TOD will compensate for losses from railway operations. This presentation will explain the characteristics of TOD

in Japanese urban railways, the current state of TOD in Asia, and the experience of TOD being deployed at all 92 stations on Japan's Shinkansen line, and discuss lessons for the future development of TOD in Asia.

Akihiro Ito: Intercity High-Speed Rail : From the Tokaido Shinkansen to the Linear Chuo Shinkansen

ABSTRACT: This presentation offers an overview of the Tokaido Shinkansen which opened in 1964, pioneering intercity high-speed rail. The Tokaido Shinkansen connects three major metropolitan areas, Tokyo, Nagoya, and Osaka, the combined GDP of which is approximately 329 trillion yen. The currently build "Linear Chuo Shinkansen" is lifting intercity high-speed rail in Japan to the next stage. The entirely new system achieves ultra-high-speed operation by replacing conventional adhesion railway with leveraging superconducting technology. Equipped with superconducting magnets, the Linear Chuo Shinkansen rolling stock operates at a speed of 500 kilometers per hour, connecting Tokyo (Shinagawa) and the Osaka area in as fast as 67 minutes. Shinagawa Station will serve as the Tokyo metropolitan area's terminal station for the Linear Chuo Shinkansen. Development is underway to integrate the area around Shinagawa Station. The transportation infrastructure is being upgraded with new ticket gates, trunk roads, subway lines, and other infrastructure enhancements. Moreover, the Linear Chuo Shinkansen will alter how Japan itself is structured. It is regarded as critical infrastructure in the new national spatial strategy. There will be four intermediate stations, one in each of the four prefectures the line passes through. A new national corridor will evolve as the blocs formed around these four stations expand and integrate to create urban area clusters. This talk will present the development and the expected broad impact of the Linear Chuo Shinkansen. Among others, it's benefits for the expressway network and co-ordination with other modes of transportation in a new era of long distance travel will be discussed.

Kiyohito Utsunomiya: Railways as urban transportation: Japanese experience and future challenges

ABSTRACT: Japan boasts an advanced urban railway network. This originates from the Transit-Oriented Development (TOD) model initiated in the early 20th century, which led to the success of railway businesses during that era. Since then, urban railways in Japan have been operated by private companies for decades. However, they now face new challenges amid increasing motorization and a declining population. In regional areas, even urban railways are being downsized, leading to a more car-dependent society and creating a vicious cycle. Nonetheless, new developments are emerging, such as the successful implementation of the Haga-Utsunomiya LRT. By investing in public transportation services through public sector support, it is possible to reverse the negative cycle faced by regional cities. To achieve this, it is essential to evaluate the value of railways, including non-monetary benefits.

Francesco Viti: Leveraging Mobile Crowdsensing Data for Transit Flow Estimation and Prediction

ABSTRACT: Transit demand estimation and prediction relies on different types of data collection methods, ranging from traditional (and expensive) off- and on-board surveys, passenger counting devices, smartcard or ticketing data, etc. Recently, growing attention has been given to new forms of information obtained from mobile crowdsensing-based information, which has been shown to enable new services such as real-time navigation, information on delays and incidents, vehicles and stations

crowding and much more. In this talk we explore the potential opportunities of leveraging mobile crowdsourced information, and in particular location popularity, for estimating and predicting transit flows at stations and stops.

The keynote will focus on providing a comparison of traditional and crowdsourced data, and then will present different crowdsourced data-driven models and applications to est.

Avishai Ceder: CASPT History and Future Urban Public Transport Service

ABSTRACT: CASPT that can be termed as the lighthouse of public transport has a history of 50-year, starting in Chicago in 1975. This presentation will start by showing some milestones of this 50-year history. The presentation will continue with the realization that presently, in 2025, it is evident that more than half the world's population resides in cities, and growth is expected almost exclusively in cities. Accordingly, urban growth acceleration can be expected to result in healthier, more efficient and more productive living for city dwellers. The believed solutions for the future rely on public transport (PT) modes of travel, regardless of whether they are metro, bus, light rail, tram, Uber service, an ordinary taxi, personal-rapid transit or any other PT-based future mode, moving horizontally, vertically, or diagonally, on surface, elevated, or underground. The core claim of the presentation justifies replacing private cars (PCs) with existing and future PT vehicles. In testing 17 major cities globally, 94% of the scenarios proved PT superior or equivalent to PCs for reducing travel time. Moreover, it shows a potential reduction in car traffic by approximately two-thirds compared with the current situation.

Special Sessions

S1A: Electrification

Sara Momen, *Soren Paul Burghardt*, *Kuldeep Kavta* and *Shadi Sharif Azadeh*

Behavioral Impact of Battery Range and Unlock Fees on Shared E-Moped Usage

ABSTRACT. Free-floating shared electric mopeds are gaining popularity as flexible, low-carbon mobility solutions in urban areas, emphasizing the need to understand user preferences. This study examines how attributes such as battery level, walking distance, and price (unlock and per-minute ride fee) influence user preferences for shared e-moped usage. Using survey data from the Netherlands, we employ a Multinomial Logit model to estimate utility and a Mixed Logit model to capture preference heterogeneity. Results underscore the significant impact of battery range on user choices, identifying an indifference threshold and offering practical insights for user-based relocation strategies and fleet management.

Luyun Zhao, *Shiyu Shen* and *Zhan Zhao*

Multi-Period Electrification of Large-Scale Bus Network via Deep Reinforcement Learning

ABSTRACT. To combat climate change and air pollution, electrifying urban bus fleets is crucial for reducing vehicular emissions. Past studies often overlook long-term phased transitions as well as the network effect. This study proposes an optimization model addressing urban bus network fleet transition and charging facility installation over multiple periods. A solution method called DRL-HetGNN is proposed, leveraging deep reinforcement learning and heterogeneous graph neural networks to solve large-scale problems efficiently. Focusing on Hong Kong's bus system, this study examines scenarios involving future price fluctuations and policy support mechanisms, aiming to guide policymakers in achieving a sustainable, zero-emission public transportation system.

Robert Janus, *Natalia Kliewer*, *Lucas Mertens* and *Mick Molitor*

Extended Simultaneous Optimization of Charging Station Locations and Electric Vehicle Scheduling for a Changing Mixed Bus Fleet

ABSTRACT. Public transport operators convert their fleets from combustion to electric buses stepwise. To efficiently plan charging infrastructure, the locations of charging stations and electric vehicle schedules must be optimized simultaneously (extended CLEVSP - Charging Location and Electric Vehicle

Jie Ma, *Xiaokuan Zhao*, *Yu Li*, *Le Zhang*, *Weihua Gu* and *Chi Xie*

Integrated Replacement Planning and Scheduling for Multi-terminal Electric Bus Systems

ABSTRACT. As urban areas worldwide increasingly prioritize environmental sustainability and energy efficiency, battery electric bus (BEB) systems have emerged as a pivotal alternative to traditional diesel bus systems. This paper addresses the pressing need for integrated replacement planning and scheduling models for BEB systems. An integrated replacement planning and scheduling model for multi-terminal BEB systems is proposed and converted to an integer linear programming (ILP) which can be solved by commercial solvers. The proposed model simultaneously determines the number of electric buses, the number of charging stations, and develops optimized dispatch and charging schedules. The model takes

deadheading, maximum number of chargers, charging time threshold, and time-of-use electricity prices into consideration as well. A branch and price framework and a heuristic algorithm are proposed to solve large-scale problems. Through a case study using data from Hong Kong's bus company, the proposed model demonstrates significant cost savings over traditional diesel bus systems, even after accounting for higher vehicle purchase cost and charging infrastructure costs. Several sensitivity analyses provide practical insights into the replacement planning of BEB systems.

S1B: Benchmarking

Daniel Graham

Model-Based Adjustment for Conditional Benchmarking of Mass Transit Systems

ABSTRACT. Japan has a long history of managing natural hazards due to its geography and geology. Simultaneously, it is known as a country with a railway system that is highly punctual, reliable, and safe. This research uses an exploratory approach to review climate change adaptation and disaster risk reduction practices in the Greater Tokyo Area. Unstructured interviews with various stakeholders and a literature review discuss how the climate is changing in Japan, what strategies are used amongst railway organisations to manage meteorological hazards, and how railway organisation acknowledge climate change adaptation alongside disaster risk reduction. Results indicate that disaster risk reduction practices still dominate within the railway sector however, more efforts of climate change adaptation set forth by the government may shift practices.

Anupriya Anupriya and *Daniel Graham*

Benchmarking Urban Rail Transit Operations Using Synthetic Units

ABSTRACT. Urban metro systems produce extensive operational data, often analysed through benchmarking to identify best practices and prioritise improvements. This process informs strategies and policies by comparing key performance indicators (KPIs) across systems. However, traditional benchmarking has limitations, particularly for top performers who gain little actionable insight and for systems focusing solely on emulating successful operators without accounting for unique contexts. While normalisation techniques attempt to address such disparities, they often fail to capture heterogeneity in system characteristics. This study advances benchmarking by using counterfactuals to create a 'synthetic' unit, offering personalised benchmarks based on each metro system's specific attributes.

Anastasios Skoufas, *Matej Cebecauer*, *Wilco Burghout*, *Erik Jenelius* and *Oded Cats*

Ex-Post Assessment of Public Transportation on-Board Crowding Induced by New Urban Developments

ABSTRACT. New land-use planning configurations can have wide-ranging crowding effects on the public transportation system, given the ongoing increase in urban agglomerations worldwide. In this study, we propose a method for quantifying the network-wide crowding implications of new developments accounting for their socioeconomic and planning characteristics. Size and proximity to a high-capacity connection are highly influential factors in determining crowding implications' extent and

geographical spread. Interestingly, the income level can have a twofold effect on crowding contributions (increase or decrease). The proposed method can serve as a tool for the ex-post quantification of the crowding impacts using automated data sources.

Shagun Mittal, *Rajat Verma* and *Satish Ukkusuri*

Understanding Income-Based Inequalities in Public Transit in Data-Poor Environments

ABSTRACT. Public transit inequalities persist globally, yet traditional assessment methods remain infeasible in data-poor environments. This study develops a framework leveraging mobile phone data to simultaneously evaluate supply and demand-side transit inequalities. Analyzing six global cities, we find three distinct equity tiers, with demand-side disparities consistently exceeding supply-side inequalities. High-density cities achieve better equity through gradual transit evolution, while rapidly growing cities show stark access disparities despite similar infrastructure levels. These findings suggest transit agencies should prioritize alignment between infrastructure distribution and actual usage patterns, particularly in rapidly urbanizing regions.

S2A: Crowdsourcing

Laura Kolcheva, *Antoine Legrain* and *Martin Trépanier*

Network-Wide Transfer Synchronization Strategies in a Public Bus System with Real-Time AVL and Smart Card Data

ABSTRACT. This paper presents a scalable methodology for real-time transfer synchronization in urban bus networks, using online stochastic optimization (OSO). The approach integrates three key components. First, an offline arc-flow model captures all control tactics—hold, speedup, and skip-stop—for a main line and its feeder connections, using a graph-based representation over a fixed control horizon. Second, the REGRET (R) algorithm operates in real time within an OSO framework, leveraging the offline model to evaluate multiple stochastic scenarios and select robust control tactics. Third, a network-wide simulator (NWS) integrates the full OSO framework and re-optimizes decisions dynamically at each bus departure from any stop, allowing the coordination of multiple interconnected lines. The NWS is applied to the transit network of Laval, Canada, using historical vehicle positions and smart-card validations to replicate real-time stochastic conditions. Results show significant improvements in both passenger travel and transfer times across a variety of network structures, highlighting the scalability and applicability of real-time transfer synchronization for urban multi-line transit networks.

Rabi Mishalani, *Mark Mccord* and *Diego Ribeiro de Oliveira Galdino*

Using APC Data to Investigate Changes in City-Wide Transit Origin-Destination Flows Resulting from Exogenous Events: Application to the Covid-19 Pandemic

ABSTRACT. Automatic Passenger Count (APC) data are used to estimate city-wide origin destination (OD) passenger flows for the purpose of investigating changes in travel patterns resulting from exogenous events. Quantified changes from such “before and after” analyses can assess impacts of events and be used to inform service improvements. APC data collected on Central Ohio Transit Authority buses

over 33 months are used to estimate route-direction-bus-trip stop-to-stop passenger OD flows that are aggregated into city-wide zone to zone flows by time-of-day. Measures derived from these flows are analyzed over time to quantify the impacts of the covid-19 pandemic on travel patterns.

Chris Yung, *Charalampos Sipetas* and *Claudio Roncoli*

A Machine Learning Framework for Public Transport Ridership Estimation Using Multi-Source Data Fusion with Low-Cost Bluetooth Data

ABSTRACT. Information about demand volumes at certain locations within public transport networks is critical. This paper proposes a framework that extends beyond statistical methods to leverage the advance capabilities of machine learning. The goal is to fuse diverse data sources to estimate the number of boardings of public transport vehicles in an area affected by nearby ferry operations. The model includes low-cost Bluetooth counts, though often noisy, combined with novel drone data. GTFS-RT and ferry schedule data are included to represent the service operations in the area. Results indicated that models of high accuracy can be developed through the proposed framework.

Teethat Vongvanich, *Jan-Dirk Schmöcker*, *Wenzhe Sun*, *Francesco Viti* and *Federico Bigi*

Estimating Station User Activity and Origin-Destination Flows Using Crowdsourced Data

ABSTRACT. We developed an approach to estimate OD flows, including activities performed at destinations, using crowdsourced Google Popular Times (GPT) data and mobile spatial statistics on population presence. Our method is suggested to be of particular relevance to transit operators to understand the activities that public transport users engage in after their journey, enabling insights into demand sensitivities to urban activities. The study uses data from Kyoto, Japan with a focus on the Kyoto Station area. Results show that GPT data effectively estimate the time-varying population in the station vicinity. Further analysis illustrates the origin of station users and the activities they engage in.

S2B: Evaluation

Jérémy Gelb, *Hamzeh Alizadeh* and *Ludwig Desjardins*

Towards Fair Transit: a Toolbox for Equity Diagnostics in Spatial Accessibility

ABSTRACT. This research introduces a comprehensive toolbox designed to evaluate the equitable distribution of spatial accessibility across a given territory. The toolbox is demonstrated through a case study comparing accessibility levels to public transit and urban opportunities for potentially vulnerable and non-vulnerable populations within two municipal sectors in the Montreal region. The tools leverage primarily open data, offer straightforward result interpretation, support multi-scale analyses, and enable scenario-based comparisons. These features position the toolbox as a valuable resource for territorial planning and public transit decision-making.

Itsuki Sato, *Kiyoshi Takami* and *Giancarlos Parady*

Evaluation of Public Transport Accessibility Under Delay Conditions: a Case Study of a Japanese Regional City

ABSTRACT. Accessibility analysis on public transport delays has not been significantly prioritized

in Japan. This research quantifies the impact of public transport delays on accessibility to educational facilities (high schools) in a Japanese regional city, utilizing two types of GTFS data. While nearly all regions have at least one commutable high school within one hour, the city's outer edges exhibit unsatisfying degree of access to opportunities, and the adverse effects of delays are pronounced. Interestingly, delays have made some areas more accessible due to irregular transfers and reduced waiting times, underscoring the imperative for transit agencies to reassess current operational issues.

Gen Hayauchi, *Kensaku Yoshida* and *Takayuki Morikawa*

Towards a Livability Index by Public Transport (Lipt): Conceptual Framework and Tool Prototyping

ABSTRACT. This paper proposes the Livability Index by Public Transport (LIPT), a novel accessibility indicator designed to assess quantitively the feasibility of completing trip chains using public transport. Alongside, we present LIPT-sim, a tool enabling users to compute several accessibily indicators using GTFS public transport data. A case study in the Nagoya region reveals that traditional coverage-based methods may overestimate accessibility in some rural regions, highlighting the need for trip chain–oriented assessments. Through these proposal and prototyping, this paper propose our direction to improve public transport assessment and designing to enable it surely support people's daily activities.

Yurie Toyama and *Ryo Ariyoshi*

The Role of Family Ride-Giving in Supporting Children's Mobility in Japan

ABSTRACT. This study examines intra-household ride-giving through the lens of Mobility of Care, using person trip survey data from Nagoya City. Findings reveal pronounced gender differences in mobility patterns: women make more trips, travel shorter distances, and bear a greater share of caregiving-related travel, especially ride-giving for children. These patterns reflect structural inequalities and invisible care labor embedded in daily transport. The study also highlights growing burdens associated with children's extracurricular mobility in urban Japan. Addressing caregiving mobility is essential for ensuring equitable access to opportunities. Policy implications include the need for care-sensitive transport planning and inclusive mobility systems.

Ryo Ariyoshi and *Tomoichi Ebata*

Quantification Method for Resident Contact Opportunities Generated by Public Transport

ABSTRACT. This study aims to construct and verify a quantitative evaluation method for providing opportunities for residents of the same town to meet, based on public transport services. We defined situations where multiple travellers are in the same space at the same time as 'Co-exist', and situations where specific pairs of residents repeatedly encounter each other in the same place as 'RCM' (repeated chance meetings). We developed a method to quantify these indicators using Multi-Agent Simulation (MAS). Based on individual data from a person-trip survey conducted in the target area, agents were generated to reproduce the intra-district travel patterns of around 18,000 residents. These agents were then simulated, enabling us to analyse the frequency and trends of Co-exits and RCMs. The results revealed that high-density Co-exits are distributed around community facilities and stations, with

approximately 6,000 RCMs occurring daily across the entire target area. Additionally, the generation intensity of Co-exits and RCMs varies significantly depending on the travel mode; RCMs associated with bus and shared taxi travel were found to be significantly more common than those associated with walking or car travel.

Oral Presentation Sessions

O1A: Optimization

Qiande He, *Wai Yuen Szeto* and *Yi Wang*

A Modified Genetic Algorithm for Solving the Joint Regular Bus Route Design, Express Bus Service Design, and Frequency Setting Problem

ABSTRACT. Express bus services, which use faster routes and make fewer stops than regular bus services, are a potential solution to reduce travel time. This study aims to solve the regular bus network design problem, the express service design problem, and the frequency setting problem simultaneously. A hybrid genetic algorithm is modified to solve this integrated problem. A waypoint mechanism is proposed to facilitate the design of both regular and express routes. The numerical result shows that the solution obtained by designing the regular routes and express services simultaneously is better than the sequential approach that designs them separately and sequentially.

Zhiya Su, *Enoch Lee*, *Hong K. Lo* and *Joseph Y.J. Chow*

Resilient Bus Services Design Under Correlated Stochastic Metro System Disruption

ABSTRACT. This study develops a robust multimodal network design integrating metro and bus services, addressing correlated stochastic disruptions. Using a vine copula technique, we model dependencies among disrupted metro links for realistic correlation representation. A two-stage correlation-aware stochastic program is formulated to optimize bus routing and frequencies, minimizing total costs while accounting for unmet demand. By designing the entire network to withstand metro disruptions, the proposed approach demonstrates superior performance, reducing demand losses by 99% compared to benchmark that neglects correlation. This framework enhances the resilience of public transport systems under uncertainty, ensuring efficient and reliable service during disruptions.

Ali Akbar Sadat Asl, *Hugues Delmaire*, *Antoine Legrain* and *François Soumis*

A Real-Time Multi-Modal Transport System: Balancing Perspectives on Users, Operators, Sustainability, and System-Wide Efficiency

ABSTRACT. Ridesharing could offer a solution to urban mobility challenges by enhancing affordability, convenience, and sustainability. This study explores a system designed for transportation hubs with parking facilities, integrating personal vehicles with carpooling options and shuttle services as dynamic transit solutions to serve inbound and outbound ride requests. To capture diverse interests and priorities within urban transportation, we apply column generation to minimize four objectives: user costs, operator costs, emissions, and vehicle underutilization as a system-wide objective. Our evaluation of the proposed system across various scenarios demonstrates its potential to address the complexities of large-scale transportation systems.

Markus Reuther and *Torsten Klug*

A Hungarian Heuristic for the Rolling Stock Rotation Problem

ABSTRACT. The Rolling Stock Rotation Problem (RSRP) is to find a cost optimal set of cycles, i.e., rotations in order to cover given timetabled trips by rail vehicles. In this paper, we consider a dedicated

variant of the RSRP arising at our partner DB Fernverkehr AG, which is the largest passenger railway operator in Europe. There, rail vehicles need to be composed in order to form vehicle compositions and also need to be maintained within given maintenance intervals. While the first requirement is known to be efficiently manageable by a hypergraph approach in our application, the maintenance constraints appear harder as they have a similar computational flavor as, e.g., constraints in vehicle routing applications. We contribute the utilization of a heuristic concept, called regional search. Its idea is to mime an exact iterative improvement procedure for a hard problem's relaxation, in order to derive an efficient large neighborhood search procedure. Here, we construct promising neighborhoods for the RSRP from alternating cycles found via linear programming arguments by the primal version of the famous Hungarian method. We show that the procedure is able to produce near-optimal as well as optimal solutions for industrial scenarios by a proof-of-concept computational study.

O1B: Scheduling

Nattanon Luangboroboon, *Marcella Samà*, *Andrea D'Ariano* and *Taku Fujiyama*

Train Platforming Problem from the Viewpoint of Passenger Flow Management

ABSTRACT. This study addresses the Train Platforming and Passenger Management Problem (TPPMP), integrating train platforming and passenger flow management problem. A mixed integer linear programming (MILP) model is proposed to optimise the passenger flow within stations. A case study at London Euston Station shows that reassigning trains to flexible platforms can significantly reduce passenger delays and improve station flow. By incorporating passenger flow into platforming decisions, it enhances the efficiency and safety of station operations.

Chuhan Yin, *Zhiyuan Lin*, *Ronghui Liu*, *Zixian Zhang* and *Jin Liu*

Train Unit Scheduling Considering Two Capacity Levels Derived from Multiple Demand Sources

ABSTRACT. The Train Unit Scheduling Problem assigns train unit configurations to trips, ensuring capacity meets passenger demand. UK train operating companies (TOCs) set a mandatory minimum demand level and a higher desirable level, derived from various sources. Limited resources force TOCs to prioritize capacity allocation, addressing only a subset of trips' higher demand. This is complicated by an "empty-carriage dilemma", where traditional manual methods and fixed thresholds often fall short of optimal solutions. This paper proposes a Demand Assignment with Dempster-Shafer Theory (DADS) method to fuse demand data and define two-level capacity. Testing on real-world data demonstrates superior performance compared to existing methods.

Neema Nassir, *Andres Fielbaum*, *Sapan Tiwari* and *Avishai Ceder*

Optimal Vehicle Scheduling for Network-Based Modular Autonomous Public Transport Systems

ABSTRACT. In this paper, we present a novel vehicle scheduling model for operational planning of modular autonomous public transport (PT) services. The use of modular autonomous PT vehicles introduces unique challenges, including the coordination of module attachments, detachments, and platoon formations. The proposed model aims to minimize the fleet size requirements while optimising service frequency for the modular PT vehicles. This provides decision-makers with a powerful tool to

evaluate and compare service options prior to implementation. To demonstrate the model effectiveness and practical implications, we are applying it to a case study involving a small PT network with modular vehicles.

Valentina Cacchiani and *Andrea Bettinelli*

Extending a Mixed Integer Linear Programming Formulation for Train Rescheduling with New Real-Life Objectives and Constraints

ABSTRACT. Train Rescheduling consists of retiming, reordering and rerouting trains in real-time when unexpected delays or disruptions cause the infeasibility of the planned schedule. In this work, we extend the well-known RECIFE-MILP model, a Mixed Integer Linear Programming formulation introduced in "Pellegrini, P., Marlière, G., & Rodriguez, J. 2014. Optimal train routing and scheduling for managing traffic perturbations in complex junctions. Transportation Research Part B: Methodological, 59, 58–80", to include a new piecewise linear objective function and new constraints accounting for capacity and travel time restrictions, that were considered in the time-space graph-based heuristic algorithm proposed in "Bettinelli, A., Santini, A., & Vigo, D. 2017. A real-time conflict solution algorithm for the train rescheduling problem. Transportation Research Part B: Methodological, 106, 237–265". Computational results on realistic instances show that RECIFE-MILP is successfully extended to the new setting.

O2A: Network

Chee Yung Lo and *Daisuke Fukuda*

Development of a Semi-Dynamic Link-Based Transit Assignment Model

ABSTRACT. This study develops a semi-dynamic link-based transit assignment model to identify congested railway sections in the Tokyo Metropolitan Area (TMA). While path-based models could address the complexities of through services, multiple fare levels, and systems (flat or distance-based) in the TMA, they require explicit path enumeration, which is infeasible for more extensive networks. Using a link-based structure that avoids path enumeration and incorporating time dynamic effects through a semi-dynamic assignment framework, we successfully predict congestion rates of railway sections across time intervals within the Yamanote Line, though the model requires further calibration.

Maarten Wens, *Jeroen Verstraete* and *Pieter Vansteenwegen*

Solving the Passenger Assignment Problem with Frequency and Time Scheduling

ABSTRACT. In this paper we present a new algorithm to solve the all-to-all passenger assignment problem, assuming all passengers take the shortest path over a transit network. Compared to previous studies we gain a significant scaling advantage, that depends on the number of transfers in the network. This method is furthermore capable of solving the passenger assignment problem with individual demand requests, and a line plan that includes frequencies and time-tabled busses.

Hiroe Ando and *Francesco Corman*

Eigenvalue Analysis of Multilayer Networks for Topological Equality in Multimodal Transport System

ABSTRACT. This study explores the use of eigenvalue analysis in multilayer networks representing multimodal transportation systems composed of layers of varying sizes. This study demonstrates how eigenvalue analysis can reveal critical structural characteristics of multimodal transportation by using multilayered test networks. Specifically, the largest eigenvalue of the Adjacency matrix (LEV) is used to identify key high-accessibility hubs commonly shared across multiple transportation modes. In contrast, the second smallest eigenvalue of the Laplacian matrix (2nd SEV) is shown to reflect fluctuations in network connectivity, providing a measure of topological equality across the entire system. The results underscore the importance of evaluating integrated transport networks as a whole, rather than analyzing each mode in isolation. The method proposed in this study is to incorporate new transportation modes as additional layers and to determine their optimal placement within the existing network to enhance overall equality. This framework extends the applicability of the eigenvalue analysis and supports the development of equitable, efficient, and sustainable urban mobility systems.

Hiroshi Shimamoto

Impact of Level of Service Public Transportation on Ridesharing Penetration -a Mathematical Model Analysis-

ABSTRACT. Existing public transportation and ridesharing are similar services in that they transport non-drivers. Therefore, the level of service of public transportation may affect the diffusion of ridesharing. This study aims to determine the effect of the level of service of public transportation on the diffusion of ridesharing by comparing assignment results for cases with different levels of service of public transportation using a logit-based stochastic ridesharing user equilibrium model (RUE model). In the proposed model, travelers have three options: as a Rideshare Driver (RD), who travels in his/her own vehicle to his/her destination while allowing for shared seating; a Rider (R) who rides with an RD; and a Public Transportation User (PT), who takes public transportation to his/her destinations. The proposed model explicitly considers the en-route transfer-free condition of R/s by generating a set of paths from a path of the RD. As a result of applying the model to a hypothetical network, we confirmed that only the ratio of RD increases while the ratio of R remains unchanged if the level of service of public transportation declines. The result suggests that the efficiency of ridesharing deteriorates as the level of service of PT decreases.

O2B: Operation

Rhian Paterson, *Saeid Saidi* and *Lina Kattan*

Revisiting Bus Dwell Time Estimation with Stochastic Stopping Trends and Policy Adherence

ABSTRACT. Dwell time makes up a significant portion of total transit trip time and is important for transit agencies and users alike. This study examines the relationship between bus dwell time, the probability of stopping, numerous dwell time determinants, and the level of compliance with holding policies during operations. Different grouping methods are employed to group stops, then dwell time is estimated using the probability of stopping and historical transit data. The accuracy of estimated total trip dwell times are assessed and then improved by accounting for holding policies at timepoints and the probability of adhering to the policy.

Jiali Zhou

Impacts of Unplanned Service Disruptions on Passenger Travel Behavior: a Cluster-Based Analysis

ABSTRACT. Disruptions in public transport often frustrate passengers. Studies on their effects overlook passenger heterogeneity in travel habits and sociodemographics. This paper proposes a three-stage framework using smart card data to analyze disruptions' impacts on passenger behavior. First, sociodemographic characteristics from inferred residential zones enrich the data. Second, key indicators characterize transport usage. Third, passengers are clustered based on sociodemographic and usage traits, and their behaviors during disruptions are analyzed. Applied to a derailment incident on Hong Kong MTR East Rail Line, results reveal distinct patterns, providing actionable insights for public transport agencies in managing disruptions effectively.

Jilin Song, *Amer Shalaby* and *Merve Bodur*

Real-Time Assignment of Extraboard Transit Operators

ABSTRACT. This study explores the real-time assignment decisions for extraboard transit operators, who are responsible for covering open work resulting from unexpected events such as driver absenteeism. The problem is formulated as a Markov decision process to capture its stochastic nature. Due to the problem's very large state space, an approximate policy is proposed and solved using a backward dynamic programming algorithm. The proposed policy produces high-quality solutions for a test case based on real-world operations.

Marketa Jirmanova, *Vojtech Novotny*, *Michal Matowicki* and *Ching-Fu Chen*

Evaluating and Prioritizing Public Transit Infrastructure Using Man-Hours Savings: a Case Study of New York City and Kaohsiung Bus Operations

ABSTRACT. Evaluation and prioritization of public transport infrastructure remain pivotal challenges for urban planners and transport agencies. Traditional Level of Service (LoS) metrics, while useful, often overlook the compounded impacts of delays on passengers, particularly on heavily used transport corridors. This paper introduces the "Men-Hours M-H Factor", a novel evaluation metric that integrates vehicle operational data, travel time deviations, and passenger occupancy to quantify the potential cumulative burden of delays on passenger time. Using Manhattan's and Kaohsiung's public bus network as a case study, the methodology uses extensive data, including GPS-based travel times and hourly passenger counts, to recalibrate LoS metrics and identify high-priority inter-stop segments for intervention. The results reveal significant man-hour savings potential in select inter-stop sections and demonstrate how Man-Hour (M-H) factor shifts prioritization to heavily utilized routes, offering a more equitable and actionable framework for decision-making. By incorporating passenger-centric metrics, this study provides a scalable, data-driven approach to the evaluation and planning of transport infrastructure, with broad implications for sustainable and equitable urban mobility systems.

O3A: Emerging Mobility

Zhihua Jin, *Gregory Erhardt* and *Rolf Moeckel*

How Much Should This Ride Cost? Pricing Transportation Network Company Trips to Complement and Not Compete with Transit

ABSTRACT. The rapid growth of transportation network companies (TNCs) over the past decades has accompanied several challenges, including competition with transit and increased congestion. To address these issues, some US cities started taxing TNC trips. It has successfully collected tax but is less efficient in tackling congestion and loss in transit ridership. Hence, there is a need to seek a pricing scheme that can position TNCs as a complementary mode rather than as a competitor to transit while minimizing their impact on congestion. This research explores zero-net pricing schemes that encourage TNC trips where transit is insufficient and discourage others. We use tax and subsidy that sum up to zero to nudge a modal shift with Chicago's peak hour data. We found that with a fixed criterion for pricing, there is a tax level that affects demand the most, and a generalized-cost-based pricing scheme has more impact on downtown trips. This indicates that a zero-net pricing scheme can effectively target TNC trips in congested areas with competitive transit for tax and subsidize those without good transit connections. Further, it diminishes the competition between TNC and transit and mitigates congestion.

Riki Kawase, *Elnaz Emami* and *Mohsen Ramezani*

Fleet Sizing, Dynamic Pricing, and Parking Recommendations in Dockless Bike-Sharing Systems Under Demand Uncertainty

ABSTRACT. Dockless bike-sharing systems have emerged as a promising transportation mode that is low-carbon, environment-friendly, and sustainable. The nature of one-way usage in bike-sharing systems inherently poses the issue of demand-supply incongruence over time and space. The spatial flexibility of parking and the uncertainty of travel demand in dockless systems can accelerate the incongruence, resulting in a significant decrease in user satisfaction with bike-sharing services. This study deals with the stochastic version of a user-based rebalancing problem in dockless bike-sharing systems that integrates strategic bike fleet sizing, operational dynamic pricing, and parking recommendations. The problem is formulated as a multi-stage stochastic convex programming model, which determines bike fleet size planning at first and then optimizes bike fares and parking recommendations sequentially and recursively while observing the spatial distribution of idle bikes and realizations of stochastic trip requests. The objective is to minimize the investment cost of bike fleets and maximize the revenue from dynamic pricing. An iterative algorithm based on a multi-stage Benders decomposition provides the optimal solution to the proposed model with guaranteed convergence. We conduct numerical experiments to demonstrate the Pareto efficiency and robustness of user-based rebalancing with parking recommendations.

Bing Liu, *Christopher Szymula* and *Nikola Besinovic*

Integrating Air and Rail Services with Rerouting Strategy

ABSTRACT. The integration of rail and air services has been attracting increasing attention with the growing emphasis on multimodal transport systems. In this paper, we propose an air-rail timetable

synchronization model to improve the passenger transfer experience in integrated air-rail transport networks. The model applies the time shift and rerouting strategy to existing rail and air timetables to provide more connections and smoother transfers for multimodal travelers. It also captures the passenger itinerary shifts resulting from timetable adjustments. The problem is formulated as a mixed-integer linear program. The effectiveness of the proposed method is demonstrated through a real-world case study of the Spanish rail and air network. The results show that the rerouting strategy can significantly reduce passenger transfer times.

Zhicheng Jin, *Weihua Gu*, *Xiaokuan Zhao* and *Huizhao Tu*

Complement or Substitution: a Spatial Investigation over TNC-PT Relationships in Shanghai

ABSTRACT. This study investigates the relationship between ride-hailing services and public transit (PT) in a saturated market environment, using data from 35.94 million trips in Shanghai, September 2022. Our findings indicate nearly comparable ratios of complementary trips (9.22%) and substitute trips (9.06%), contrasting sharply with the findings of prior studies. The results show significant nonlinear effects in some variables, including the distance to the nearest metro station and the density of bus stops. These findings offer valuable insights for policymakers to promote urban multimodal mobility systems integrating ride-hailing and public transit.

O3B: Time Table

Florian Fuchs, *Viera Klasovitá* and *Francesco Corman*

Line Planning with Resilience Against Blockages Through Γ-Robustness

ABSTRACT. In this paper, we explore a two-stage model with Γ-robustness for line planning in public transport systems, focusing on link blockages and re-routing of passengers in the second stage. We keep changes to the line concept small, running the line before and after closures with the same frequency if unblocked. Our network includes bypass links, allowing alternative modes and ensuring feasible solutions. We analyse the benefits of Γ-robustness and the addition of bypass links, highlighting their impact on the reliability of public transport systems.

Hoang Thi Khue Nguyen, *Paul Bouman* and *Dennis Huisman*

Solving Train Timetabling Adjustment Problems with Integrated Track Assignments

ABSTRACT. This study tackles the Train Timetabling Adjustment Problem with integrated track assignments in response to planned maintenance. Building upon existing models that primarily operate at a macroscopic level, we propose a mesoscopic approach and extend the standard event-activity network, allowing for assigning tracks, modelling train short-turning and track capacity directly, and accounting for partial open track possessions which are often overlooked in previous studies. The problem is formulated as a mixed-integer linear programming model and tested on real-world instances with multiple possession scenarios. Results indicate that the model can find optimal alternative timetables and feasible train routings within reasonable times.

Renate J.H. van der Knaap, *Niels van Oort* and *Rob Goverde*

Balancing Flexibility and Predictability: Evaluating the Impact of Multi-Period Timetabling on Railway Demand

ABSTRACT. There are significant fluctuations in passenger railway demand throughout the day. Despite these fluctuations, many European countries use a fixed line plan and cyclic timetable that is the same throughout the day. Conversely, the multi-period railway timetable is designed to address fluctuating demand patterns throughout the day, while maintaining the memorability of cyclic schedules. This study evaluates how the railway demand would be impacted by implementing such a timetable. A case study conducted on a segment of the Dutch railway network, compares the passengers' Generalised Journey Time (GJT) in the multi-period timetable with their GJT in the cyclic reference timetable. Based on the change in GJT, passenger demand is then altered using incremental elasticity analysis with time elasticities. Our analysis of the case study shows improved average journey times and a slight increase in passenger demand, particularly during the off-peak period. However, during the morning peak the loss of direct connections and resulting increased journey times cause significant decreases in demand. The findings underscore the importance of determining an optimal line plan for each period and improving waiting times during transitions between cyclic schedules.

Yu Li, *Weihua Gu*, *Ronghui Liu*, *Weitiao Wu* and *Li Zhen*

Joint Robust Optimization of Bus Timetabling and Vehicle Scheduling with Dynamic Holding Strategies

ABSTRACT. Ensuring operational efficiency and stability in public transit systems under stochastic conditions is paramount. This paper develops a novel robust optimization framework that incorporates tactical timetabling, vehicle scheduling and slack time pre -allocation on a congested bidirectional bus route, which integrates a dynamic holding strategy that considers capacity -constrained bus motion modes to effectively capture service irregularities and schedule disruptions. We propose and analyse two models a stochastic programming model and a robust optimization model to solve this problem, assuming known and unknown distribution of passenger demand and travel time, respectively. A case study in Chengdu, China, demonstrates the practical application and effectiveness s of the proposed approach.

O4A: Dynamic and Evolution

Yanhao Li, *Xin Li*, *Huaiyue Li* and *Yun Yuan*

Evolutionary Game Analysis on Carbon Generalized System of Preferences Policy for Public Transportations

ABSTRACT. In the context of carbon-neutral, the carbon generalized system of preferences (CGSP) policy is newly implemented to encourage passengers to shift from automobiles to public transport, in which the government obtains the excess income by trading travelers’ carbon emission reduction (CER) and offers a corresponding subsidy to public transport enterprises, while enterprises provide fare discounts to attract more passengers. In this study, an evolutionary game model is established to simulate the behaviors of the government, public transport enterprises and heterogenous traveler groups, which is distinguished by the value of time. Evolutionary stability strategies in different scenarios are investigated

with both numerical analysis and real-world based simulations. Results are expected to provide references to pre-evaluate the policy implementation.

Richard Connors, *Haruko Nakao*, *Francesco Viti* and *Tai-Yu Ma*

Tackling the Problem of Ride-Time Volatility in Demand Responsive Transport

ABSTRACT. Demand Responsive Transport (DRT) systems can struggle with user retention due to variability in ride-time experiences, even within guaranteed service levels. Under constant aggregate demand, the stochasticity of users' daily travel decisions can alter the order of pick-ups and hence ride-time. Simulation results indicate that users can experience very high levels of ride-time volatility, regardless of their origin. This work investigates how the detour factor, as an individual level-of-service constraint, can limit experienced ride-time fluctuations and hence mitigate against users leaving the system.

Chao Yang, *Wentao Dong* and *Chengcheng Yu*

MBSE-Net: Multi-View Attributed Graph Model for Individual-Level Multimodal Transit Behavior Status Evolution Prediction

ABSTRACT. To address the challenge of predicting individual-level behavior evolution in multimodal transit systems, we propose MBSE-Net, a novel end-to-end deep learning framework incorporating a Multi-view Attributed Graph Model (MAGM) to encode multimodal trip chains and estimate spatiotemporal similarities among riders. MBSE-Net synergistically performs behavior status identification and evolution prediction by integrating MAGMs with advanced deep learning techniques. This data-driven approach eliminates the need for manual feature selection, advancing the analysis of multimodal transit rider behavior. Our framework provides valuable insights for personalized interventions in intelligent public transit systems.

Watcharapong Wongkaew, *Kongtup Wanichjaroenporn* and *Pongsun Bunditsakulchai*

Spatiotemporal Dynamics of Land Use and Ridership: a Geographically Weighted Regression Analysis of Bangkok's MRT Blue Line

ABSTRACT. This study investigates the spatiotemporal relationship between land use patterns and transit ridership along Bangkok's MRT Blue Line using stepwise and geographically weighted regression (GWR) analysis. Drawing on ridership data and analysing land use composition within 500-meter buffers, the study identifies residential, commercial-office, and transport utility land uses as the primary predictors of both weekday and weekend ridership. Additionally, malls and markets emerge as significant predictors during late evening weekday and afternoon weekend periods, reflecting non-commuting travel behaviour. The GWR results highlight substantial spatial heterogeneity, demonstrating how the influence of land use on ridership varies across time and location.

O4B: Fares and Pricing

Ying Lu, *Mark Hickman* and *Xin Chen*

Exploring the Heterogeneity in Subscription and Travel Behaviours of MaaS Users: a Segmentation Approach and Thematic Analysis

ABSTRACT. Mobility as a Service (MaaS) integrates multiple transport options into one platform to reduce car ownership and congestion. In July 2021, the ODIN PASS MaaS trial at the University of Queensland (UQ) gathered data on UQ staff and students' trip characteristics, reasons for using MaaS, subscriptions, and feedback. This study aims to identify user travel and subscription patterns via latent class analysis, and explore attitudes and improvement suggestions through thematic analysis. Findings show non-car users favour public transport bundles, while users with fewer trips prefer bundles with micro-mobility; feedback varies by user type, emphasizing fare policy and app functionality.

Wenzhe Sun, *Zifeng Wang*, *Yihe Zhou*, *Jan-Dirk Schmöcker* and *Jing Zhao*

Pricing Premium-Class Seats in Transit Fares

ABSTRACT. As megacities grow, urban transit must address increasing travel times by offering both efficiency and comfort. The few emerging premium options in intracity transit lack scientific discussion on the optimal fare level and structure. This study develops a pricing model for premium-class seating, integrating passenger segmentation and willingness-to-pay using a discrete choice and fare optimization framework. The model obtains profit-maximizing fares given crowding levels, value-of-time distributions, and in-vehicle productivity provided by the premium class. Results provide insights into fare structures to balance enhanced passenger experiences and operational profitability. This research offers guidance for implementing differentiated services in public transport systems.

Wei Wei, *Muqing Du*, *Yu Gu*, *Anthony Chen* and *Zhong Wu*

Collaborative Pricing of Public Transit and E-Hailing Service Considering Travellers' Loyalty

ABSTRACT. With the popularity of emerging transportation such as e-hailing, the traditional public transit (PT) faces an intensive competition. Thus, how to regulate the competition between PT and e-hailing mode, and enhance the share rate of PT has become an important issue in urban transportation management. This study develops a bi-level programming model to explore the collaborative pricing problem between e-hailing and PT in a multimodal urban transportation network. The upper-level model maximizes e-hailing service revenue through the optimal flag-down fare. Constraints are targeted at the PT mode share rate and the initial cost balance. The initial travel cost refers to the difference between the flag-down fare of e-hailing and the PT fare within the same OD pair. The lower-level model characterizes the mode choice behavior of choice travellers and loyal travellers by a dogit-nested logit (DNL) model. Results show that setting an initial cost balance increases the PT mode share rate and facilitates low-carbon mobility. Also, a suitable collaborative pricing strategy can balance PT share rate and e-hailing profitability under different levels of PT service.

Yihe Zhou, *Jan-Dirk Schmöcker* and *Wenzhe Sun*

Optimal Transit Fares With Delay Insurance Considering Required Incentives to Alternative Service Providers

ABSTRACT. Previous work proposed "premium fare tickets" that offer passengers free access to alternative modes if public transport services are delayed beyond a set threshold, enhancing travel time reliability. A problem with the concept is the need to guarantee the availability of sufficient alternative transport options in case of a delay. In this work we address this by providing alternative mode companies compensations for deploying more vehicles to a station then the normal expected demand might justify. The model is applied to a railway line network considering multiple origin stations. In the resulting objective function we consider a social cost perspective. The results show that even considering incentives, the premium fare can reduce the expected travel cost and still be beneficial for the PT operator.

O5A: Multimodal and Mode Choice

Sebastián Raveau, *Jaime Soza-Parra* and *Angel Cantillo*

Behavioural Modelling of Public Transport Users: Understanding Fare Payers and Evaders Mode and Route Choices

ABSTRACT. This study explores fare evasion in public transport by analysing the mode and route choices of users in Santiago, Chile. Using survey and smartcard data, latent class choice models were developed to distinguish fare payers and evaders, uncovering heterogeneity in their preferences. Results indicate that fare evaders prioritize fewer transfers, shorter wait times, and sometimes longer travel times, reflecting distinct behavioural patterns. These findings enhance understanding of travel behaviour and can inform targeted policies to reduce evasion, optimize public transport operations, and improve the overall efficiency of the transit system.

Youxin Lin, *Judith Y.T. Wang*, *Chris Nash* and *Zhiyuan Lin*

Evaluating Network Integration of Rail and Long Distance Bus Based on an Extended Node-Place Model

ABSTRACT. Rail and long-distance bus integration has been widely advocated to enhance connectivity. This study develops a rail-bus network to quantify integration through indicators of travel time-weighted population, network centrality, and service availability. These indicators are further incorporated into an expanded node-place model to evaluate the balance between transport provision and potential demand. Based on the proposed model, the study examines 102 rail stations across Scotland's rural areas, identifying potential improvements, including relocating bus terminus closer to rail stations and addressing imbalances in network accessibility. The findings offer data-driven insights to support transport planners in optimising rail and bus network integration.

Kang Wang, *Jan-Dirk Schmöcker* and *Simon Hu*

Carbon Credit-Based Incentive Model for Multimodal Transport System

ABSTRACT. Decarbonizing the urban passenger transport sector faces significant barriers, highlighting the potential of innovative strategies like incentive schemes. Such a scheme could play a pivotal role in

incentivizing emission reductions and fostering a shift toward sustainable mobility options. This study introduces a dual incentive scheme designed to promote sustainable shifts in travel behaviours. The framework integrates a departure time incentive, encouraging shifts from peak-hour road traffic to off-peak road traffic, and a travel mode incentive, promoting transitions from off-peak road travel to off-peak metro usage. The models capture the interactions between five distinct passenger flow types and account for incentive allocation and equilibrium conditions. Numerical simulations using standard networks show that by providing a 10 CNY incentive to each traveller, the proposed scheme reduces carbon emissions by 15.96%, lowers travel costs by 7.09%, and increases metro usage by 14.38%. This study highlights the effectiveness of incentive schemes in optimising multimodal traffic systems and offers insights into designing sustainable transport policies.

Max T.M. Ng, *Hani S. Mahmassani*, *Draco Tong*, *Omer Verbas* and *Taner Cokyasar*

Joint Optimization of Multimodal Transit Frequency and Shared Autonomous Vehicle Fleet Size with Hybrid Metaheuristic and Nonlinear Programming

ABSTRACT. Redesigning multimodal transit network can utilize shared autonomous vehicles (SAVs) as feeders to enhance service efficiency and coverage. This paper presents an optimization framework for the joint multimodal transit frequency and SAV fleet size problem, a variant of the transit network frequency setting problem. The objective is to maximize total transit ridership (including SAV-fed trips and subtracting boarding rejections) across multiple time periods under budget constraints, considering endogenous mode choice (transit, point-to-point SAVs, driving) and route selection, while allowing for strategic route removal by setting frequencies to zero. Due to the problem's non-linear, non-convex nature and the computational challenges of large-scale networks, we develop a hybrid solution approach that combines a metaheuristic approach (particle swarm optimization) with nonlinear programming for local solution refinement. To ensure computational tractability, the framework integrates analytical approximation models for SAV waiting times based on fleet utilization, multimodal network assignment for route choice, and multinomial logit mode choice behavior, bypassing the need for computationally intensive simulations within the main optimization loop. Applied to the Chicago metropolitan area's multimodal network, our method illustrates a 33.3% increase in transit ridership through optimized transit route frequencies and SAV integration, particularly enhancing off-peak service accessibility and strategically reallocating resources.

O5B: Bus Demand and Priority Measures

Anupriya Anupriya, *Emma McCoy* and *Daniel Graham*

Urban Rail Transit and Sustainable Urbanisation

ABSTRACT. There is a growing interest in understanding the capacity of cities to reduce global energy use and thus mitigate climate change. The energy requirement of the transport sector remains central to this theme as it accounts for roughly one-third of global energy demand. Using unique multi-city datasets, this study provides new insights into the causal impact of density on the energy use of major urban travel modes. Our analysis shows that the densification of rail transit operations substantially reduces its energy requirement per unit of passenger kilometres. Increasing private vehicular operations on road networks,

on the other hand, offers no energy benefits. These results underscore that a compact urban form, primarily driven by rail-based travel, can lead to a more sustainable future.

Rupam Fedujwar and *Amit Agarwal*

Impact of Urban Form and Socio-Demographic on Transit Boarding: a Case Study of Indore, India

ABSTRACT. This study employs multiscale geographically weighted regression (MGWR) to examine how various urban forms and socio-demographic variables influence passenger boarding at transit stops in the city of Indore, India. The research analyzes the public transport network operated by Atal Indore City Transport Service Limited (AICTSL) across 39 routes. Using diverse data, including the number of transit lines passing a stop, road length, socio-demographic factors, and land use characteristics, the study reveals key patterns. The findings indicate that the number of transit lines at stops, household industries population density and transport infrastructure consistently show positive relationships with passenger boarding, while other factors such as the ratio of literate by ill-literate population, road length in stop catchment areas, and public management and service land use show mixed or negative effects on passenger boarding at a transit stop.

Tingsen Xian, *John Nelson* and *Emily Moylan*

Design Evaluation of Bus Cross-Traffic Turn Priority Box

ABSTRACT. Cross-traffic turns (left turns in right-hand traffic) significantly delay buses at intersections, reducing transit reliability. This study introduces the Bus Cross-Traffic Turn Priority Box, a design that allows buses to bypass turn queues using through lanes and enables the pre-acceleration of turning traffic when no bus is present. Microscopic simulations conducted at two intersections demonstrate substantial delay reductions for buses and minor improvements for general traffic. Unlike traditional bus priority measures, this approach requires minimal infrastructure changes and enhances overall intersection efficiency, supporting its adoption in space-constrained urban settings to improve public transport performance without adversely affecting other road users.

Hugo Silva and *Felipe Gonzalez*

Efficiency of Bus Priority Infrastructure

ABSTRACT. We use bus GPS data across 500 routes to estimate the impact of priority infrastructure on buses' speed and ridership in Chile. Almost 100 million bus trips allow us to leverage within-route variation in the proportion of the route in which buses travel along bus lanes or Bus Rapid Transit (BRT) corridors. Corridors increase bus speeds by 20% at peak hours. Bus lanes, often seen as an equally effective but cheaper alternative to a BRT corridor, are, on average, ineffective. However, bus lanes achieve the same travel time savings as BRT corridors only when fully isolated from private vehicles, coupled with monitoring cameras and enforcement.

O6A: Vulnerability and Robustness

Christopher Szymula, *Bing Liu* and *Nikola Besinovic*

Multimodal Network Vulnerability Assessment Using a Path-Based Disruption Management Model with Timetable Sensitive Passenger Routing

ABSTRACT. This paper presents the multimodal vulnerability network model (MVNM), which determines the critical links to assess the effects of multimodality on disruption management. Therefore, we combine a path-based multicommodity approach with timetable sensitive passenger routing to optimally adjust the operating services under disruptions. The resulting MVNM is solved by combining multi-column generation and row generation, to iteratively identify beneficial passenger routes and disruption management measures. The MNVM is applied on the long-distance air-rail network of Spain. The results show, that multimodality increases the survivability of a network. However, multimodal networks appear to be more vulnerable under few disruptions.

Meisam Ghasedi, *Jinhyung Lee*, *Scott Bell* and *Ehab Diab*

Do We Need to Measure Transit Reliability at the Stop Level? Exploring the Relationship Between Ridership and Stop- and Route-Level Reliability Measures

ABSTRACT. Transit agencies commonly evaluate their reliability using route-level on-time performance (OTP) measures. Nevertheless, users experience service reliability at the stop-level by witnessing variations in the service. This study investigates the association between different stop-level reliability measures and ridership at the stop-level, while comparing these measures performance with commonly used route-level OTP measures. Using data from Winnipeg Transit, statistical models were developed to assess the relationship between ridership and ten different stop-level and four route-level OTP measures. The results show that stop-level measures consistently have a stronger association with ridership than route-level measures. However, the degree to which stop-level reliability measures improve ridership predictions varies.

Georgios Laskaris, *Alexandros iazos*, *Christina Iliopoulou* and *Konstantinos Kepaptsoglou*

Transit Network Design and Frequency Setting Accounting for Vulnerability

ABSTRACT. Transit network design in the phase of transit route design and frequency setting primarily aims on the minimization of passenger and operator related costs, neglecting vulnerability sourcing from its critical infrastructure. This study focuses on enhancing the resilience of public transit networks by incorporating vulnerability analysis into the transit network design problem. After estimating a set of candidate solutions with their critical infrastructure, we proceed to the optimization of frequencies of the solution that resulted to the lowest disruption cost. Simulated annealing is used to adjust the frequencies of the transit lines subject to fleet availability and capacity constraints. Applied to a toy and a real-world network, the results show that the final solution experiences significantly limited losses from disruption, while offering a result comparable to the other candidate solutions that their objective is limited to cost optimization.

Marta Leonina Tessitore, *Marcella Samà*, *Giorgio Sartor*, *Carlo Mannino* and *Dario Pacciarelli*

Exploiting the Concept of Fragility in Tactical Timetable Planning

ABSTRACT. In a typical tactical timetabling process, route planners must follow a complex and iterative process to develop new timetables, often relying on trial-and-error methods. To guide practitioners throughout their decision-making process, this study introduces a fragility-based approach to timetable design and shows how route planners can exploit the concept of fragility to design more robust timetables. We propose a MILP model that aims to enhance timetable robustness by focusing on its most critical part. Considering real-life scenarios from a Norwegian railway line, we show that we can improve the fragility of a timetable, even when adopting conservative improvement strategies.

O6B: Travel Demand Forecast

Zhicheng Dai, *Dewei Li*, *Soora Rasouli* and *Chenyi Yang*

Passenger Flow Distribution Forecasting at Integrated Transport Hub: A Group Evolution Mechanism with Multimodal Transit Data Integration

ABSTRACT. Integrated transport hubs are critical node-based infrastructures for achieving sustainable public transportation development. Accurately forecasting the distribution of passenger flows within the hub is essential for enhancing operational efficiency, ensuring passenger safety and effectively responding to extreme passenger volumes and emergencies. To thoroughly investigate the evolution mechanism of passenger activities within hub spaces, this study integrates multimodal data sources, including monitoring video data, passenger behavioral experiment data within a digitally hub environment, train schedules, and ticketing records. By analyzing the topological characteristics of spatial mobility networks of passenger groups and the causal impacts of public transport operational events on regional passenger flow fluctuations, this research develops a passenger flow distribution prediction model (GEME-Net) that incorporates group evolution mechanism and regional network topological features. Furthermore, knowledge distillation techniques are applied to achieve lightweight model deployment, effectively balancing prediction accuracy and real-time inference performance . Experimental results at the Shanghai Hongqiao integrated transport hub demonstrate significantly improved prediction accuracy compared to baseline models, validating the effectiveness and superiority of the proposed spatial evolution mechanism and multimodal data fusion approach.

Heqi Wang and *Claudio Roncoli*

Multi-Line Short-Term Onboard Passenger Loading Prediction via Relational Multi-Graph Convolutional-Recurrent Networks

ABSTRACT. Accurate and timely predicting onboard passenger loading is essential for enhancing public transport efficiency, service quality, and safety. Considering the difficulties of existing model-based approaches in capturing complex spatiotemporal patterns and interconnected network structures, this paper presents a data-driven approach that utilizes dynamic graph convolution, multiple graphs, and relational interdependency to predict passenger loading across multiple urban commuter train lines. The model is evaluated using automatic passenger count and automatic vehicle location data from the Greater Helsinki region's commuter train system. Experimental results demonstrate that the proposed model

achieves a very good prediction performance, superior to that of a set of tested baseline approaches.

Enze Liu, *Zhiyuan Lin* and *Shuguang Zhan*

A Mobile Data Driven Reinforcement Learning Framework for Real-Time Demand-Responsive Railway Rescheduling

ABSTRACT. Real-time railway rescheduling is crucial in response to unexpected passenger conditions in a timely and flexible manner. Current passenger-oriented rescheduling strategies primarily focus on offline planning based on static demand data. Uneven distribution of demand over time is often neglected, despite its dynamic nature during long-term disruptions. This study defines a real-time demand-responsive rescheduling problem that addresses disasters at a railway hub station, focusing on five key challenges: uncertain disruption duration, dynamic passenger mobility, rolling stock insufficiency, multi-route balancing, and in-station overcrowding. We propose a novel data-driven approach leveraging real-time mobile data to capture passenger mobility. A hierarchical deep reinforcement learning framework, consisting of two cooperating agents, is introduced to handle the sparse reward environment. A real-world disaster case demonstrates the advantage of our approach in sparse reward navigation and multi-objective balancing, compared to global search, rolling horizon, and single-level deep reinforcement learning algorithms. The online applicability is validated by transferring pretrained agents to new environments with varying rolling stock availability and passenger demand distributions.

Tara Saeidi and *Babak Mehran*

Estimating Elderly Transit Demand Using Boarding Count Data with Policy Implications for DRT Zoning

ABSTRACT. This study develops a data-driven framework to estimate elderly transit demand in Winnipeg, a single-mode, bus-only city, with a focus on spatial and seasonal variations to inform Demand-Responsive Transit (DRT) zoning strategies. Recognizing the uneven distribution of older adults and seasonal shifts in travel behavior, this study generates monthly Origin-Destination (OD) matrices by combining boarding data with symmetry-based alighting estimations, calibrated through a weighted averaging technique. Spatial and temporal analysis reveal significant seasonal variations in trip distance sensitivity: longer trips dominate during low-sensitivity periods, while localized travel increase during high-sensitivity periods. These findings underscore the need for adaptive DRT zoning, recommending radial layout with smaller, denser zones in warmer season and larger zones in colder season. The proposed approach addresses challenges associated with incomplete data in smaller transit systems and provides actionable insights to support the planning of cost-efficient, equitable, and elderly-focused DRT services.

O7: Simulation

Yunlong Wang, *Minh Kieu*, *Prakash Ranjitkar*, *Yi Wang* and *Avishai Ceder*

A Framework for Continuous Operation of Shared Autonomous Vehicles in Dynamic Public Transport Networks

ABSTRACT. The rapid advancement of artificial intelligence has accelerated the potential for shared

autonomous vehicles (SAVs). Dynamic Wireless Charging (DWC) technology has emerged as an ideal solution to enable the continuous operation of SAVs, allowing SAVs to charge while in motion. However, conventional vehicle routing algorithms are inadequate for SAVs' pickup, delivery, and charging problems, lacking flexibility in dynamic traffic. This study introduces a Two-Stage Deep Reinforcement Learning framework (TDRL) to address these challenges. The proposed framework operates in two stages: developing global routing strategies that consider route costs, state of charge (SOC), and route re-planning strategies that can handle dynamic traffic. In the first stage, the TDRL uses a heterogeneous attention mechanism to integrate diverse node information for optimal DWC node selection. In the second stage, using the first stage result as a baseline, the framework reassesses current traffic to enable strategic route adjustments, including deleting and reinserting node pairs under a dynamic Mask scheme. The experimental results show that TDRL not only outperforms existing heuristic algorithms in reducing route costs but also effectively maintains SOC stability. Furthermore, TDRL significantly mitigates the impact of traffic fluctuations on route costs by 16.2¥% for the 50-node model and 23.7¥% for the 100-node model, as well as on SOC distribution.

Chaopeng Tan, *Georgios Laskaris*, *Dingshan Sun*, *Robin Abohariri*, *Marco Rinaldi* and *Hans van Lint*

Dwelling and Speed Advisory Enhanced Max-Pressure Control with Transit Signal Priority

ABSTRACT. Max-Pressure (MP) control is a decentralized real-time traffic signal control method that is popular for its simplicity and theoretical stability. However, most existing MP controllers prioritize throughput for private vehicles without accounting for the specific needs of transit services that are essential for sustainable urban mobility. This oversight can exacerbate transit delays and undermine the effectiveness of public transportation systems. To address these challenges, this study introduces a Priority-MP framework that integrates transit signal priority and driver advisory systems into MP control for multi-modal traffic networks. By weighting pressures based on real-time vehicle occupancy, Priority-MP prioritizes high-occupancy transit vehicles while guaranteeing network queue stability. In addition, the framework considers more realistic scenarios with the presence of transit stations and integrates driver advisory systems to provide speed and dwell time recommendations. Simulations on a real-world multi-modal traffic corridor in Amsterdam show that compared to existing MP control methods: 1) Priority-MP significantly reduces average passenger delay when only vehicle occupancy is considered, but significantly increases average vehicle delay; 2) Priority-MP considering transit stations further reduces both vehicle delay and passenger delay while maintaining the network stability; and 3) Priority-MP integrating driver advisory systems further reduces transit queuing counts.

Qiru Ma, *Enoch Lee*, *Kejun Du*, *Hong K. Lo* and *S. W. Ricky Lee*

Modelling Spatiotemporal Platform Passenger Flow: A Macroscopic Simulation-Based Optimization Approach

ABSTRACT. This study proposes a novel framework integrating a cell-based passenger dynamics model (CPDM) and simulation-based optimization (SBO) to analyze spatiotemporal passenger flow dynamics on metro platforms. The proposed model achieves high behavioral accuracy by incorporating heterogeneous passenger characteristics and multi-destination patterns. The CPDM is cast into a

computational graph to enable calibration by iterative backpropagation (IB) algorithm, that uses automatic differentiation to derive the analytical gradient and iteratively refines model parameters. The methodology demonstrates superior performance in capturing complex passenger behaviors while maintaining computational tractability. The results provide valuable insights for metro station design and crowd management.

Mustafa Rezazada, *Neema Nassir*, *Egemen Tanin* and *Avishai Ceder*

Pre-Emptive Modelling of Bus Bunching: Identifying Key Sources of Reliability Issues and Bunching Patterns

ABSTRACT. This paper introduces a novel framework for modelling bus bunching under multiple uncertainties stemming from demand, supply, and exogenous factors, unified within a comprehensive and scalable model featuring microscopic granularity. The methodology is validated through a real-world case study enabling the measurement and quantification of bunching sources and their cascading effects. The findings reveal the model's capability to accurately capture day-to-day variability and differentiate between distinct types of bunching. This advanced approach facilitates informed, targeted and context-specific decision-making by allowing the evaluation of control measures and their effectiveness across dynamic conditions including peak and off-peak periods, varying congestion levels, and fluctuating passenger demand.

Shotgun and Poster Presentations

P1A: Optimization and Environmental Assessment

Michelle Ochsner, *Sarah Greenham*, *Daniel del Barrio Álvarez* and *Hironori Kato*

On Track to Climate Resilience? Insights from Japanese Railways

ABSTRACT. Japan has a long history of managing natural hazards due to its geography and geology. Simultaneously, it is known as a country with a railway system that is highly punctual, reliable, and safe. This research uses an exploratory approach to review climate change adaptation and disaster risk reduction practices in the Greater Tokyo Area. Unstructured interviews with various stakeholders and a literature review discuss how the climate is changing in Japan, what strategies are used amongst railway organisations to manage meteorological hazards, and how railway organisation acknowledges climate change adaptation alongside disaster risk reduction. Results indicate that disaster risk reduction practices still dominate within the railway sector however, more efforts of climate change adaptation set forth by the government may shift practices.

Barbara T.H. Yen, *Chia-Jung Yeh*, *Yu-Chiun Chiou*, *Chin-Chih Liao*, *Chin-Tung Tsai*, *Jin-Yuan Wang* and *Pai-Chu Lee*

Public Transport Promotion Effect Measurement: Monthly Pass (Tpass) Case Study in Taiwan

ABSTRACT. How to promote public transport to the level before COVID is what government in all levels attempt to achieve. In Taiwan, regional level monthly public transport pass, TPASS, introduced in July 2023. This study aims to explore travel pattern change before and after TPASS introduction with big data (i.e., smart card data). There are around 30% users transfer to TPASS with monthly increase rate of 11.4%. Further, the current analysis provides spatial analysis for TAPSS usage. The outcomes can allow policymakers to understand how to revise or improve current TPASS ticket to attract target group.

Zhiya Su, *Joseph Chow* and *Hong Lo*

Dynamic Shuttle Bus Frequency Control for Stochastic Metro Disruption

ABSTRACT. Unplanned metro disruptions can severely reduce transit capacity, triggering passenger spillovers that require rapid and adaptive shuttle bus deployment. While existing strategies often rely on static planning or scenario-based optimization, they typically neglect the need for real-time adaptation to evolving system conditions. This study develops a rolling-horizon model predictive control (MPC) framework for dynamically adjusting shuttle bus frequencies in response to uncertain metro capacity recovery. Metro capacity is modelled as a stochastic process with unknown recovery dynamics, which are estimated online through sequential data assimilation. The proposed framework generates forward-looking frequency decisions that adapt to newly observed capacity realizations over time. Numerical experiments on a synthetic transit network demonstrate that the MPC policy consistently reduces total system cost compared to benchmark strategies based on static capacity assumptions. Moreover, the adaptive policy achieves performance that does not deviate substantially from a theoretical lower bound defined by an oracle with perfect foresight. These results highlight the potential of rolling-horizon, learning-based control for improving transit service resilience under disruption uncertainty.

Yumeng Fang, *Tai-Yu Ma* and *Francesco Viti*

A Hybrid Large Neighborhood Algorithm for the Integrated Dial-a-Ride Problem

ABSTRACT. This paper investigates an integrated dial-a-ride problem combining on-demand vehicles and existing mass transit services to minimize both bus operation costs and customer inconvenience. A hybrid large neighborhood algorithm is developed with problem-specific destroy and repair operators to address the routing complexities involving both modes. The algorithm is benchmarked against a state-of-the-art commercial mixed-integer programming solver on instances with 10-50 customers and two transit lines. On average, our approach delivers solutions of 23.8% higher quality in just 136 seconds, compared with the solver's eight-hour run time. Moreover, a case study using real microtransit data compares the performance of the proposed service against the microtransit service, public transport and private car. Results indicate that the integrated service reduces vehicle kilometers travelled by 36% compared to microtransit service. It also significantly reduces customer travel time over public transport, while customers traveling by private car remains only 19% faster.

Chiang Fu, *Barbara T.H. Yen*, *Ching-Ming Lai*, *Hsin-Tung Tu* and *Pai-Chu Lee*

How Sustainable Policy Influences the Green Vehicle Decision: a Meta-Analysis

ABSTRACT. Sustainable development is critical in the transport field, particularly in the form of promoting green vehicle (e.g., electric vehicle, EV) development. This study focuses on the behaviours of operators on EV type identification through meta-analysis with a logistic regression. Four vehicles (i.e., trucks, vans, buses, and cars) are identified for 52 samples collected from 43 literature. In particular, heavy policy incentives have been implemented via vehicle purchase subsidies for the public transport sector. Key findings reveal that fuel and infrastructure costs positively influence the selection of electric buses (E-bus). The results provide valuable insights for fleet operators about EV type recognition and promote E-bus adoption in terms of other vehicles.

James C Chu, *Yi-Wei Sung*, *Yi-Chen Chou*, *Kuang-Che Lo* and *Chao-Hua Wu*

Optimizing Integrated Passenger-Freight Transportation with Configurable Vehicles

ABSTRACT. Limited and dispersed demand in rural areas challenges traditional public transportation. To address this, the government has introduced demand-responsive services with flexible routing and begun using passenger transport resources for freight to boost revenue. This study proposes an integrated passenger-freight transport model using configurable vehicles to improve efficiency and reduce costs. By adjusting passenger-freight configurations and minimizing reconfiguration inconvenience, this approach leverages freight revenue to enhance rural transport operations. Case studies show that this model improves efficiency and decreases operational costs compared to separate transport methods.

Nishtha Rawat and *Amit Agarwal*

Integration of Dimensionality Reduction and Metaheuristic Optimization for Spatiotemporal Clustering

ABSTRACT. Given the spatiotemporal nature of passenger occupancy at stops in a transit network, the present study develops a clustering framework for spatiotemporal data. The proposed framework integrates a dimensionality reduction technique with different clustering methods while using metaheuristic optimization of multiple hyperparameters. For the former, Uniform Manifold

Approximation and Projection (UMAP) isused, whereas for optimization, Whale Optimization Algorithm (WOA) is employed, considering Moran'I as an objective function. As a real-world application, electronic ticketing machine (ETM) data for 7 months from Bhopal, India, is used. It is demonstrated that UMAP with WOA and Affinity propagation provided the highest performance while considering the spatiotemporal variability in the data.

Shih-Hung Yang and *Tzu-Chang Lee*

Exploring the Impact of Urban Greenness and Shading Levels on Cycling Routes by Using Street View Imagery Data

ABSTRACT. Bike-Sharing System is one of the most used transport modes in urban areas. This study examines the impact of urban greenery and shading of cycling routes using Street View imagery data from the smart card data of 367 YouBike stations in Taipei. Utilizing Geographically Weighted Regression and the transformed gravity model by using Markov Chain Monte Carlo, the findings show that street-view elements exert varying influences under different urban structures, urban greenness in suburban areas, and shading levels in urban areas may enhance the cycling environment for bike-sharing usage. These insights can guide in designing green transport to encourage cycling.

William Andersson, *Florian Fuchs*, *Zahra Ansarilari* and *Francesco Corman*

Stochastic Transit Network Design

ABSTRACT. Most transit network design studies overlook demand variations. We propose a two-stage stochastic model that accounts for stochastic demand, minimizing passenger travel time---including access, egress, in-vehicle, and transfer times---and operating costs. The model designs distinct networks for varying weather and peak/off-peak conditions, maintaining consistent line configurations while adapting frequencies. Using MATSim data for a Zurich subnetwork with 28,000 transit passengers, our results show the stochastic model outperforms the deterministic model in reliability and serving higher demand. Compared to the robust model, the stochastic model achieves similar performance in serving high demand but with lower passenger and operating costs.

Xiaokuan Zhao, *Weihua Gu*, *Zhicheng Jin*, *Jie Ma* and *Chi Xie*

Energy Consumption Evaluation of Electric Buses and Hydrogen Buses Using Real Data

ABSTRACT. Accurate energy consumption evaluation of zero-emission buses (electric and hydrogen buses) benefits operational optimization and decision-making. This study collected data from 710 trips of double-deck electric buses (DDEBs) and double-deck hydrogen buses (DDHBs) in Hong Kong. Features were extracted across six aspects: route, bus status, environment, traffic, driver, and driving behavior. Four distinct machine learning models were employed to predict energy consumption. The results show prediction errors of 5.745% for DDEBs and 7.173% for DDHBs. Ambient temperature and congestion index exhibited a significant positive correlation with energy consumption for both bus types. Additionally, the initial state of charge (SoC) of the supplementary battery onboard DDHBs was found to have a notable impact. Ensuring sufficient battery charge before each trip can reduce energy consumption in DDHBs.

Kartikyan, *Pramesh Kumar* and *Karthik K. Srinivasan*

Joint Optimization of Transit Service Frequency and Fare with Passenger Assignment

ABSTRACT. This paper addresses the challenge of jointly optimizing transit service frequency and fare in urban public transportation systems with elastic demand. We propose a mathematical model that maximizes social welfare while accounting for the strategic behavior of passengers within the network. It also incorporates constraints related to operational resources, passenger flow, and vehicle capacity. A branch-and-cut algorithm with outer approximation-based cuts is proposed to solve the problem. Numerical results are presented for a small case study. The presented model will help transit agencies maximize their profit without compromising transit user satisfaction.

Yung-Hsiang Cheng and *Ying-Chieh Kuo*

Uncertainty on Users' Behavior Intention: Evidence from Electric Moped Scooter Sharing

ABSTRACT. Electric moped scooter sharing (EMSS) has emerged as a key solution to the first-last mile problem in public transportation, experiencing substantial growth recently. However, passengers encounter risks due to inherent uncertainties during their travels, primarily related to potential service unavailability, such as a lack of nearby scooters or available parking spaces. Many prior studies have overlooked these uncertainties, leading to overly optimistic evaluations of shared mobility's potential, and research specifically focusing on EMSS remains limited. This study investigates the impact of uncertainty on the intention to use EMSS. A hybrid choice model (HCM) is utilized to integrate latent variables within a discrete choice framework, enabling the simultaneous consideration of both tangible and intangible attributes from the passenger's perspective. Using survey data from Taiwan's metropolitan areas, we propose a mixed logit model for variable analysis alongside a behavioral reasoning theory model to assess latent factors. Our findings indicate that the "probability of finding a parking space" significantly influences mode choice utility. Additionally, perceived risks, including scarcity and functional risks, negatively impact EMSS usage. The managerial implications derived from this study are expected to enhance the understanding of influential factors for system operators and city governments regarding EMSS utilization.

Diana Quintanar and *Omar Ibarra*

Integrated Timetabling and Vehicle Scheduling and Electric Fleet Procurement for a Sustainable Transit System

ABSTRACT. This study presents a multi-objective optimization model addressing three key problems: timetable design to enhance service regularity (social objective), vehicle scheduling to minimize operational costs (economic objective), and electric vehicle acquisition to maximize electrified kilometers (ecological objective). Based on mixed-integer linear programming and the epsilon constraint technique, the model explores trade-offs between objectives and approximates the Pareto front. Results demonstrate its utility in understanding the impact of electric bus adoption on public transport systems. Future work focuses on larger instances, efficient solution methods, and incorporating factors like battery lifecycle and seasonal operating conditions.

Luis A. Guzman, *Santiago Gomez*, *Olga Lucía Sarmiento* and *Carlos Moncada*

Boosting Welfare for the Poor: the Role of Public Transport Subsidies

ABSTRACT. This paper investigates the effectiveness of a novel way of delivering public transport subsidies in Bogota, Colombia. A randomized controlled trial with 1,607 participants assessed the impact of subsidies in the form of vouchers on travel behavior and user welfare. Results show that vouchers significantly increased the utility of public transport, leading to increased BRT usage, decreased regular bus usage, and reduced travel times. Notably, female participants and those making non-work trips experienced the greatest welfare gains. These findings suggest that voucher-based subsidies can effectively improve public transport usage and user welfare, particularly for vulnerable groups.

Satoshi Sugiura, *Fumitaka Kurauchi*, *Kam-Fung Cheung*, *Michael Bell* and *D. Glenn Geers*

Bus Lane Design Problem with Steiner Trees and Road Congestion

ABSTRACT. This paper aims to design a network of bus lanes connecting the key bus stops (bus interchanges) to minimize traffic impact. A Steiner tree of bus lanes would be one that gives maximum benefits to bus passengers (the minimal passenger-km Steiner tree) while minimizing the impact on individual traffic (the minimal additional vehicle hours). This problem is formulated as a bi-level programming with the user equilibrium (UE) condition of individual traffic as a constraint. We provide a new sensitivity analysis method that assumes bush-based UE assignment for this problem, which has a vast solution space, and propose an efficient method to obtain an exact solution.

Ziyi Qin, *Daisuke Fukuda* and *Mayo Mieno*

Explore the Impact of Green Slow Mobility Introduction: a Social Capital Perspective

ABSTRACT. This study explores the social effect of a new type of public transport in Japan known as Green Slow Mobility (GSM). Using structural equation modeling, we examine how the introduction of GSM influences the development of social capital. Results show that a positive impression of GSM, interest in GSM activities, and GSM usage significantly contribute to social capital building. The findings highlight GSM's symbolic value and operational influence, offering valuable insights for regional transport policy fostering social inclusion.

Oriol Marquet, *Monika Maciejewska* and *Oriol Roig-Costa*

Intermodality, Disrupted: Evaluating the Impacts of Banning E-Scooters on Public Transport Use in Barcelona

ABSTRACT. This study investigates the effects of a 2023 policy banning privately-owned e-scooters on public transport in Barcelona. Prior to the ban, e-scooters served as critical connectors to transit, particularly for intermunicipal commuters with limited mobility alternatives. A two-wave longitudinal survey (n=311 pre-ban, n=111 post-ban) revealed that 73% of trips were intermodal. The ban disrupted these routines, disproportionately affecting women and lower-income users who lacked viable substitutes. Many users adapted by walking more or relying solely on public transport, but these strategies often increased travel time and reduced satisfaction. Some shifted to full e-scooter or car use, experiencing improved travel times but disengaging from public transport. The most significant declines

were emotional: stress and frustration increased, and overall satisfaction dropped, especially among users with strong ties to e-scooter commuting. Anticipated responses to the ban frequently diverged from actual behavior, highlighting unpredictable adaptation dynamics. The findings underscore the risks of restrictive micromobility policies, which can exacerbate existing inequalities and undermine intermodal transport goals. Policymakers should consider flexible alternatives, such as partial access windows or designated transfer hubs, to maintain equitable connectivity. This case emphasizes the need for inclusive, evidence-based regulation that preserves both safety and mobility integration.

Vikram Singh and *Amit Agarwal*

Monitoring Air Pollution Exposure of Public Bus Drivers in Delhi

ABSTRACT. Bus drivers are among the occupational groups most exposed to air pollution due to long driving hours. This study aims to assess the exposure risk for drivers of non-Air Conditioning (AC) buses in Delhi using continuous mobile monitoring. To comprehend the objectives, PM2.5 concentrations were measured for 30 bus drivers in 15 buses (morning and evening shifts) using low-cost air quality devices over eight months. The results demonstrate substantial temporal and spatial heterogeneity in PM2.5 concentrations for bus drivers during both shifts. The cumulative inhalation dose is found to be very high for all bus drivers, indicating a higher risk of exposure. The findings indicate that bus drivers face a very high exposure risk while driving, necessitating immediate attention to mitigate it. Various policies aimed at lowering exposure risk values are formulated, and proposed policies can offer drivers practical guidelines for reducing health risks associated with PM2.5 concentrations.

Rashmi Choudhary and *Amit Agarwal*

Shift from Private Mode to Public Transit with Provision of Air Pollution Information

ABSTRACT. Rapid motorization and urbanization have significantly increased air pollution exposure of urban residents. The present study explores integration of real-time air pollution data into choice modeling which helps in identifying pollution levels that prompt changes in travel behavior. Data collection is conducted through a face-to-face questionnaire survey using the TSaaS portal, and a total of 471 responses are retained after data preprocessing. The survey collects data on trip and socio-demographic characteristics, and users' mode preferences for their current mode and public transit alternatives, considering real-time exposure and travel time information. The study examines the impact of travel time, cost, waiting time, and pollution exposure on mode choice between private and public transit for Delhi city. A nested logit model is developed, grouping buses and metro under the public transit nest. The findings indicate that increased travel time and degrading air quality negatively affect mode choice. These insights can assist policymakers and transport planners in enhancing public transit and encouraging adoption of sustainable travel modes.

Leena Ahmed, *Matthias Ehrgott*, *Judith Y. T. Wang* and *Ahmed Kheiri*

Walking School Bus Planning – PART I: Multi-Objective Routing Optimisation with Open Source Data

ABSTRACT. Walking School Bus (WSB) promotes Active School Traveling (AST) while reducing

congestion and pollution around schools caused by parental chauffeuring. We introduce a framework to generate WSB walking networks from public data and perform multi-objective routing optimisation to support efficient route planning. Our approach ensures optimal routes that balance multiple criteria and meet the needs of both parents and children. By automating network extraction and optimisation, our tool maximises the effectiveness of WSB programs, making them more practical and beneficial for communities.

P1B: Passenger Behavior

R.C.P. Wong, *W. L.Y. Wan*, *W.Y. Szeto* and *Nazam Ali*

Revolutionizing Elderly Mobility Through Autonomous Demand-Responsive Transport Services

ABSTRACT. The ageing population presents a global demographic challenge, as the elderly mobility declines rapidly due to their unstable income and limited physical and cognitive abilities. Autonomous demand-responsive transport emerges as a potential solution to cater to their specific transport needs. In order to comprehend their acceptance and adoption of autonomous demand-responsive transport, a stated preference survey was conducted, interviewing 232 elderly individuals aged 60 or above. The design of choice experiments was pivoted with respect to revealed trips from the surveyed elderly to simulate realistic choice scenarios. Using the collected data, logistic regression models were developed to identify contributory factors influencing their mode choice selections between their currently chosen alternative and the new transport mode. The model results indicate that travel fare, walk time, on-street wait time, in-vehicle travel time, seat availability, and the provision of on-board staff are the significant attributes. An unobserved heterogeneity among the elderly is identified in the provision of on-board staff. About 35% of them hold a negative perception of this arrangement, and preferred a fully autonomous service, while others prefer having an on-board supervisor for safety concerns. The study highlights that the elderly are hesitant to shift to autonomous demand-responsive transport due to their concerns about autonomous driving and digital proficiency.

Jan Lordieck and *Francesco Corman*

How Much Do They Know? Timetable Awareness and Waiting Time of Public Transport Passengers

ABSTRACT. Initial waiting time at stations contributes to passengers' generalized travel time. Timetable awareness is its most influential factor. This study reports from a survey in Zurich, Switzerland about timetable awareness for different headways, age groups and times of day. We link the surveyed share of timetable awareness with the estimated share of randomly arriving passengers, based on passenger arrival distributions from the literature. In our case study, estimated shares of randomly arriving passengers differ from the share of timetable aware passengers. We discuss the possibility that timetable independent passengers do not arrive perfectly randomly but also time their arrivals at least sparsely.

Christopher Tacker-Mischenko, *Cheok Kit Lei*, *Yu-Ting Hsu* and *Yung-Cheng Lai*

Exploring Passenger Backtracking Behavior in Taipei Metro Using Smart Card Transaction Data

ABSTRACT. Travelers are often assumed to be rational actors who aim to minimize their travel time and

fare costs. Some travelers may backtrack to their respective terminal stations before heading toward their destinations in order to attain comfort (higher chance of getting a seat). However, backtracking has not yet been explicitly considered for the utility of passenger comfort at the expense of longer travel time and potentially higher fare. An algorithm has been developed to capture this backtracking behavior from Smart Card transaction data and used to train a binary logit model, attempting to identify variables that significantly influence travelers' decisions to backtrack.

Mio Hosoe and *Masashi Kuwano*

Change in Bus Route Search Trends Before and During Covid-19 Pandemic

ABSTRACT. This study examines the decision-making process behind planning outings, specifically focusing on the timing and origin of travel choices. It also investigates the impact of the COVID-19 pandemic on the number of route searches and assesses the recovery of bus routes post-pandemic. Furthermore, the study analyzes the correlation between population distribution, facility locations, and the characteristics of bus routes to determine which routes have successfully recovered from the effects of COVID-19. The results indicate that many routes have recovered or are expected to recover. Route searches for these routes may be related to business and leisure travel.

Patricio Miño, *Sebastián Raveau* and *Delgado Felipe*

Mode Choice Behaviour for Public Transport Airport Ground Egress

ABSTRACT. The rise in air traffic demand necessitates sustainable and efficient airport connectivity. This study analyses the modal choices of passengers and workers at Santiago de Chile's airport, focusing on the impact of the new bus service (line 555) launched in 2023. Based on a revealed preferences survey, the proposed Mixed Logit model revealed key factors influencing choices, including cost, income, luggage, and travel purpose. Results highlight challenges with line 555, such as its indirect connection to terminals and low user awareness. These findings underline the need for improved connectivity to enhance airport accessibility and support sustainable urban development.

Jaeyeong Lee, *Hyunseung Kim* and *Minsu Won*

An Algorithm for Extracting Access Trips at Railway Stations from Mobility Data and Analyzing Travel Patterns

ABSTRACT. Accessibility is a key factor influencing railway demand, and improving access trip quality could increase ridership. However, there is no practical way to accurately determine where and how people travel to stations. As a result, access trips are often assumed to be uniformly distributed with identical speeds and travel patterns. Variables such as access time and speed are also applied as fixed values in mode choice models, leading to errors in railway demand forecasts and potential failure in preliminary feasibility studies.

To address this, we propose an algorithm that defines access trips and analyzes regional travel patterns using empirical mobility data instead of survey-based data. We calculated the rate of change in traffic volume from mobility data to define access boundaries and applied the DBSCAN clustering algorithm to group similar access trips.

A case study at Osong Station in South Korea was conducted to validate the algorithm. The results showed that while some areas had well-distributed public transport services, others had coverage concentrated in limited zones. In one region, travel times exceeded 70 minutes, yet Osong Station was still used, suggesting a need for more stop routes. These findings highlight the effectiveness of the proposed algorithm in identifying access trip characteristics from real-world mobility data.

Wei-Lun Tsai and *Ching-Fu Chen*

Investigating the Heterogeneity of MaaS Adoption Intention: Evidence from Taiwan

ABSTRACT. Mobility as a Service (MaaS) offers a promising solution to urban transportation challenges by encouraging public transport use. In Taiwan, the Public Transport Pass (TPASS) serves as a simplified MaaS model. This study analyzes data from 498 non-users through latent profile analysis, identifying four user profiles: flexible multimodal commuters, economy-oriented commuters, private transport enthusiasts, and sustainable transport supporters. Findings indicate that psychological factors, such as perceived economic benefits and habitual behavior, significantly influence TPASS adoption, highlighting the need for targeted strategies to promote its uptake and foster sustainable travel behaviors.

Santiago Cardona, *Jaime Soza-Parra*, *Sebastián Raveau* and *Dick Ettema*

The Role of Transport Exclusion and Aerial Cable Cars in Shaping Commuting Choices in Steep Cities

ABSTRACT. This paper examines the determinants of commuting modal choice by focusing on aerial cable car (ACC) users and transport-related social exclusion (TRSE) factors. The case study is set in Manizales (Colombia), a medium-sized city known for pioneering ACC as a transit mode. Manizales is characterised by steep topography and housing development in hilly terrain, making it a unique context for studying ACC's impact on mobility. Data was collected through a questionnaire survey conducted in two phases, and responses were analysed using discrete choice models and exploratory factor analysis. We estimated an MNL model with time and cost parameters, which will be the initial step in employing a hybrid choice model, including TRSE latent variables, to better understand modal choice behaviours.

Marianthi Kallidoni, *Jesper Bláfoss Ingvardson* and *Otto Anker Nielsen*

Public Transport Passenger Perceptions: Analysing Train Station Attributes in Denmark

ABSTRACT. This study examines the influence of physical facilities and station surroundings on public transport attractiveness. Using an online survey (N = 4,801) on train stations within Denmark, we identified three factors: "Cleanliness & Maintenance," "Crowding & Environment," and "Safety & Urban Life." Newer transport modes, like light rail and metro, scored higher in cleanliness but were more isolated with less lighting and urban life. Conversely, S-train stations in Copenhagen's suburbs scored low across all factors, highlighting significant challenges. These findings align with previous studies suggesting that aesthetically pleasing and well-maintained stations positively influence passengers' perceptions.

Aditya Pitale, *Shubhajit Sadhukhan* and *Manoranjan Parida*

Impact of Proposed Regional Rapid Transit System on Intercity Travel Mode Share

ABSTRACT. Introduction of a new transit system influences the travel choice of commuters. This paper assesses changes in intercity travel mode share in the case of the proposed regional rapid transit system (RRTS), National Capital Region (NCR), India. A stated choice experiment of Meerut – Delhi commuters analyzed using the random parameter logit (RPL) model. The findings reveal RRTS as the preferred alternative for intercity travel. Increase in RRTS mode share was significantly linked to improvement in comfort during travel. It is also observed that the qualitative attributes like comfort and safety have a significant impact on mode choice of commuters. Further, the sensitivity analysis performed considering five different scenarios also indicated a major shift in the travel choice of commuters with change in comfort during travel. These results suggest that transportation planners should prioritize enhancing qualitative aspects to attract commuters and boost adoption of new transportation modes.

Matthew Liu, *Kari Watkins* and *Susan Cayar*

Rural Microtransit Service to Replace Fixed Route Service: a California Case Study

ABSTRACT. This study aims to identify who rides rural microtransit and how changes in travel behaviour due to microtransit vary between rural and non-rural riders through a case study evaluation of the Yolobus BeeLine, based in Yolo County, California. Through the conducting of ride-along interviews and surveys with riders of the BeeLine, we find that rural microtransit provides vulnerable populations, such as women, those without drivers' licenses, and those with physical or similar limitations, means to complete trips that they would not take otherwise. Both rural and non-rural riders decreased use of other modes of travel, especially taxi/ride-hailing services, because of the microtransit service. However, rural riders tended to use the microtransit service more frequently. While riders indicated that the availability and waiting times for the service could be unreliable, most riders still viewed the BeeLine positively, indicating that microtransit services like the BeeLine provide a valuable mobility option to rural transit riders.

Shu-Wei Liang, *Chin-Shan Lu* and *K.I. Wong*

Passengers' Perceptions of the Acceptance of Autonomous Ferry

ABSTRACT. Stemming from the Extended Unified Theory of Acceptance and Use of Technology (UTAUT2), we develop a model to explain the effects of passenger's service expectancy, innovative traits, safety concerns, entertainment, environmental perception, and facilitating factors on their acceptance of autonomous ferry. We analyze the survey data from 594 passengers using the ferry routes between Cijin Island and Kaohsiung City in Taiwan. Preliminary results indicate that passengers' safety concern, facilitating factors, innovative traits, entertainment, and entertainment significantly influence their use intention of autonomous ferries. The influence of service expectancy on the use intention of autonomous ferries was supported in this study.

Oren Nahum, *Avishai Ceder* and *Neema Nassir*

User-Centric Transfer Attributes for Path Selection and Bottleneck Detection in Public Transport Network

ABSTRACT. This study develops analytical tools aimed at enhancing public transport (PT) transfers to improve efficiency, comfort, and safety. Building on Hadas and Ranjitkar (2012), and on Hadas and Ceder (2010), it emphasizes the significance of transfer quality over route selection for users. Recognizing the anticipated increase in transfers driven by services similar to the London Tube, this research identifies critical transfer attributes that users find intolerable and proposes optimal locations for transfer points requiring the most significant improvements. Utilizing optimization models, the study allows passengers to select routes tailored to their preferences while minimizing transfer-related costs. A toy example illustrates the application of network-flow models to detect bottlenecks and optimize route selection, fostering a user-centric PT experience.

Kejun Du, *Enoch Lee*, *Qiru Ma* and *Hong Lo*

Identification, Categorization and Rationalization of Metro Passenger Rerouting Choices Under Metro Disruptions

ABSTRACT. This study proposes a framework to identify affected regular commuters and categorize their rerouting choices during a Hong Kong MTR system disruption. It analyzes AFC data before, during, and after the disruption to reflect actual passenger rerouting behaviors. Multi-modal routing information is aggregated from various third-party platforms. Finally, the study examines affected passengers' rerouting choices based on alternative routes' attributes, rationalizes patterns, and provides insights for metro system operators to prepare for future disruptions.

Monika Maciejewska

The Real Cost of Women's Daily Mobility in the Context of Public Transport Scarcity in Cuba

ABSTRACT. Daily mobility in Santiago de Cuba relies heavily on public transport (PT) and walking, making it a low -carbon urban transport system. However, material scarcity, caused by long -standing US-imposed embargos, oil shortages, and the COVID-19 pandemic, has severely reduced PT services. This study explores how transport scarcity impacts women's mobility and daily lives, focusing on travel behaviour, experiences, coping strategies, and social roles. Women, balancing work and caregiving, face heightened stress, r educed sleep, and significant time and financial burdens. Challenges include unreliable PT, overcrowding, and physical discomfort, with mutual support among passengers partially mitigating these difficulties.

Xin Chen, *Ying Lu* and *Mark Hickman*

Investigating Customers' Inertial and Variety-Seeking Tendencies in Bundle Choices in a Mobility as a Service (Maas) Trial

ABSTRACT. This study examines customers' longitudinal MaaS bundle choices during Semester 1, 2023, using data from the University of Queensland Mobility as a Service trial. Analysing 709 student panels, a latent class choice model identifies two customer classes. Specifically, Class 1 shows strong

inertial effects for 30-day public transport-only (PT30) bundles, while Class 2 exhibits similar tendencies for 7-day public transport-only (PT7) bundles. Furthermore, both classes also demonstrate the existence of some variety-seeking behaviours in multi-modal bundle choices. These findings reveal heterogeneous roles of individuals' past choices in shaping their bundle preferences, offering valuable insights for MaaS operations.

Achille Fonzone and *Lucy Downey*

Likelihood of Choosing Automated Buses: a Discrete Choice Experiment

ABSTRACT. A Discrete Choice Experiments (DCE) was designed to explore consumer preferences for different transportation modes (car, robo-taxi, bus or bicycle) and their willingness to pay (WTP) for attributes including travel time, staff presence and role, automated driving capabilities, electric vehicles, and on-demand services. The analysis, based on 14,190 responses from 2,004 participants, revealed that the presence of a human driver significantly increased the likelihood of choosing the bus over alternative modes, while remote supervision did not significantly increase bus choice compared to situations without staff. Providing electric buses significantly increased the proportion of individuals choosing to travel by bus.

Hanghun Jo and *Sungtaek Choi*

What Drives Public Transport Satisfaction? Comparing Metropolitan and Provincial Areas

ABSTRACT. This study investigates regional disparities in public transport satisfaction by comparing the Seoul metropolitan area and provincial regions in South Korea. Drawing on data from a large-scale national satisfaction survey (n = 82,000), we employ a Structural Equation Modeling framework using the Multiple Indicators and Multiple Causes (SEM-MIMIC) approach to identify key service attributes affecting satisfaction. To guide service enhancement strategies, we further apply Importance-Performance Analysis (IPA), mapping perceived performance against its influence on satisfaction. Results reveal region-specific determinants: in the Seoul metropolitan area, congestion reduction and accessibility are the most influential, while in provincial areas, service frequency (headways) and fare affordability are more critical. The IPA results reinforce these findings, highlighting congestion and user environment as top improvement priorities in metropolitan areas, as well as accessibility and comfort in provincial regions. These findings emphasize the necessity of region-tailored transport policies that account for spatial differences in service needs and user expectations. By addressing these regional disparities, public transport providers can more effectively promote modal shift, enhance user satisfaction, and support sustainable urban mobility in high-density and low-density contexts.

Howard Wong, *Sophie Levi-Kallin*, *David Arquati* and *Joseph Fenwick*

Segmenting the Activity Frequency and Regularity to Study Public Transport Usage

ABSTRACT. To support the investigation of the mobility behavioural pattern by different traveller groups, we propose a framework that segments the activities from public transport (PT) smartcards by their regularity and frequency. It uses the activity start time, duration and location to assess the spatiotemporal regularity. Utilising data from London, we demonstrate that this framework works for

infrequent and frequent users and activities, and that regularity can be aggregated to card and location levels. The insights can assist operators and planners to optimise staffing, service planning and marketing, and inform the analysis of home-working, night working patterns and night-time activity locations.

P2A: Emerging Mobility

Prawira Fajarindra Belgiawan, *Cintia Nurliyana*, *Indira Ayu Adzhani*, *Meldi Romadhani*, *I Gusti Ayu Andani*, *Muhammad Fakhrul Rozi Ashadi*, *Hasbian Fauzy Perdhana*, *Henndy Ginting* and *Mustika Sufiati Purwanegara*

User Preferences and Attitudes Toward Urban Air Mobility as a Feeder for High-Speed Rail

ABSTRACT. The Jakarta-Bandung High-Speed Rail (HSR) represents Indonesia's first high-speed rail, significantly reducing travel time between Jakarta and Bandung by over 50%. However, transportation options from the HSR terminus to Bandung city centre remain limited and time-consuming, creating a critical last-mile connectivity gap. This presents an opportunity for innovative transit solutions like Urban Air Mobility (UAM) to complete the journey. This study investigates user preferences and attitudes toward UAM as a feeder mode for the Jakarta-Bandung high speed rail station to Bandung city center. Using a stated choice experiment and PLS-SEM analysis, key determinants of UAM adoption were identified, including travel cost, travel time, attitude, performance expectancy, perceived safety, and social influence. While feeder trains and ride-hailing services remain preferred, UAM shows potential if cost and time efficiencies improve. Findings highlight the importance of leveraging social norms and enhancing perceptions of convenience and value, providing actionable insights for policymakers in advancing sustainable urban mobility solutions.

Watetu Mbugua, *Dorine Duives*, *Jan Anne Annema* and *Niels van Oort*

Integrated Bike-Sharing Systems and Public Transport: Societal Costs and Benefits

ABSTRACT. Integrating bike-sharing programs with public transport enhances accessibility and car-independent mobility, yet a comprehensive societal cost-benefit analysis of this integration remains scarce. This study addresses this gap by conducting an ex-durante analysis of the OV-fiets program in the Netherlands, a station-based round-trip bike-sharing system designed to improve last-mile connectivity for train commuters. The analysis reveals that, on average, with a balanced view of costs and benefits, the net present value (NPV) of the OV-fiets scheme is positive, with a benefit-cost ratio (BCR) of 1.5. Primary benefits include enhanced accessibility, reduced road congestion, and improved health outcomes.

Fatemeh Torabi Kachousangi, *Yashar Araghi*, *Niels van Oort*, *Sascha Hoogendoorn-Lanser* and *Serge Hoogendoorn*

Examining Shared Mobility Adoption in Two Settings: Insights in User Preferences for First/ Last Mile Connections and Urban Trips

ABSTRACT. Abstract: This study examines shared mobility preferences focusing on two distinct settings: a train station, where shared mobility serves as an access and egress mode for train commuters, and an inner city, where local mobility hubs provide shared modes as main travel options for residents

travelling within and beyond the city centre. The city of Delft in the Netherlands is used as a case study. Findings reveal that younger users prefer cost-effective shared bicycles and e-scooters as access/egress modes for short distances, while older adults and families favour shared bicycles and cars as main modes for longer trips. Insights support tailored mobility policies to reduce car dependency and enhance accessibility.

Nejc Geržinič, *Mark van Hagen*, *Hussein Al-Tamimi*, *Dorine Duives* and *Niels van Oort*

Shared Micromobility: the Last Mile Solution for Train Stations?

ABSTRACT. Access/egress travel to train stations continues to pose a significant barrier to increasing the number of train travellers. Shared micromobility (SMM), including bicycles, e-bikes, steps and mopeds, is often cited as a prominent solution, especially for the activity-end of the trip chain. Using a stated preference survey, we analyse activity-end mode-choice preferences for SMM, walking and public transport (PT) among the Dutch population. By means of a latent class choice model, we uncover three user groups with respect to activity-end mode choice behaviour, namely the Multimodal sharing enthusiast (58%), Sharing hesitant cyclists (16%) and Sharing-averse PT users (27%). The three classes differ in their modal preferences, travel time valuation, as well as in their willingness and ability to use SMM. All three exhibit a high preference to walk for short egress distances, reaffirming the need for transit-oriented development policies. For longer egress distances, PT should be the primary focus at stations in high-density areas with high demand, where high frequencies and dense networks are justified, while stations in lower demand areas are better served by SMM. Providing multiple SMM options would result mainly in competition for the same travellers.

Zhuowei Wang, *Jiangbo Yu*, *An Wang*, *Yiyang Peng*, *Hongxing Yang* and *Anthony Chen*

Lifecycle Economic Feasibility of Zero-Emission Buses in Hong Kong: a System Dynamics Approach

ABSTRACT. Hydrogen buses (H-buses) and battery electric buses (E-buses) are viable zero-emission bus (ZEB) options for achieving carbon neutrality. In Hong Kong, where bus companies are profit-driven and do not rely on subsidies, economic considerations are crucial. The choice between ZEB types depends not only on costs in the vehicle-usage stage such as purchase, fuel, and maintenance, but also on upstream energy supply chain costs, including fuel sources and facility development. The choice of ZEB can, in turn, influence market conditions, affecting costs through economies of scale and infrastructure decisions over the long term. The H-bus market, in particular, may significantly impact upstream energy facility decisions, serving as a potential catalyst for a hydrogen economy in Hong Kong. To address these complexities and long-term interactions, this paper uses a system dynamics (SD) approach for a lifecycle economic assessment from a fuel-cycle perspective. It incorporates three feedback loops—H-bus facility, E-bus facility, and the ZEB market—enhancing traditional lifecycle cost (LCC) assessments by integrating dynamic feedback mechanisms. The findings aim to inform LCC assessments of Hong Kong's ZEB market and offer insights for developing tailored LCC frameworks and modeling feedback decisions in broader contexts.

Muchlis Muchlisin, *Jaime Soza-Parra* and *Dick Ettema*

Who Are the Happiest Ride-Hailing Riders? Exploring Determinants of Ride-Hailing Travel Satisfaction Across Income Levels in Yogyakarta, Indonesia

ABSTRACT. This study examines the determinants of ride-hailing travel satisfaction across income groups, including those living in poverty, using survey data from Yogyakarta, Indonesia. Employing a structural equation model (SEM), the results reveal that income levels significantly influence satisfaction. Individuals in poverty report higher satisfaction, as ride-hailing facilitates their mobility needs. Key factors like perceived ease and safety positively impact satisfaction, with motorcycle-based ride-hailing (RH MC) playing a crucial role. These findings provide insights into how ride-hailing services can improve mobility for diverse income groups. Policy recommendations are proposed to enhance travel satisfaction and mobility equity, addressing study limitations.

Chung Cheng Lu, *Yu Shyun Chien*, *Lei Jie Wang* and *Yu Kai Huang*

An Electric Bus Scheduling Problem for a Mixed Fleet of Electric and Diesel Buses

ABSTRACT. Electric buses play a critical role in advancing urban green transportation. However, a transition period remains before the full conversion to electric buses is achieved. During this period, it is essential to address the scheduling challenges associated with operating a mixed bus fleet of electric and diesel buses. This study considers the scheduling problem for mixed bus fleets using a time-space network modeling approach. To evaluate the proposed model, test instances of varying sizes are generated based on real-world data. The findings provide practical insights and serve as a reference for bus companies managing mixed fleets in their scheduling operations.

Wenxiang Li, *Xingguang Zhang* and *Weiwei Liu*

Collaborative Prediction of Bike-Sharing Demand Around Subway Stations Based on Deep Spatio-Temporal Neural Networks

ABSTRACT. Bike-sharing has emerged as a crucial first- and last-mile solution in urban mobility, particularly around subway stations where multimodal connectivity is essential. Accurate demand forecasting and intelligent dispatching of shared bikes in these areas present significant challenges due to complex spatial-temporal dependencies. To address this issue, this study proposes a collaborative prediction model—CoGLSTM—for bike-sharing demand, considering its spatiotemporal dependence on subway travel demand. Specifically, metro passenger flow, bike-sharing trip orders, and built environment data are fused to analyze usage patterns of bike-sharing around metro stations. A Graph Convolutional Network (GCN) is employed to model spatial heterogeneity among stations, while a Long Short-Term Memory (LSTM) network captures temporal evolution. Experimental results based on real-world data from multiple bike-sharing platforms in Shanghai show that the proposed CoGLSTM model substantially outperforms baseline approaches in short-term demand prediction. The model offers robust support for dynamic shared bike redistribution and operational optimization in urban transportation systems.

Cheng Zhang, *Min-Ci Sun* and *Luca Quadrifoglio*

A Peer-to-Peer Ridesharing Model Incorporating Value of Time

ABSTRACT. In metropolitan areas, low vehicle occupancy rates exacerbate traffic congestion, fuel consumption, and greenhouse gas emissions. To address these challenges, this study proposes a peer-to-peer (P2P) ridesharing model without predetermined drivers. The model enhances matching efficiency through a set-packing formulation and column generation (CG) with a clique-based method to form multi-passenger groups, aiming for maximum cost savings. It incorporates constraints including maximum waiting time and detour distance to improve user experience. Importantly, the model integrates the value of time (VoT) to reflect participants' dissatisfaction with extra travel time. Validated with Chicago taxi data, the model shows a network effect: higher participation improves matching rates, and increases cost and distance savings. Sensitivity analysis reveals that VoT has a more significant impact in low-fare scenarios, especially with low distance rates. For example, under a $0 base fare and $0.10/km distance rate, increasing VoT from $0/minute to $1/minute reduces cost savings by 20% and lowers average occupancy from 2 to 1.5 passengers per vehicle kilometer. These results emphasize the necessity of incorporating VoT in ridesharing models for practicality and user satisfaction. The proposed model is a scalable and policy-relevant solution to increase vehicle occupancy, reduce travel distances, and promote sustainable urban transportation.

Nidhi Kathait and *Amit Agarwal*

Comparative Service Quality Evaluation of Bicycle-Sharing and E-Bike Sharing System: a Case Study of Delhi, India

ABSTRACT. Shared micro-mobility services have attracted attention worldwide as a smart, sustainable, affordable, and active transportation option. This study focuses on assessing the service quality of bicycle-sharing and e-bike-sharing systems in the National Capital Territory (NCT) of Delhi, India, employing the Relative to an Identified Distribution Integral Transformation (RIDIT) method to analyze and compare user satisfaction. Users of bicycle-sharing systems value these services for being cost-effective, promoting physical well-being, and benefitting the environment, whereas those who opt for shared e-bikes emphasize the convenience of e-bikes and the ability to improve first or last-mile connectivity. The evaluation pinpoints specific strengths and weaknesses across both shared micro-mobility modes, offering crucial recommendations for operators and policymakers to meet user needs better, address service gaps, and encourage frequent usage as well as adoption. The findings underline the role of shared micro-mobility in advancing sustainable urban mobility, especially within the context of developing economies.

Vahed Barzegari Bafghi and *Mehdi Nourinejad*

Comprehensive Optimization of Charging Infrastructure Placement and Scheduling for Electric Buses Under Dynamic Electricity Pricing

ABSTRACT. Electrifying urban buses is a global initiative toward achieving sustainable transportation. This paper advances the field of bus electrification by presenting an integrated optimization model that simultaneously addresses charging infrastructure placement, battery type selection, and charging

scheduling. Additionally, we incorporate the impact of time-of-day electricity pricing, enabling a realistic assessment of charging costs under varying energy rates. We analyze General Transit Feed Specification (GTFS) data from Detroit transit agency to evaluate the effectiveness of the model and derive actionable insights.

Junhyeon Kweon and *Sugie Lee*

Dynamic Interactions Between E-Scooters and Subway: Focusing on First-Mile and Last-Mile Trips in Seoul, Korea

ABSTRACT. E-scooters represent a personal micro-mobility solution that enhances sustainable transportation and improves urban mobility. They have the potential to complement public transit and promote mobility equity within cities. This study examines the extent to which e-scooters facilitate connectivity with the subway system in Seoul. Specifically, we identify mobility zones for e-scooter trips that start or end within 100 meters of a subway station and propose a methodology for comparing first-mile and last-mile impacts. Ultimately, this research aims to establish a framework for integrating various transport modes and advancing the concept of Mobility as a Service (MaaS) in the future.

Chaione Kim and *Junghwa Kim*

Integrating Shared Autonomous Vehicles into Public Transit: Optimizing Pick-up and Drop-off Locations Using Taxi Data

ABSTRACT. This study proposes a method for determining the optimal location and capacity of pick-up and drop-off (PUDO) sections by utilizing Flex Zones as shared autonomous vehicle (SAV) service points. Using taxi Digital Tachograph (DTG) data, high-demand travel patterns and frequently used road segments are identified, and candidate PUDO sites are selected based on clustering of taxi activity. Key spatial variables such as road classification, proximity to public transit, and surrounding facility density are extracted using machine learning models to inform location suitability. A Mixed-Integer Linear Programming (MILP) model is developed to optimize the spatial distribution of Flex Zones. The objective function minimizes total travel distance for passengers and improves service accessibility while satisfying constraints on zone capacity, assignment logic, and maximum number of active PUDO sites. Time-of-day variations in demand are incorporated to ensure operational feasibility under dynamic conditions. The model recommends strategically placing Flex Zones along arterial and sub-arterial roads with strong transit connectivity and commercial accessibility, while dynamically adjusting the number of vehicles served per site to match demand and spatial constraints.

Zhuoye Zhang, *Zhichen Liu*, *Yafeng Yin*, *Daniel Vignon* and *Fangni Zhang*

Differentiated Order Allocation to Electrify Ride-Sourcing System

ABSTRACT. This study examines the impact of differentiating electric and gasoline vehicles in order allocations to promote ride-sourcing fleet electrification and aims to provide practical guidance for ride-sourcing platforms. Specifically, this study develops an aggregate and static model of a ride-sourcing platform with electric vehicles that experience longer per-trip service times due to additional charging downtime but incur lower per-trip operation costs than gasoline vehicles. The platform uses differentiated

order allocation to promote fleet electrification. Our findings suggest that, unlike monetary incentives that require direct financial investment, differentiated order allocation offers a flexible and cost-effective approach to electrifying the ride-sourcing fleet, potentially improving social welfare without adversely affecting the platform's profitability.

P2B: Prediction and Estimation

Bingxun Wang, *Zhibin Jiang* and *Wei Liu*

Predicting Individual next Trip in Metro Networks Using a Transformer-Based Deep Learning Model

ABSTRACT. Predicting individual passengers' next trips in metro networks is critical yet challenging due to complex spatiotemporal contexts and long-term dependencies. We propose a spatiotemporal context-aware transformer-based multi-task learning framework that integrates station and time embeddings, a transformer encoder for capturing trip patterns, and a multi-task module for origin-destination prediction with auxiliary time slot estimation. Validated on real-world data, the model outperforms baselines, with ablation studies highlighting key components' contributions. Analysis of contextual factors reveals the influence of passenger regularity, station, and temporal attributes. This work offers a solution for mobility prediction, enhancing transit management and service personalization.

Nazam Ali, *Djamila Ouelhadj*, *Seda Sucu Sagmanli*, *Nima Dadashzadeh* and *Graham Fletcher*

A Comparative Study of Different Explainable Machine Learning Techniques for Mode Choice Prediction of Mobility-as-a-Service Users

ABSTRACT. Private cars offer flexibility, convenience and freedom in traveling. However, excessive use of private car is not sustainable mobility solution. While, Mobility-as-a-Service (MaaS) is promoted as a sustainable mobility solution to the problems associated with private car use. In this research study, we have used different machine learning techniques such as Logistic Regression, Decision Tree, k-NN, Random Forest, AdaBoost, and Gradient Boosting to study the mode choice prediction between private car versus other sustainable transport modes. A total of 2,688 completed responses of MaaS users were collected through Breeze app, which is a first multicity MaaS app developed by the Solent Transport in the UK. The results showed that among different machine learning techniques Random Forest with an accuracy of 83% and AUC -ROC of 0.84 emerged as the most balanced classifiers, offering strong precision, accuracy, recall, F1-Score, and ROC -AUC values. Feature importance of Random Forest model was analysed using both Gini importance and permutation importance methods, revealing that car ownership, age, income and residential area type were the most influential factors in predicting the mode choice of MaaS users. The findings can inform recommendations for policymakers to encourage a shift from private car use to more sustainable transport modes, specifically from the perspective of MaaS users in car-dependent societies.

Mohammad Maleki, *Scott Rayburg* and *Stephen Glackin*

Predictors of Crowdshipping Participation in Public Transport Systems: a Mixed-Methods Analysis with Managerial Insights

ABSTRACT. Rapid e-commerce growth is straining urban streets and carbon budgets, turning the last-mile into a costly source of congestion and emissions. Crowdshipping—where regular train commuters are paid to carry small parcels between station parcel lockers—offers a low-carbon alternative that repurposes existing passenger capacity rather than adding new vehicles. Guided by the Theory of Planned Behavior, this study combines a survey of 405 Australian rail users with nineteen expert interviews to identify the factors that will determine commercial success. Binary logistic regression shows that environmental concern, confidence in reliable earnings, and peer endorsement are the strongest predictors of a commuter's willingness to participate, physical comfort and routine train frequency also double or triple uptake. Interviews corroborate these findings and stress three operational imperatives: strategically placed lockers that do not disrupt passenger flow, simple yet transparent pay-and-insurance schemes, and referral programs that convert early adopters into ambassadors. Demographic variables proved largely irrelevant once these design features were addressed, indicating that a single, well-structured offer can attract a broad user base. The paper concludes with actionable recommendations for policymakers, transit agencies, and logistics providers seeking to invest in public-transport-based crowdshipping.

Kwangho Baek and *Alireza Khani*

A Discrete Choice Model with Segmentation and Embedding via AI-Learning (DCM-SEAL) for Transit Mode Choice and Planning

ABSTRACT. We propose a generalized discrete choice modeling framework that unifies and extends previous AI-integrated approaches. Our model features three components, including (1) feed-forward neural networks to identify heterogeneous latent classes through nonlinear combinations of demographic variables helpful to derive policy/equity implications and resolving endogeneity and (2) class-specific embedding matrices to reduce the dimensionality of high-cardinality categorical variables and to provide rich behavioral insights, and (3) a conventional linear utility formulation to preserve econometric interpretability. Results highlight the importance of appropriately assigning input variables to specific roles and demonstrate that the integration outperforms existing models.

Sebastián Contreras, *Jacqueline Arriagada* and *Eduardo Graells-Garrido*

Bus Arrival Time Prediction at Bus Stops for Multiple Cities

ABSTRACT. Public transport enhances urban mobility, making accurate bus arrival predictions essential for Advanced Traveller Information Systems that promote public transport use. This study develops a unified multi-citycity-agnostic, multi-city model for bus arrival time prediction using data from seven Chilean cities. Leveraging GTFS-RT feeds, historical commercial speeds, and real-time headway information, we compare the performance of XGBoost, CatBoost, and LightGBM. CatBoost consistently outperformsoutperform all other approaches, including city-specific models and considering complex scenarios where data from the target city is excluded during training. We further demonstrate that this unified approach can be extended to city-agnostic predictions, where reliable estimates are provided for

cities not included in the training data. Using SHAP analysis, we identify key predictive features and their contributions across different urban contexts. These findings demonstrate the feasibility of scalable, unified prediction models across diverse urban environments, with significant implications for transit authorities managing multi-city systems with limited resources. the other models, especially in complex scenarios where data from the target city is excluded during training. These findings demonstrate the feasibility of scalable, generalizable ETA prediction models across diverse urban environments.

Melvin Huang, *Martin Trépanier* and *Amaury Philippe*

Improvement to Destination Estimation in AFC Systems

ABSTRACT. Smart card data in public transportation provides a continuous and detailed source of information on passenger movements. Although typically limited to entry validations, this data can be enhanced using destination estimation algorithms to reconstruct origin-destination trips. These reconstructed trajectories are essential for calculating key performance indicators such as passenger-kilometers, occupancy rates and schedule adherence supporting both daily operations and long-term planning. While existing algorithms are generally effective at estimating destinations for most trips, some cases remain difficult to resolve particularly isolated or incomplete transactions. To address this an improved estimation model is proposed. It combines criteria based on stop sequence analysis, the travel history of the individual smart card and a final criterion leveraging the collective historical data of all cards in the system. This last approach uses a weighted random sampling method to select the most probable alighting points. The combination improves both the coverage and coherence of the estimations. To ensure reliability the algorithm’s outputs are compared with passenger counts at tram stations. Although validation revealed some errors and left uncertainty about accuracy this comparison significantly reduces the risk of inaccuracies compared to relying solely on smart card data.

Laura Knappik, *Lorena S. Reyes-Rubiano* and *Sven Müller*

Optimizing Passengers' Boarding and Alighting Operations in Urban Mass Transit

ABSTRACT. During boarding and alighting in urban mass transit, some train doors become overcrowded while others are underutilized. This imbalance increases dwell time as trains wait for the last passengers to board or alight. We propose a MINLP which may be nonconvex to minimize boarding and alighting times—a function of the number of boarding and alighting passengers—by optimally allocating passengers to doors. To capture the process of passengers’ choosing doors, we developed a choice model with financial incentives to guide passengers to specific doors. Optimal discounts are determined within the choice model and integrated into the optimization framework to adjust passengers per door.

Tak Chun Marcus Chan and *Kari Watkins*

Transit Ridership Prediction for Student-Centric Communities

ABSTRACT. This study improves university transit system ridership forecasting using Direct Demand Models (DDMs). Key objectives include improving prediction precision and exploring factors affecting passenger counts. Models were divided into undergraduate and graduate categories, as well as all-day and peak-period models. Fixed effects regression addressed route-level variables, while log

transformations handled heteroscedasticity and allowed elasticity interpretations. Findings show delays, weather, enrolment patterns, new housing, academic quarters, and day of the week significantly impact ridership. This research translates the findings into a practical tool designed for transit agencies operating in university settings to support better-informed service planning decisions, enhance operational efficiency, and improve the overall transit experience for riders.

Javad Esmailpour and *Saeid Saidi*

Assessment of Transit OD Scaling Methods Under Varying AFC Penetration Rates

ABSTRACT. Transit OD estimation is vital for transportation planning and operations, but data collection systems often fail to capture all passenger movements. While many studies have scaled transit OD matrices derived from AFC systems, the impact of penetration rates of such systems on the accuracy of scaled OD matrices remains unexplored. This paper utilizes simulated transit data on the Sioux Falls network to analyze the effects of varying penetration rates on scaled OD matrices. Findings show that existing scaling methods struggle with low-penetration AFC systems, highlighting the need for new approaches to address the limitations of incomplete data collection systems.

Christos Gkartzonikas, *Paraskevas Nikolaou* and *Loukas Dimitriou*

Estimating Spatial Spillover Effects in Public Transportation Network Changes

ABSTRACT. This study assesses spatial spillover effects due to public transportation network changes on ridership using a spatial Difference-in-Differences (DiD) method. Traditional DiD approaches neglect spatial spillovers and dependencies; hence, this study integrates a spatial dimension with distance-based spatial weights to capture both direct and indirect effects. Data from Nicosia, Cyprus (2018–2023), comprised of bus routes, frequency, socio-demographics, and land use, the analysis reveals mixed effects for urban areas and positive effects for rural areas. The findings highlight statistically significant causal effects, emphasizing the importance of spatial considerations in policy evaluation for public transportation improvements.

Xinyu Wang and *Andrés Fielbaum*

RL-Based Anticipatory Matching in on-Demand Ridepooling

ABSTRACT. On-demand ridepooling systems aim to enhance traffic efficiency by allowing passengers with similar routes to share vehicles. While existing matching algorithms optimize immediate assignments, they often overlook long-term system performance. We propose a Graph Neural Network-based Reinforcement Learning framework that dynamically adjusts the level of anticipatory matching through a tuning parameter θ. The framework is matching-algorithm-agnostic and adaptable to different urban contexts, requiring only state parameters and network topology as input. Using the NYC yellow taxi dataset, we demonstrate that our approach achieves both lower rejection rates and user costs compared to fixed-anticipation methods, validating the effectiveness of dynamic anticipation in ridepooling systems.

Constantin von Beck, *Valeria Jana Schwanitz* and *August Wierling*

A Regression Model for Estimating Rural Traffic Volumes in Vestland County, Norway

ABSTRACT. Traffic volume indicates potential for mode shifts towards public transportation. Estimating traffic volume for rural roads is challenging because most transport models are developed for urban areas. This study investigates a multiple linear regression model for traffic volume prediction in the Norwegian County Vestland. The best regression model utilizes the road width, the census unit population, the municipal household density, the number of registered vehicles, and a dummy for build-up places and forests to explain 0.64 of the variation in traffic. The analysis reveals a need for more rural measurements including vehicle lengths and small-scale socioeconomic data for accurate estimations.

Taewoo Kim and *Joonho Ko*

Understanding User Reusability on Bike Sharing System: Using RFM Model on Rental Data

ABSTRACT. Bike-sharing systems (BSS) are increasingly essential in mega-cities, with many studies focusing on predicting future demand using rental record data and surveys. Aggregating rental records into a personal dimension is crucial, and the RFM (Recency, Frequency, Monetary) method from marketing has recently been introduced for this purpose. While most studies use RFM for clustering, few examine its relationship with future demand. This study analysed two years of data from Seoul's BSS, Ttareungi, over 8 quarters, incorporating ridership distance and duration. By pairing RFM values from one quarter with the next and using logistic regression with random effects, the study found strong correlations between past and future RFM variables. Specifically, recency increased when past RFM values were lower, frequency increased with higher past values, and monetary increased with lower recency and monetary but higher frequency. These results highlight the complex and separate effects of RFM components on future demand. Unlike other transportation studies, recency changes negatively influenced future demand. The findings validate using RFM for BSS demand prediction and suggest potential for advanced methods like machine learning to enhance accuracy.

Seungbin Im, *Inseong Lee*, *Ria Roida Minarta* and *Joonho Ko*

Developing a Bus Speed Prediction Model for Exclusive Median Bus Lanes: Considering Autonomous Driving Constraints

ABSTRACT. Modern cities are implementing various public transportation policies to address issues like traffic congestion and improve urban mobility. Autonomous buses are expected to initially run in exclusive median bus lanes, making accurate bus speed prediction increasingly important. In this study, a model for predicting bus speed in EMBLs was developed by comprehensively considering Bus Management System and smart card data, along with factors that can affect autonomous driving constraints. An ensemble machine learning approach was applied to enhance prediction performance. The findings provide accurate speed predictions and support stable and efficient operations during the initial adoption of autonomous buses.

Yining Di, *Jie Zeng*, *Zheng Zhu*, *Hao Wen*, *Puyan Zhao*, *Qipeng Chen* and *Hai Yang*

Dual-Hierarchical Dynamic Graph Neural Network for Multi-Modal Demand Prediction

ABSTRACT. Nowadays, urban travellers choose from or jointly utilize multiple transportation modes to complete their trips. Prediction of travel demand in this multi-modal context is crucial yet challenging due to the dynamic and complex interactions between modal usage. In this work, we propose a Dual-hierarchical Dynamic Graph Neural Network (DHDG) for simultaneous prediction of arrival and departure demand for multiple transportation modes. Specifically, DHDG introduces a copula-based module to generate subgraphs at two hierarchies: OD-related intra-mode demand, and local inter-mode demand, and a fluctuation detection module update them when triggered. Preliminary experimental results show that our proposed method achieves comparable high accuracy in predicting long-term multi-modal transportation demands.

Alaa Itani, *Amer Shalaby* and *Khandker Nurul Habib*

Exploring Trip Cancellation Behaviour of on-Demand Transit Riders

ABSTRACT. On-demand transit (ODT) service, provided by transit agencies, have grown rapidly in the last few years in different countries and cities around the globe. The popularity of ODT resulted in multiple challenges, a common challenge is frequent ride cancellations and no shows. Unfortunately, very little is known about ODT cancellations because of the complex data sharing agreements of trip records, due to the sensitivity of such datasets. This study examines a rich dataset of individual ODT trip records across the Regional Municipality of Durham in Canada for 18 months between January 2022 and June 2023. The trip records feature both, completed trips and cancelled trips. This paper presents models that can predict cancellations based on trip and rider characteristics using choice modelling. These models would provide transit agencies with influencing factors that increase cancellations and therefore help formulate better cancellation policies. A mixed-effect logistic regression model is used, with varying random effects of the service zone. This allows us to capture unobserved effects based on individual ODT service zones. The results showed that increased walking time at pickup and dropoff, increase schedule deviation, and early booking significantly increase trip cancellations.

P3A: Policy

Gülin Göksu Başaran, *Jesper Bláfoss Ingvardson* and *Otto Anker Nielsen*

Where the Station Ends and Surroundings Begin: a Holistic Gender Perspective on Perceived Safety in Public Transport

ABSTRACT. Women and gender non-conforming individuals (GNC) often feel less safe at and around public transport (PT) stations, compared to men. While the significant influence of built environment (BE) on perceived safety is agreed upon, its interaction with gender remains underexplored. Using a tailor-made survey data (N=3,101) from East Denmark, we investigate BE features effective at addressing women & GNC's safety concerns at the home and activity travel environments. Linear regression models reveal that lighting, cleanliness, trees and greenery benefit all travellers, while activating isolated areas around stations would especially benefit women & GNC, and opening up facades would enhance safety at the activity end. These findings are relevant for public transport agencies

and local authorities seeking to address women & GNC's safety concerns while contributing to a more inclusive and attractive public transport system.

Mohammad Ansari Esfeh, *Diego Da Silva*, *Amer Shalaby* and *Eric Miller*

Metro System Vulnerability: Understanding Factors Affecting the Severity of Disruptive Events

ABSTRACT. This study introduces a data- driven framework to evaluate factors affecting the severity of disruptions and identify critical stations in subway networks. Using the Toronto subway as a case study, we integrate incident, passenger demand, and trip data to analyze the impact of disruptions. Incident severity was found to be affected by incident type, path length, and line association. Passenger -related incidents were found to contribute significantly to network performance degradation. Additionally, we propose a novel vulnerability index, incorporating incident probabilities, travel cost increases, and ridership loss. The proposed method identifies stations with high ridership and aging infrastructure as the most vulnerable.

Marko Kapetanović and *Niels van Oort*

Multi-Criteria Evaluation of Propulsion Alternatives for a City Bus Fleet Renewal: a Dutch Case Study

ABSTRACT. Public transport companies (PTCs) are facing significant challenge in phasing out high-polluting diesel vehicles and selecting alternative propulsion solution for their city bus fleet renewal. To support PTCs in this complex multi-criteria decision making process, this paper presents an integrated method, that includes the improved Analytical Hierarchy Process (AHP) to define the weights of criteria, and the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) to assess and rank considered solutions. The method is applied in a case study of Arriva, one of the Dutch major PTCs, with battery-electric system with opportunity charging identified as the optimal configuration.

Hyundo Kang and *Tomio Miwa*

Node-Place Model with Accessibility Based on Potential Factors and Clustering: TOD Typology for Chukyo Metropolitan Area, Japan

ABSTRACT. We classified and evaluated main railway stations in Chukyo Metropolitan Area with advanced node-place model based on potential factors considering feeder networks. Using five factors of rail-based node, car assisted node, and three places, stations are classified into six clusters. The results showed that firstly, node and place could be divided based on feeder modes and activity types, suggesting the necessity of advancement in model. Secondly, stations could be evaluated by various isochrones. Finally, stations were in monocentric structure while different patterns were identified with respect to access/egress potential between transit and car, suggesting delicate approaches for multimodal policies.

Raashid Altaf, *Kshitij Srivastava* and *Pravesh Biyani*

The Road Less Congested: a Policy-Driven Approach to Alleviating Congestion Through Last-Mile and Public Transit Integration

ABSTRACT. Urban congestion remains a critical challenge for sustainable urban mobility. This paper

examines how road-rationing policies, such as the odd-even vehicle regulation, can act as a trigger to increase public transit (PT) usage when integrated with enhanced last-mile solutions. Using real-world data from Delhi, India, we analyze the impact of road rationing on public transit speeds, demonstrating improvements of up to 50%, alongside significant reductions in travel costs. We propose a policy framework leveraging these short-term benefits to encourage long-term shifts towards public transit adoption. Our findings highlight the potential of combining road-rationing with strategic multimodal transit planning to mitigate congestion and promote sustainable urban mobility.

Filippos Alogdianakis, *Christos Gkartzonikas* and *Loukas Dimitriou*

The Interplay of Demand for Public Transportation, Shared Micro-Mobility and Land Use Patterns

ABSTRACT. This study assesses the interrelationships between public transportation demand, shared micro-mobility usage, and land use characteristics in a car-centric urban environment using a two-stage least squares modeling approach. ZIP code-level analysis reveals that proximity to urban centers, road infrastructure, and land use types significantly influence population density and mobility patterns. Public transportation ridership benefits from high-density areas and frequent service, while shared micro-mobility is less utilized in densely populated zones, complementing public transit in lower-density areas. The findings emphasize the importance of integrating land use and transportation planning to mitigate urban sprawl and promote sustainable urban mobility.

Andres Medaglia, *Luis A. Guzman* and *Olga Lucía Sarmiento*

Extended Transit Opportunity Index for Large-Scale Public Transport Systems

ABSTRACT. Traditional public transport performance metrics, such as passengers per hour per direction, rely exclusively on the number of people mobilized as a proxy for the good performance of the system, failing to consider other key elements of the service. Therefore, quantifying public transport performance, including travel time, routes, transfers, frequency, and vehicle capacity will be very helpful in quantifying the performance, connectivity, and potential costs of public transport services to enable better decision-making and the appropriate allocation of resources. This study develops a comprehensive public transport performance index based on the Transit Opportunity Index (TOI) for Bogota, which has a large number of routes, with different capacity vehicles, frequencies, coverage, and ridership, in addition to the possibility of combining different routes and sub-systems. The proposed methodology uses the General Transit Feed Specification (GTFS) data by combining measures of stations/stops coverage (800 m buffer), and schedule times to compute these components of the zone-to-zone public transport system in Bogota.

Jaimy Fischer, *Brenn Anderson-Gregson*, *Steven Farber*, *Ignacio Tiznado-Aitken*, *Antonio Páez*, *Meghan Winters*, *Ben Woodward* and *Alex Smith*

The Mobilizing Justice's Transportation Equity Dashboard: an Online Platform for Transit Accessibility and Equity Analysis in Canada

ABSTRACT. Equitable access to opportunities is essential for building connected and inclusive

communities. Yet, many Canadian cities continue to show disparities in how different population groups reach key destinations. This research presents the Mobilizing Justice's Transportation Equity Dashboard, a new interactive platform designed to support data-driven transportation infrastructure planning across Canada. The Dashboard combines open data on transportation networks, land use, and census demographics to measure access to seven essential destinations: employment, primary schools, groceries, healthcare, recreation, cultural venues, and post-secondary institutions. It does so across three travel modes —walking, cycling, and public transit (both peak and off-peak periods)— and disaggregates results by 20 equity-deserving population groups, including low-income, seniors, recent immigrants, and visible minorities. Covering all 41 Census Metropolitan Areas in Canada, the Dashboard allows users to identify spatial inequalities in access, compare across cities and groups, and prioritize neighbourhoods where low accessibility levels and high concentration of equity-seeking groups intersect. By offering a national, standardized tool for accessibility and equity analysis, this tool is designed for planners, policymakers, researchers, and advocates seeking to integrate equity into transportation decisions.

Taejun Kim and *Junghwa Kim*

Analyzing Transit Hub Types Considering Metro User Trip Patterns and Station Area Environment

ABSTRACT. Urban transit hubs face increasing congestion due to growing transit demand and complex trip patterns. Effective management is essential to improve connectivity and reduce travel time. This study analyzes transfer hubs by integrating user trip patterns and station area environments. Utilizing correlation analysis, PCA, and clustering methods, diverse hub types are identified, providing foundational data for systematic management strategies. The findings offer significant insights for future facility expansion, congestion mitigation, and demand forecasting, serving as critical baseline data for efficient transit operations in metropolitan areas.

Jiahao Wang and *Amer Shalaby*

IROAM: Integrated Route Operation and Anomaly Monitor

ABSTRACT. In this paper, we propose an LLM-based knowledge system that transforms historical incident reports into institutional knowledge for incident management in public transit. By converting unstructured data into a structured knowledge graph, the system captures seasoned personnel's practical experience and merges it with official guidelines, providing decision support. A retrieval augmented generation approach integrates these data sources to yield context-specific recommendations for route supervisors. This framework underscores the potential of advanced language models for consistent, transparent, and explainable incident control.

Tatsuki Nakanishi and *Yukimasa Matsumoto*

Identifying Areas Suitable for Introducing Transfer-Based DRT Based on User Mobility Evaluation

ABSTRACT. In Japan, the transportation gap between urban and rural areas is widening, emphasizing the need for flexible mobility options for rural communities. Demand Responsive Transport (DRT) offers

a potential solution with reservation-based flexibility. However, it may compete with existing public transportation services, which could undermine the efficiency of the transportation network. This study proposes a method for identifying areas suitable for introducing transfer-based DRT that complements existing bus services. The method uses generalized cost to evaluate travel options from the user's perspective. The method was applied to Kameyama City, Japan, and considers three transportation mode combinations: 1. Traveling directly from the origin to the destination using a taxi, 2. Walking to the nearest bus stop, taking buses to the stop closest to the destination, and then walking to the final destination, 3. Using DRT to reach a specific bus stop, taking buses to the stop nearest to the destination, and then walking to the final destination. The results indicated that generalized costs are minimized in regions with few bus routes situated far from the city center, as well as in areas surrounding the city center that have better access to hub bus stops situated within the center.

Achille Fonzone and *Lucy Downey*

Public Perceptions Towards Transport Policy and Investment

ABSTRACT. This paper explores Scottish residents prioritisation of key transport policies and their preferences for investment across different transport modes. Data was collected through an online survey (n=2,004) with quotas for age, gender, and household income to ensure that the sample was representative of the Scottish population. The findings indicate that while Scotland's National Transport Strategy (NTS) prioritises walking and cycling the public has a stronger preference for investment in public transport, especially among those without car access and older age groups. Respondents who prioritised economic growth showed greater support for measures that promote private car use.

Michael Leong, *Anson Stewart* and *Jinhua Zhao*

Rethinking Transit-Oriented Development: a Post-Pandemic Strategy to Revitalize Transit Ridership?

ABSTRACT. The COVID-19 pandemic has led to enduring changes in urban mobility and real estate sectors, with transit ridership stabilizing at 73% of 2019 levels by 2024 and remote work patterns remaining consistent since 2022. Disaggregated analysis of ridership trajectories in Washington DC, however, reveals significant heterogeneity which can be partially explained by real estate characteristics. This study jointly analyzes transit ridership and corresponding characteristics and changes to the real estate markets around stations, employing time-series clustering station ridership trajectories to identify distinct recovery patterns. These findings underscore the significant potential of strategic TOD planning to play a pivotal role in revitalizing urban transit systems in the post-pandemic era.

Tomohiro Yakura, *Yasuhiro Shiomi* and *Ngoc An Minh*

To What Extent Can Online Activities Complement Mobility Needs in an Aging Society? a Generalized Cost-Based Accessibility Analysis

ABSTRACT. If aging individuals who rely heavily on private vehicles lose the ability to drive, they must either use alternative transportation or forgo certain activities. With the expansion of online services, some daily activities can potentially be conducted virtually, serving as substitutes for physical mobility.

Although many accessibility indicators have been proposed in the literature, none has accounted for the complementarity between online services and physical transportation. This study develops a new accessibility index that incorporates the acceptability of online alternatives and quantifies the impact of losing access to private vehicles. Based on a questionnaire survey, the study also evaluates the extent to which online services can compensate for reduced physical mobility. The results reveal that 10 to 15% of individuals are likely to stop traveling when they can no longer use a private car, and about half of them do not accept online alternatives. This means that approximately 5% of people may be at risk of being unable to continue their daily activities in the future. This tendency is particularly pronounced in less densely populated areas—especially those far from train stations and with a high proportion of elderly residents—suggesting the need for both enhanced physical mobility support and improved access to digital services in such regions.

P3B: Service and Operation

Fan Yujie, *Liang Yunyi* and *Wu Zhizhou*

A Study of the Reasonable Service Scope for Metro Transit Connections Considering Demand Response Bus

ABSTRACT. The study introduces the demand-response bus and develops a generalized cost function model that accounts for time costs, direct economic costs, and comfort costs throughout the entire travel chain involving metro transit connections. It explores the optimal service areas for various connecting modes, highlighting that for connection distances greater than 1,800 meters (R > 1800m),the demand-response bus becomes a more competitive option. Furthermore, the competitive dynamics between the demand-response bus and shared bike usage are analyzed. The findings indicate that factors such as direct economic costs, travel speed, and waiting time significantly influence travelers' willingness to accept the service scope of the demand-response bus.

Thiago Carvalho and *Ahmed El-Geneidy*

Measuring the Impacts of a New Bus Rapid Transit (BRT) Service on Running Time and Schedule Deviation in Montréal Canada

ABSTRACT. Recent research on Bus Rapid Transit (BRT) systems has mostly focused on ridership forecasting and scheduled travel time gains, with little empirical evidence on potential operational improvements. This study examines the short-term impacts of implementing a new BRT corridor in Montreal, Canada, on key bus performance indicators: running time, running time deviation, and headway deviation. Using Automatic Vehicle Location (AVL) and Automated Passenger Count (APC) data from 2022 to 2023, we compare the performance of the BRT to a parallel local bus route operating along the same corridor, before and after the BRT implementation. Our findings indicate that the BRT significantly reduced trip durations (over five minutes on average) primarily due to infrastructure features such as dedicated lanes and all-door boarding policy. The local route experienced modest running time improvements post-BRT, suggesting potential corridor-wide benefits. However, both run time deviation and headway deviation were significantly higher for the BRT, particularly during peak periods. These

findings highlight the importance of integrating infrastructure investments with dynamic operational strategies such as real-time dispatching and headway control. It emphasizes the need for schedule calibration following implementation to ensure that planned service aligns with actual performance. These findings offer practical insights for transit agencies planning or managing BRT systems.

Hung-Yi Hsueh, *Tai-Ting Chen* and *Chia-Chun Tai*

Optimized Mass Rapid Transit Operation Model to Maximize Station Transportation Efficiency and Commercial Benefits

ABSTRACT. Train headway and passenger flow are key factors affecting MRT station transportation efficiency and commercial benefits. This study proposes an integrated operational model that involves signalling system adjustments and pedestrian flow simulations that can enhance overall MRT services. Using the Taiwan Taoyuan International Airport MRT as a case study, an OpenTrack simulation was run to demonstrate how signalling system modifications can be applied to reduce headways along the entire line. In addition, BIM and pedestrian flow simulation tool PTV Viswalk were used to assess the impact of reduced headways at A19 station of the Airport MRT, and the results informed recommendations for allocating underutilized retail space within the station. Simulation outcomes show that the proposed model can improve both transportation efficiency and commercial benefits.

Yinfei Feng, *Tao Liu* and *Yong Yin*

Virtual Coupling and Decoupling Operation of Autonomous Rail Rapid Transit Lines Connecting with a High-Speed Railway Station

ABSTRACT. Autonomous Rail Rapid Transit (ART) has been adopted in several cities around the world. Moreover, with the ongoing expansion of China's high-speed rail (HSR) network, the number of newly constructed HSR stations is also increasing. To address the last-mile connection between existing ART lines and new HSR stations, this study proposes the establishment of demand-responsive HSR-ART branch lines. With the addition of the HSR branch, the ART network forms a Y-type structure. By adding a turnaround track at the node station and utilizing virtual coupling technology, the system can accommodate passenger travel demands in all directions—between trunk lines as well as between trunk and branch lines. To simultaneously meet passenger travel demand and minimize the operator's operating costs, this study proposes a MINLP model, which is then transformed into a MILP model to facilitate solving with Gurobi. Finally, the proposed model is applied to a real-world case in Yibin, China. The solution proposed in this study reduced the total cost by 9.0% and 33.7% compared to Scenario 2 and Scenario 3, respectively.

Qingyun Tian, *Yun Hui Lin*, *Yitong Yu*, *Kaidi Yang* and *David Z W Wang*

Operation Design of Last-Mile Transit Service with Modular Vehicles

ABSTRACT. Bridging the last-mile service of the backbone/trunk lines such as mass transit system is indeed a challenging problem. This study proposes a flexible last-mile transit service using modular vehicles, which can can dynamically adjust their formation size by coupling or decoupling modules in response to real-time, spatially heterogeneous passenger demand along different routes and stops. We

propose a model that explicitly considers the dynamic passenger arrivals and the optimal modular vehicle formations to accommodate the time and spatial demand variation. Specifically, passenger-to-route assignments, limited number of modules, and early return of modules at intermediate stops are all considered in the model formulation. To solve the dynamic operations of the modular-vehicle last-mile service, we propose a two-stage route-stop reinforcement learning-based approach, in which the Advantage Actor-Critic (A2C) algorithm and the optimization model are integrated into the framework. Specifically, the A2C based reinforcement learning approach is proposed to predict the initial dispatching decisions before departures on each service route. Then an optimization model is adopted to derive more detailed operation decisions for both the modules and the passengers. Numerical experiments are conducted to demonstrate that the proposed model can provide a high level of service and significantly reduce total costs.

Kelvin Lee, *Yu Jiang* and *Avishai Ceder*

Public Transit Limited-Stop Service: Alternative Paths Using Deep Reinforcement Learning Approach

ABSTRACT. This study introduces a novel limited-stop transit service designed to operate alongside fixed-route services, aimed at accommodating significant observed or anticipated passenger demand. The key innovation of this approach is that buses can take shorter paths than those of the fixed route, when stops are skipped. The proposed framework employs a bilevel programming model, where the upper-level determines the service pattern and frequency, and the lower-level performs transit assignment problem based on optimal routing strategies. A reinforcement learning-based solver is developed to generate high-quality solutions for diverse problem instances. In the case study conducted in Singapore, the proposed approach is shown to reduce passengers' travel time by up to 14.5%.

Marco Innao

Run Time Allowances in Rail Planning and Travel Time Estimation: International Perspectives and Practices

ABSTRACT. Accurately estimating travel times is essential for developing reliable rail schedules and ensuring operational efficiency. Run time allowances—also known as time buffers, recovery margins, time supplements, or schedule padding—are added to minimum run times to absorb potential delays and support punctuality. This paper examines the wide range of methodologies used globally to integrate these allowances into train schedules. Through a literature review, expert consultations, and interviews with U.S.-based rail agencies, the study identifies both simple and complex approaches, from fixed percentage-based allowances to geographically distributed models. Key findings include the absence of universal guidelines, inconsistent terminology, reliance on institutional knowledge, and significant impacts on both capital costs and operational behavior. This paper is intended to assist rail practitioners by presenting not only academic research but also practical recommendations. It summarizes various methods with associated advantages and limitations, and provides a glossary to clarify terms and their roles in scheduling and capacity planning. Given the locally dependent nature of current practices, the paper also aims to encourage further research and collaboration. Its broader goal is to promote the

development of structured, adaptable guidelines for implementing run time allowances, leading to more reliable, cost-effective, and passenger-focused rail operations.

Jia Hui Zhu, *Dennis Huisman* and *Twan Dollevoet*

Rolling Horizon Stochastic Programming Approach for Real-Time Rolling Stock Rescheduling

ABSTRACT. On the day of operations, disruptions can occur on the railway network, which require the rolling stock plan to be adjusted. In this paper, we consider the problem of rolling stock rescheduling with disruptions for which information about the duration, location and severity is uncertain and becomes available dynamically. In current practice, it is typical that the most recent disruption information is naively used to reschedule the rolling stock, which can lead to unnecessary cancellations or decreased passenger satisfaction in case the disruption turns out different than expected. We propose a rolling horizon stochastic programming approach for real-time rolling stock rescheduling, which has the ability to anticipate changes in the disruption information. The approach takes into account a variety of disruption scenarios and iteratively creates interim rolling stock schedules with a rolling horizon. Computational experiments are conducted on instances of the Dutch railway network. Compared to the naive rolling stock rescheduling approach, the proposed approach successfully creates rolling stock schedules with fewer cancellations and lower rescheduling costs for disruptions with changing information, in short computation times.

Howard Wong and *Ed Manley*

Evaluating the Impact of Metro Expansion on Public Transport Demand at Od-Level Using Longitudinal Data and Multilevel Modelling

ABSTRACT. Public transport (PT) interventions such as metro openings can vastly enhance the accessibility within a city. However the impact is more nuanced to the connectivity and the resulting demand flows at the origin-destination (OD) level. We have developed a multilevel regression model that uses the longitudinal PT schedule and OD-level demand data for 11 years from Santiago de Chile to evaluate the impact of OD flows after the opening of 2 metros lines. The result shows a large variation of positive and negative effects to OD flows along and beyond the alignment of the new lines.

Jing Teng, *Chenlu Zhu* and *Enhui Chen*

Evaluation of Demand Responsive Transit: a Multidimensional Review of Theories, Methods, and Performance Indicators

ABSTRACT. While Demand-responsive-transit (DRT) offers advantages, it faces operational complexities and financial sustainability issues. Existing research lacks a comprehensive evaluation framework from multiple stakeholders' perspectives. This study proposes a multidimensional analysis framework, encompassing operator cost-benefit, government social welfare, and passenger service quality evaluations. Key findings reveal insights into DRT cost structure, equity and accessibility impacts, environmental sustainability, and service quality indicators. Future research should deepen empirical studies, integrate multi-source data, and develop balanced strategies to optimize DRT systems for sustainable urban mobility.

Jing Heng Chen, *Chia Chung Chen* and *Yung Chen Lai*

Light Rail Line Capacity Analysis Considering C-Type Right-of-Way

ABSTRACT. Light rail can flexibly share road infrastructure, making its capacity in mixed right-of-way conditions critical for system planning. Existing studies focus on dedicated lanes, overlooking shared lanes with highway traffic, where bottlenecks often occur at stations. This study develops models to calculate station capacity under three scenarios: no nearby signals, signals behind, and signals ahead. Using VISSIM, the models are validated with capacity prediction errors mostly within 10%. Combined with turnback operations, these models aid in designing efficient, reliable light rail systems by addressing capacity variations in mixed-traffic environments.

Jing Teng, *Tong Wu* and *Enhui Chen*

Identifying the Relationship Between Travel Demand and Spatial Patterns in Areas with Limited Public Transport Access to Transportation Hubs: a Case Study of Shanghai

ABSTRACT. In response to the issue of mismatched travel demand and accessibility at urban transportation hubs, this study proposes a comprehensive analytical framework that takes into account travel demand, accessibility, and spatial patterns. Firstly, identification rules are introduced to detect grid cells imbalanced between travel demand and accessibility to transportation hubs. Subsequently, interpretable machine learning models are developed to analyze the relationships between travel demand with accessibility, built environment, and transportation facilities. Taking Shanghai's Hongqiao Transportation Hub as a case study, policy implications are provided based on the results of the analysis.

Marco Petrelli

A Methodology for the Definition of the Supply Level of the Public Transport Services

ABSTRACT. This study proposes a new method for the estimation of the supply level of bus services for urban areas. Italy’s framework for subsidy allocation includes provisions for: a) ensuring minimum service levels in all areas, as mandated by national mobility policies; b) funding allocation based on the computation of the standard costs depending on operational and urban characteristics. In the last years, the revision of funding allocation is started but subsidies are still distributed according historical data. While a standard costs computation model was provided by Ministry of Transport, the first process is still not developed and, according to regulations, should be defined for ensuring, in quality and quantity, the mobility needs of the population. For overcoming the existing limits, the proposed method is based on the identification of the effective transport needs as output of a Cobb-Douglas function. Such production function is widely used to model relationship between inputs and output. Input factors are the reference length of the public transport network and the average number of runs made by each line. The new method derives from the idea of reproducing the usual process of design of public transport services where the two factors computed can refer to the phase of route identification and frequency setting.

Yaochen Ma, *Xiaoyan Wang*, *Hongbo Ye* and *Hai Yang*

Train Scheduling with Virtual Coupling and Stop-Skipping in Metro Systems

ABSTRACT. This study investigates train timetable scheduling for a metro line, utilizing virtual coupling

and stop-skipping to address spatially and temporally imbalanced passenger demand. The problem is formulated as a mixed integer linear programming model, aiming to minimize train operational costs and total passenger travel time. Multiple operational strategies are integrated within a time-space network to accommodate time-dependent passenger demand patterns. A tailored branch-and-price algorithm is developed to solve the model for large-scale networks efficiently.

Qin Zhang and *Zhou Xu*

Incorporating Freight Assignment and Platform Allocation in High-Speed Railway Timetabling

ABSTRACT. New technologies, such as dedicated freight trains, specialized cargo containers, and rapid loading and unloading equipment, ensure the feasibility of integrating freight transport into high-speed railway systems. This paper emphasizes the importance of freight assignment and platform allocation in train timetabling problem for a mixed passenger and freight transport. We construct a space-time-state network to facilitate there presentation of loading and unloading operations at stations. Building on this network, we develop a Mixed Integer Linear Programming model and a Lagrangian relaxation-based algorithm, with a case study verifying the effectiveness of the model and algorithm.

Zaixu Yang, *Jun Zhao* and *Qiyuan Peng*

Analysis of Railway Traffic Flow Under Train Group Operation Based on Fundamental Diagram

ABSTRACT. China is developing the train group operation technology to enhance the railway capacity. Under this technology, trains are tracked closely to present a flow state. In this research, the fundamental diagram model under train group operation is established based on the analysis of train operation. The group train flow characteristics under different influencing factors are studied and validated. The results show that the train type, line gradient, train group size and train order all have different effects on train flow. These findings can provide references for the transportation organization under train group operation.

Karla Isabel Cervantes-Sanmiguel, *Ricardo Giesen* and *Omar Jorge Ibarra Rojas*

Multi-Objective Optimization Model for Sustainable Planning of Bus Fleet Replacement

ABSTRACT. The transition from diesel-powered bus fleets to electric vehicles (EVs) is a crucial step toward achieving sustainable urban transport systems, but the adoption of electric buses involves complex decision-making processes, including determining the optimal timing and quantity of EV acquisitions, selecting the most suitable technology, and assigning vehicles to specific bus lines. This study presents a multi-objective optimization approach to address these challenges, incorporating constraints such as budget, maximum vehicle age, total electrification at the end of the planning period, among others. Our problem aims to minimize total costs (economic objective), optimize a gradual fleet electrification (ecologic objective), and fostering an equitable distribution of electric vehicles across different urban regions (social objective). We implement an epsilon-constraint algorithm that effectively approximates the Pareto front, enabling decision-makers to evaluate trade-offs and select solutions that align with their priorities leading to a significant contribution to the growing body of research on sustainable transport systems.

Maha Ahmad and *Kari Watkins*

Designing a Survey to Test Service Improvements on Regional Rail Ridership Impacts

ABSTRACT. Post-pandemic, the rapid and drastic changes in people's mobility styles have left transit agencies grappling with financial stress. California's transit ridership has generally tracked alongside national ridership trends in the US with a substantial dip in ridership and then slow recovery. However, post-pandemic mode shares in Northern California appear to be remaining lower than pre-pandemic shares, most noticeably on commuter rail services. To reverse some of the declines in commuter rail ridership, we are using survey research to better understand how rail markets have evolved since the pandemic and how the potential user base views rail services.

P4A: Simulation

Deo Chimba

Evaluating Green Extension and Red Truncation Strategies in Transit Signal Priority Systems

ABSTRACT. Transit Signal Priority (TSP) improves bus transit efficiency but can negatively impact minor street traffic. This study assessed TSP effects on bus travel times, recovery from lateness, delays on major and minor streets, and intersection Level of Service (LOS). Using VISSIM, TSP strategies were analysed for buses 75 meters from the stop line. Key findings show TSP reduces bus lateness by 34%, improves bus travel time by 8%, and increases minor street delay by 16%. Other vehicles on the priority approach see travel time and delay reductions of 6% and 12%. TSP does not significantly affect LOS under low to medium traffic but may under high traffic conditions.

Tianqi Wang, *Weihan Xu* and *Xin Li*

Do We Still Need the Dedicated Bus Lane in Connected Environment?

ABSTRACT. To study whether the bus lane is still need ed in connected environment, this paper proposes an analytical model based on fundamental diagram, and corresponding indicators are evaluated in the scenarios with general lanes, dedicated bus lane, and intermittent bus lane. A simulation method is developed to verify the model accuracy. Further analysis for the necessity of bus lane is conducted according to the real-world data. The results show that when the penetration rate ranges from 30% to 60%, the dedicated bus lane is still needed. When the penetration rate is larger than 70%, the intermittent bus lane is more preferrable.

Muslina Syahril, *Widyarini Weningtyas* and *Taufiq Suryo Nugroho*

The Effect of Skip-Stops Service on BRT Scheduling Based on Smart Card Data (Case Study: Transjakarta Bus Corridor 13)

ABSTRACT. TransJakarta is facing unreliability schedule. This study attempts utilizing smart card combine with GPS data to identify passengers travel patterns. Then, we develop a skip-stop-service (SS) scenario and evaluate its impact using MATLAB. The results showed that from the tap data 58.56% of O-D were matched. The rest of the O-D were matched using trip chain assumptions and time relaxation.

Implementing the SS at high-demand stops reduced waiting time by 34.3%, load factor by 22.5%, and travel time by 6.68%. Even with the addition of only 6 buses, the load factor decreased by 12.5%. The SS has proven more efficient.

Federico Bigi, *Yumeng Fang* and *Francesco Viti*

Evaluating Dynamic-Responsive Transport at Equilibrium Within an Agent-Based Simulation Environment

ABSTRACT. This study proposes a new approach to assess Demand-Responsive Transport. We developed the DRT Equilibrium (DRT EQ) within an agent-based simulation environment, an iterative procedure in which DRT routes are defined at each procedure iteration and treated as conventional bus lines, with the routes refined at each iteration based on equilibrium performance. To assess the performance of this methodology, we tested it against MATSim's dynamic DRT module using a case study from Luxembourg. We show that under a stress test scenario, the DRT EQ performs better and more consistently than the DRT Module from both the customers' and provider's perspective.

Max Coey, *John Moody* and *Devin Wilkins*

Improvements for Capacity and Reliability at Passenger Railway Terminals: a Simulation-Based Case Study of Boston'S South Station

ABSTRACT. Many rail operators are shifting from a traditional commuter rail model towards all-day, frequent bidirectional service. However, rail terminals configured for infrequent, peak-direction travel may not provide sufficient capacity to meet these new demands, leading to delays. This study investigates operational, tactical, and strategic solutions to reduce delays at terminals while increasing service frequencies, using Boston's South Station as a case study and SUMO as a simulation engine. The analysis shows that minimization of train movements to and from the yard, reallocation of platforms to meet each line's capacity demands, and a simplified interlocking yield a higher-performance terminal.

Manik Mondal, *Yushi Ishijima*, *Hideki Yaginuma* and *Shintaro Terabe*

Activity Data Generative Model Integrating Ai for Enhanced Travel Behaviour Analysis

ABSTRACT. This study proposes an AI-driven generative framework to produce high-quality synthetic personal trip activity data for transportation behaviour analysis. Using Tokyo personal trip data, we apply Conditional Tabular GAN (CTGAN) combined with Long Short-Term Memory (LSTM) and a Triplet-based Variational Autoencoder (TVAE) with Autoencoder architecture to capture complex with-in-day activity patterns. To improve sequence modelling, we introduce a novel LSTM-GAN that integrates LSTM layers into generative models, enhancing the realism of synthetic Activity sequences. Generated datasets are evaluated against real-world data using statistical metrics such as KL divergence and likelihood, as well as predictive model performance. Results indicate that TVAE excels in data quality and generation speed, while CTGAN performs better in likelihood. LSTM-GAN demonstrates the best structural fidelity, accurately preserving temporal and categorical distributions of travel time, stay time, activity patterns, and transportation modes. Visualizations confirm the ability of LSTM-GAN to reflect

real-world behaviour, highlighting its applicability in mobility studies. This research enhances data generation methodologies for transportation modelling, offering a cost-effective alternative to extensive survey-based collection.

Ming-Yu Tu, *Chen-Wei Huang* and *Yung-Cheng Lai*

Simulation Model for Capacity Analysis of Intermediate Turn-Back Stations in High-Speed Rail Systems with Path Consideration

ABSTRACT. This study develops a simulation model specifically tailored to the characteristics and precisely analyzes the capacity of the intermediate turn-back stations within high-speed rail systems. Additionally, this research conducts in-depth case studies to explore the most suitable track utilization in various scenarios. The study also examines how variations in train turn-back times and the ratio of train types affect capacity. The results not only enhance understanding of the operational efficiency and capacity management of intermediate turn-back stations but also provide effective evaluation tools for planning and capacity analysis of high-speed rail systems.

Sarah Wise, *Fuko Nakai*, *Wendi Han* and *Hitomi Nakanishi*

Going off the Rails: an Agent-Based Simulation of Evacuation in Areas with Mass Transit

ABSTRACT. Municipality-led evacuation planning often fails to account for the significant impact of commuters and mass transport, even though both are central to urban functioning and everyday mobility. This study addresses that gap by integrating both commuter and local transport systems into an agent-based model (ABM) to simulate flood-related evacuation in Okazaki, Japan. The model captures the dynamics of both resident and commuter populations, reflecting statistically grounded travel patterns and public transport dependencies. By comparing scenarios with and without commuting populations within the target area, the results reveal significant differences in evacuation outcomes, particularly in the number of people trapped by flood inundation. Commuters, often excluded from local evacuation planning, are disproportionately affected, highlighting critical vulnerabilities. The simulation demonstrates how rail station closures due to flooding increase congestion and leave thousands unable to evacuate or return home. This case study underscores the need to account for transient populations and commuter transport systems in evacuation models, especially in workplace cluster regions. The findings suggest that integrating mass transport systems into ABMs provides valuable insights for municipality-led evacuation planning. This approach offers a scalable framework for enhancing urban evacuation strategies worldwide.

Dolgorsuren Gombojav and *Mend-Amar Majig*

Revenue Leakage in Urban Transit: a Case Study of Ulaanbaatar's Fare Payment System

ABSTRACT. Abstract: This study explores the fare management challenges in Ulaanbaatar's public transportation system, focusing on revenue losses caused by cash payments and fare evasion. In October 2024, we surveyed over 6,945 passengers across 38 routes and found that only 56% used smart cards, while others paid cash or evaded fares. We validated these findings with smart card data and simulated alternative fare policies to explore the implications for revenue. Our results show that promoting smart

card adoption and aligning fares with travel distance can boost revenue. This work highlights practical strategies to enhance Ulaanbaatar's transit efficiency and financial sustainability.

Xuan Li, *Jiho Yeo* and *Sugie Lee*

Scenario-Based Prediction Models for Public Bike Systems Using Temporal Fusion Transformers

ABSTRACT. This research develops a novel machine-learning based transportation prediction model, integrating environmental variables as adjustable parameters to enable flexible scenario analysis in response to environmental changes. The model considers the network effect of bike docks, unmet demand hidden in ridership, and long-term environmental changes, using Temporal Fusion Transformers farmwork, addressing the limitations of traditional transportation prediction methods. Applied to the public bike system in Seoul, South Korea, the model showcases its ability to dynamically predict the potential ridership under various environmental scenarios. We also measured the difference in extrapolation ability between the transformer and linear models. Simulation results demonstrate how adjustments like new docks or e-bikes can improve user experience and bike usage, informing strategic level and operational level of decision making on public bike systems.

Ludger Heide, *Shuyao Guo*, *Dietmar Göhlich* and *Yang Song*

Assessment of Electrification Strategies Using a Micro-and Macroscopic Simulation Approach: a Case Study for the Kyoto Bus Network

ABSTRACT. In this study, we combine a microscopic traffic simulation with the eFLIPS scheduling approach to analyze bus electrification in part of Kyoto's bus network. We compare two scenarios -- solely depot charging and terminus fast charging -- to estimate vehicle requirements, charger allocation, and peak power loads. The microscopic simulation provides detailed trip-level energy consumption, while eFLIPS optimally assigns trips and simulates charging events. Results show terminus charging demands extra vehicles but uses smaller onboard batteries, whereas depot charging lowers peak electric loads. The method yields rapid insight into operational and economic trade-offs and can adapt to larger networks or additional constraints.

Tarek Chouaki, *Sebastian Hörl* and *Yann Briand*

A Decision-Support Tool for Inclusive Cooperative Connected Automated Mobility Solutions: from Simulation Research to Operational Implications

ABSTRACT. Cooperative Connected Automated Mobility services are envisioned to increase the quality of passenger mobility. The design of such services and the evaluation of their impacts constitute an active field of research, where quantitative methodologies such as agent-based simulations are extensively deployed. Several contributions regarding various aspects of CCAM services were made using open-source frameworks, and today, the methodologies and tools have reached a level of maturity that allows them to be deployed at scale. In this paper, a decision-support tool that builds upon well-established methods is proposed to allow non-experts to use simulation models for the evaluation of CCAM solutions.

Andreas Keler, *Yang Song*, *Ali Gul Qureshi* and *Jan-Dirk Schmöcker*

Simulation of Adaptive Signal Control on Bus Energy Consumption

ABSTRACT. This study examines energy consumption differences in simulated electric bus operations using microsimulation networks and open data. Eight baseline scenarios incorporating varying vehicle and environmental parameters were extended with advanced traffic control strategies, including actuated signals and cycle adaptation based on Webster (1958). Results demonstrate that traffic conditions and driver behavior significantly impact energy use, with some scenarios showing reduced consumption due to enhanced driver abilities. The study highlights the value of integrating traffic calibration and trajectory validation for practitioners utilizing open data and cost-effective tracking experiments, providing insights for energy-efficient e-bus operations under diverse traffic conditions.

Nakhyeon Choi, *Andreas Keler* and *Jan-Dirk Schmöcker*

Microsimulation of Passenger Incentives to Reduce Dwell Times

ABSTRACT. We propose the introduction of bus incentives to reduce long bus dwell times at stops near demand hotspots. We designed a microscopic traffic scenario for the Kyoto City Bus line 201 in the SUMO simulation. An intermodal routing of a novel agent was introduced to extract boarding and alighting times. Our results show that an appropriate bus incentive is effective in reducing bus dwell time. Additionally, this suggests that in-vehicle crowding is a determining factor for bus dwell time.

Yang Song, *Andreas Keler*, *Jan-Dirk Schmöcker*, *Ali Gul Qureshi* and *Wenzhe Sun*

Modeling and Simulating Energy Consumption of Electric Buses in Kyoto Using Sumo

ABSTRACT. The adoption of electric buses is often limited by battery capacity and slow recharging. Accurate energy consumption estimation is therefore crucial. This research simulates the daily operations of several bus routes of Kyoto city bus using actual GPS data and the SUMO simulation, combined with the vehicle energy model (VEM). We analyze energy consumption under different scenarios, considering temperature and passenger load variations, and assess the impact of traffic stochasticity. The findings offer insights into bus fleet electrification and the optimization of charging strategies.

Zhipu Chen, *Yunyi Liang*, *Cheng Lyu* and *Constantinos Antoniou*

Graph Multi-Agent Reinforcement Learning for Distributed Control of Traffic Signals and Connected Autonomous Vehicles

ABSTRACT. Building on advances in intelligent transportation, this study proposes a novel real-time control framework that integrates Graph Neural Networks (GNNs) with multi-agent reinforcement learning for distributed control of traffic signals and Connected Autonomous Vehicles (CAVs). The Heterogeneous Graph Reinforcement Learning (HGRL) framework facilitates dynamic and mutual interactions among agents, optimizing traffic efficiency, safety, and environmental sustainability. Comparative evaluations show that HGRL outperforms state-of-the-art approaches, reducing travel time by 21.9%, delays by 57.3%, time-to-collision by 85%, and both fuel consumption and CO2 emissions by 15.5%. Sensitivity analysis across different CAV penetration rates and GNN configurations further indicates HGRL's robust performance.

P4B: Transit Data Analysis

Ka Kee Alfred Chu, *Bruno Allard* and *Guillaume Bisaillon*

Modelling the Potential Impacts of a New Tap-in Tap-out Scheme with Smart Card Transaction Data

ABSTRACT. In order to lessen passengers' burden to select and prepay the correct zonal fare, to reduce the reliance of fare inspection and to open up other fare options, the Montreal Transit Authority (ARTM) is examining the implementation of a partial "tap-in tap-out" scheme to replace the current "tap-in" only practice. This paper describes the datasets and the methodology used to evaluate the potential impacts on flow, user experience and revenue. Passive smart card fare validation data are the main inputs in the modelling process. The research aims 1) to estimate the passenger flow at the exit faregates, 2) to characterize passenger flow according to time of the day, fare types, previous and subsequent journey leg, and other relevant variables, 3) to perform sensitivity analyses on contributing factors, such as the number of exit faregates and the impact of concurrent entry-exit dynamics, and 4) to model the impacts on fare revenue when the exit function is deactivated. This paper incorporates several past advancements of smart card data research, namely in data processing, fusion and enrichment. The results, though specific to Montréal, demonstrate a practice-ready application of passive data in a real-world environment.

Noriyasu Tsumita, *Vichiensan Varameth* and *Atsushi Fukuda*

Enhancing Urban Accessibility with Railway Network Development: a Comparative Scenario Analysis in Bangkok

ABSTRACT. In developing cities, rail transit systems are planned based on transportation masterplans, often lacking detailed analyses of accessibility provided by public transportation. This study assessed the impact of railway network expansion using cumulative accessibility index. The results revealed 10% increase in citywide accessibility, with 50% of facilities within 20 km of the city center reachable within 60 minutes due to the expanded rail transit network. While rail development significantly enhances accessibility, some areas may continue to experience low service levels. These findings underscore the need for detailed evaluations to guide future rail transit planning and ensure equitable regional access.

Shu-Hao Chang, *Kuan-Yao Wang* and *S.K. Jason Chang*

Modeling Bus ADAS Warning Occurrences and Traffic Environment with Machine Learning

ABSTRACT. This study aims to apply XGBoost and Random Forest models to explore the relationship between safety-related road environment factors and Advanced driver assistance systems (ADAS) multi-warning events based on data from Taipei City buses. It is shown that XGBoost model has comparatively better performance in terms of revealing key factors that significantly affect forward collision warnings (FCW), lane departures, and speeding incidents. Key findings indicate that FCW events are strongly associated with large vehicle ratios, lane numbers, and occupancy rates, while lane departure warnings are linked to traffic conditions and geometric designs. Speeding risks, however, are primarily influenced by arcade-no-motorcycle road segments and bus lanes. These insights will help of formulating strategies for road safety improvements. It is also recommended that optimizing road designs, re-assessing heavy

vehicle management schemes, and revising bus lane speed limits or bus lane layouts are worth further studies.

Pei-Fen Kuo, *Cai-Yu Yang*, *Ching-Fu Chen* and *Chung-Wei Shen*

Who's Riding and Where: Key Insights from Kaohsiung's Maas Program

ABSTRACT. Many cities have introduced free or low-cost public transit programs to increase ridership and promote equity. However, few studies have examined how these programs operate in Asia. This study examines Kaohsiung's Mobility-as-a-Service (MAAS) program, MeNGo, focusing on its impact on bus ridership and travel behavior. First, we applied clustering methods to bus data from November 2023, identifying five distinct user groups. Most program users are students; their trips occur primarily on weekdays; and travel is largely concentrated in the city center. Although the MeNGo program improves transit access, challenges such as overcrowding and limited coverage of intercity routes remain. In a second analysis, a flow clustering approach revealed especially high demand in city-center areas and at major transit hubs, highlighting the need for targeted service improvements. These findings offer insights for designing more effective and inclusive transit systems.

Sunghoon Jang, *Meng Guo* and *Shin-Hyung Cho*

Assessing Alternative Acceptance in Tour-Based Travel Behavior Using Integrated Active and Passive Public Transit Data

ABSTRACT. This study investigates individuals' alternative acceptance in tour-based travel behavior in integrated passive and active public transit data. We build the data by integrating National Household Travel Survey data in Korea and four types of passive data (navigation, smartcard, bike-sharing, and GIS data). By developing a tour-based truncated choice model, we assume that individuals do not consider unattractive alternatives (those exceeding a certain threshold) in their choice set. We empirically demonstrate that assessing alternative acceptance is significant for describing tour-based travel behavior and increases the value of travel time estimates for subway, bus, and taxi.

Momoka Ozono and *Shintaro Terabe*

Estimating Bus Passenger Counts Using Wi-Fi Packet Sensors: a Background Noise Cancellation Approach

ABSTRACT. It is important for bus operators to understand the number of passengers on their buses in order to create operation plans, such as the number of buses and routes. This study uses Wi-Fi packet sensors on small buses to estimate passenger volume by detecting Wi-Fi signals from smartphones. It distinguishes passenger signals from non-passenger signals, treating the latter as background noise. The background noise is pre-estimated through regression analysis, using route characteristics like road width, land use, and the number of buildings as dependent variables. Two estimation methods, linear and non-linear regression were tried and compared. The regression equation method estimating the amount of background noise did not have a high coefficient of determination. It will be necessary to increase the number of independent variables for estimating background noise to improve the goodness of fit.

Jonas Jostmann, *Tong Mo*, *Haoyan Wang* and *Zhenliang Ma*

Open Source Digital Twin Platform for Public Transport: a Case Study in Stockholm

ABSTRACT. Despite its practical potential, the current adoption of Digital Twins (DT) in the transportation domain and especially in Public Transport (PT) is relatively slow. A significant barrier is the substantial effort and investment in resources required during the development phase, especially for informative visualizations, thus limiting its accessibility to PT agencies. The study proposes an automated development pipeline of DT for PT, which uses Open Source software and data that make it easy to access and extend. We demonstrate the functionality of the pipeline using a scenario in Kista, Stockholm and discuss the potentials and limitations of DT for practical use cases from a conceptual perspective.

Bastian Henríquez, *Jacqueline Arriagada* and *Alejandro Tirachini*

Evidence of the Impact of Real-Time Information on Passenger Satisfaction Across Varying Public Transport Quality in 13 Chilean Cities

ABSTRACT. This paper examines the impact of real-time information apps on passenger satisfaction and their interaction with actual public transport (PT) service quality in 13 Chilean cities. We introduce two methodological innovations. First, we combine a discrete choice model with sentiment analysis using a Large Language Model (ChatGPT-3.5-turbo) to classify responses to an open-ended satisfaction question, integrating qualitative insights into a quantitative framework. Second, we incorporate an objective service quality measure—a headway reliability index based on bus GPS data—improving upon traditional models that rely solely on perceived service attributes. The model captures how satisfaction is shaped by service attributes, app-induced behavior, and perception shifts. Findings reveal a synergistic effect: real-time information enhances satisfaction, particularly under high-quality service conditions. Sentiment analysis shows that 70% of satisfied users value wait time information and time management enabled by the app, while 12% of dissatisfied users criticize low bus frequency and data inaccuracies. These results underscore the importance of real-time information in improving user experience and support the case for user-centered policies. Expanding access to reliable real-time data is especially critical in developing countries, where it can significantly boost satisfaction with PT systems.

Yihang Huang, *Qian Fu*, *David Jaroszweski* and *Lee Chapman*

Impact of Weather on Bus Ridership: Evidence and Insights from Smart Card Data in West Midlands, UK

ABSTRACT. As extreme weather events become more frequent, public transport users face growing challenges due to unreliable services and changing environmental conditions. This study examines the impact of weather conditions on bus ridership in the West Midlands, United Kingdom, using six years (2016-2022) of transit smart card data and hourly weather observations. Through a matched-pair analysis, we examine the relationships between key weather variables (e.g. precipitation and temperature) and bus ridership across different passenger groups, including commuters, students, children, elderly and disabled individuals. To better capture outdoor thermal conditions, we also incorporate thermal comfort indices that combine temperature with other meteorological factors. The findings reveal that the elderly and disabled passengers are the most sensitive to weather variations, primarily due to their greater flexibility

in travel scheduling and higher vulnerability to extreme conditions. Precipitation exerted a strong negative impact on ridership. A warm environment also influences travel behaviour, particularly among the elderly and disabled, with thermal comfort indices providing a better measure of these impacts than temperature alone. These findings contribute to a more comprehensive understanding of weather-related impacts on urban bus usage and provide valuable insights for developing more inclusive and weather-resilient transport systems.

Minsu Kim, *Jiho Yeo* and *Sugie Lee*

Building Realistic GTFS Data Using Smart Card and Bus Information Data

ABSTRACT. This study proposes a methodology to generate GTFS (General Transit Feed Specification) data reflecting actual driving patterns using smart card data and bus operation information. GTFS is a data standard that provides public transportation service information in a standardized format, but existing GTFS reflects only the planned schedule and differs from the actual driving situation. In this study, a realistic GTFS data generation process based on smart card data was developed and applied to bus routes in Seoul.

Motohiko Shiraiwa and *Ryosuke Abe*

Impact of Road-Based Public Transportation Frequency on People's Activity Levels Using GPS Tracking Data

ABSTRACT. Establishing a “public transportation corridor” that links high-frequency service with urban planning is considered a practical measure for sustainable urban mobility. This study aims to analyze the impact of bus service frequencies on people's activity levels, including the number of passengers and pedestrians along the route. We organized a dataset before and after the 2024 large-scale bus frequency reduction in Yokohama City, Japan, regarding service frequencies and the numbers of passengers and pedestrians along the route. Large-scale GPS tracking data is used to count these numbers. We then use a difference-in-difference analysis to estimate the impact using the dataset.

Theeranai Pullarp, *Hyungsub Jee*, *Jan-Dirk Schmöcker*, *Sean Barbeau* and *Kari Watkins*

Understading Transit Information Inquiry Patterns Through Long-Term Crowd-Sourced Trajecotry Data

ABSTRACT. Mobile applications have become cost-effective tools to obtain both long-term crowd sourced trajectory data for travel behaviour and app interaction logs for transit information inquiry patterns. This study used long-term data collected from 445 Puget Sound (Washington State, US) residents through the “OneBusAway” transit application. The strength of the data is the ability to obtain travel records continuously and that participating users provide data over long-time. The focus of this study is on the captured inquiry information regarding bus arrivals at stops. The study discusses users’ behaviour in inquiring real-time bus information and then shows the relationship between app usage and actual travel behaviour. Regular transit users appear to inquire as much as infrequent ones.

Diego Da Silva, *Mayuri Annerose Morais* and *Raphael Camargo*

Strategies for Implementing Open Data Technology in Public Transportation: a Case Study in Porto Alegre, Brazil

ABSTRACT. The Public Transportation (PT) sector is undergoing significant transformation, driven by open data technology, new data sources, and innovative management techniques. Open data enhances transparency, fosters collaboration, and supports innovation but requires robust data architectures for integration, security, and usability. The growing reliance on Advanced Public Transportation Systems (APTS) and disruptive technologies, such as AI models, has increased data complexity, emphasizing the need for advanced strategies to manage diverse data. This analysis will draw insights from various sources to examine strategies, best practices, and the key challenges and opportunities of creating effective open data architectures for PT agencies. We also present an open data architecture case study in Porto Alegre, Brazil.

Eunah Hong, *Taeseok Kang* and *Junghwa Kim*

Identifying Potential Long-Term Users in on-Demand Services Using DBSCANClustering

ABSTRACT. On-demand services are gaining attention as a flexible and efficient alternative to traditional fixed-route transportation systems. This study analyzes the users of On-Demand Service in Osong, Cheongju, South Korea, to identify potential long-term users of on-demand services. DBSCAN clustering is applied to distinguish long-term user characteristics. The results of this study contribute to understanding user characteristics and provide insights into strategies for enhancing service sustainability. This research strengthens the optimization of on-demand service operations by integrating clustering techniques, ensuring improved accessibility and service efficiency.

Anne Mercier, *Loïc Bodart* and *Christian Clerc*

Clustering Run Time Anomalies in Public Transit Data Using AI: a Case Study with the Transit Operator of Geneva

ABSTRACT. We present a novel approach to clustering run time anomalies using the Density-Based Spatial Clustering of Applications with Noise (DBSCAN) algorithm. Our methodology applies the DBSCAN machine-learning clustering algorithm to detect, group, and classify anomalies based on spatial and temporal characteristics. Our study focuses on real-time vehicle location data collected by the transit operator in Geneva, Switzerland. The objective is to enhance the efficiency of anomaly investigation by categorizing anomalies into three types: isolated, periodic, and continuous. Isolated anomalies occur sporadically over very short time intervals. Continuous anomalies, on the other hand, are persistent and ongoing, often indicating a systemic issue that requires immediate attention. Periodic anomalies are characterized by their recurring nature at regular intervals. The results of our study demonstrated the model's efficacy, successfully identifying all clusters of anomalies previously recognized by planners in Geneva. By forming clusters based on similar spatial and temporal characteristics, our approach enables targeted investigations. For instance, on-site verifications of recurring disruptions can be conducted more efficiently, thereby improving the overall reliability of public transit systems.

Georges Sfeir, *Filipe Rodrigues*, *Ravi Seshadri* and *Carlos Lima Azevedo*

Choice Sets and Smart Card Data in Public Transport Route Choice Models: Generated Vs. Empirical Sets

ABSTRACT. This study evaluates path sets generation for route choice models in multimodal public transportation networks, using both conventional (network algorithms) and empirical (smart card data driven) methods. While the empirical approach can present limitations with a short observation period, it improves substantially with more data, offering a computational efficiency advantage over conventional methods. In such approach, while incorporating real -world delays increased travel time variability, it still aligned with planned travel times, and relaxing access/egress assumptions further enhanced coverage. Work is undergoing on the evaluation of the impact of different choice sets in bias and efficiency of route choice parameter estimates.

Xavier Blessy David, *Varun Varghese*, *Makoto Chikaraishi* and *Akimasa Fujiwara*

A Novel Crowding Contribution Index Using Automated Fare Collection Data from Delhi, India

ABSTRACT. Abstract: Crowding in public transit impacts system efficiency and reliability. This study introduces a novel Crowding Contribution Index (CCI) to quantify how destination stations contribute to link-level congestion using Automated Fare Collection (AFC) data collected from Delhi Metro Rail Corporation, India. A linear mixed-effects model was developed to assess the influence of built environment factors, including Point of Interest (POI) entropy, POI density, and relative wealth variables. Results indicate that higher land-use diversity reduces a station's contribution to link-level crowding, while higher POI density increases it. Findings emphasize the need for decentralized development strategies and transit-oriented policies to alleviate the lopsided contribution of a few stations to link-level crowding in metro systems.

Paul Bouman

Towards Convenient Software for Event-Activity Network Based Data Visualization

ABSTRACT. While graphical train schedules are commonly used in the public transport research community, there seems to be little choice for open and free software to draw these diagrams from timetable data. This poster aims to discuss an effort to address this. By employing a modular and extensive design, open source software could be used to experiment with novel ways to visualize public transport data easily and conveniently.

P5A: Network Design, Reliability and Vulnerability

Wen Meng, *Tao Liu*, *Jian Gao* and *Yin Su*

Deployment Planning for a Modular Autonomous Vehicle-Based Shuttle Transit System

ABSTRACT. This study investigates the optimal deployment planning of a modular autonomous vehicle (MAV)-based shuttle transit line that connects an autonomous rail rapid transit (ART) station and a high-speed railway station. The proposed methodology establishes MAV dispatching plans and platoon formations while ensuring seamless transfer coordination with ART arrival times. A mathematical programming model and a graphical scheduling model are employed to determine the required MAV

fleet size. A case study conducted in Yibin, China, validates the feasibility and practical applicability of the methodology, showcasing its potential to enhance seamless integrated mobility under the concept of Mobility-as-a-Service.

Yujie Huang and *Zhipeng Zhang*

Impact of Adverse Weather on Weekday Peak-Hour Metro Ridership Dynamics: a Case Study of Shanghai

ABSTRACT. This study quantitatively investigates the impact of adverse weather on metro ridership dynamics during weekday peak hours, focusing on station-level variations and associated safety risks. Quantitative indicators, including peak values, directional imbalance, and flow concentration and deviation, are developed and analysed using a quasi-experimental approach. The analytics and impact evaluations are based on Automatic Fare Collection (AFC) data and weather records from Shanghai's flood season. Results reveal that extreme weather increases crowding risks with elevating peak ridership and directional imbalance at specific stations, while time-indexed characteristics remain largely unaffected. The findings offer implications for crowd safety enhancement under extreme weather.

Mingrui Liu, *Wai Yuen Szeto* and *Sujun Sun*

Bus Network Design with the Integration of Limited-Stop and Autonomous Bus Services

ABSTRACT. This study aims to solve the bus network design problem with the integration of limited stop service and consideration of autonomous bus operation to optimize both the total passenger travel time, the number of transfers, and the operator cost. This problem is modelled as a mixed integer nonlinear program and is NP-hard. A hybrid genetic algorithm is proposed in the solution methodology which can tackle the normal bus line design, limited stop service pattern design, autonomous bus line selection, and frequency setting problems simultaneously. The hybrid algorithm encapsulates a line search heuristic, a pattern design heuristic and an autonomous line selection heuristic to tackle the frequency setting problem, the limited stop service design problem and the autonomous bus lines determination problem respectively. Specific genetic mutation operators are developed to explore lines operated by autonomous buses. Compared with the base case of bus network design, the developed algorithm can generate a solution that can reduce the total passenger travel time and operator cost simultaneously. Numerical experiments are also implemented to demonstrate the effects of the value of travel time.

Molin Zhao and *Baonan Gu*

Potential Corridor Search Method for Rail Transit Network Design

ABSTRACT. In this study, we focus on practical and quantitative methods for designing rail transit networks. We generalize the corridor characteristics of rail transit networks and develop a potential rail transit corridor search algorithm. Potential rail transit network schemes are generated on the basis of the potential rules and algorithms of rail transit corridor combinations. These network schemes are evaluated by splitting the model and evaluating the total social costs, facilitating the identification of efficient alternatives. The method is implemented and validated in a case study, demonstrating its feasibility,

efficacy, and suitability for practical planning applications.

Li Zhen, *Weihua Gu*, *Minyu Shen*, *Yu Li* and *Zhixian Tang*

Optimal Trunk-Feeder Transit Network Design Under Heterogeneous Demand

ABSTRACT. With the extension of urbanization, enhancing efficient trunk-feeder transit systems becomes crucial to accommodate the escalating travel demand. A well-designed trunk-feeder network not only improves travel efficiency on trunk lines but also bolsters connectivity and flexibility through feeder services. In this paper, based on the heterogeneity of travel demand, we optimize a heterogeneous trunk-feeder transit network design using continuous models. We consider both the heterogeneous demand density and heterogeneous network design. This study pioneers a model that integrates heterogeneous trunk-line designs and multiple service modes. This model advances beyond previous studies that predominantly focused on homogeneous transit network designs or single service modalities. Our findings provide valuable insights for urban planners and policymakers in developing more adaptive and efficient transit solutions.

Congying Han, *Jing Teng*, *Congjian Liu* and *Tao Wang*

Bi-Level Optimization Model for Customized Tourist Bus Routes and Ticket Pricing in Tidal Tourist Traffic: a Case Study of Chongming Island, Shanghai

ABSTRACT. This study addresses tidal tourist traffic in scenic areas by proposing a bi-level optimization model for customized tourist bus routes and ticket pricing. The upper-level model optimizes routes, frequencies, and ticket prices to maximize operator revenue, while the lower-level model minimizes tourists' travel costs. A case study on Chongming Island demonstrates significant improvements in operational efficiency, vehicle utilization, and passenger waiting time. A sensitivity analysis was also conducted to assess the impact of varying pricing and scheduling strategies on both tourist behavior and operational outcomes, offering practical insights for sustainable transport in tidal tourist areas.

Thiago Carvalho and *Ahmed El-Geneidy*

Measuring the Impacts of a Major Metro Disruption in Montreal, Canada on Riders' Satisfaction and Willingness to Recommend the Service to Others

ABSTRACT. On October 3rd, 2024, three stations along the east end of Montreal's blue metro line were closed, resulting in a seven-day service disruption. While previous studies have examined the operational impacts of such disruptions, their effects on user experiences remain underexplored. To address this gap, we measure the impacts of the closure on user satisfaction and their willingness to recommend transit services. Using data from a bilingual online survey launched the day after the disruption began, we analyzed responses from blue line users (N= 655) by employing ordered probit models. The survey included a treatment group of riders directly impacted by the closure (N = 361) and a control group of those unaffected (N = 294). Additionally, we incorporate data from a secondary survey conducted one prior to the closure, which included riders living close to blue line stations (N = 161), as a secondary control. Our findings reveal a significant decrease in both user satisfaction and willingness to recommend transit services among those impacted by the metro closure. However, these negative impacts can be

mitigated when users perceive the availability of reliable and suitable transit alternatives. The findings from this research can be of interest to practitioners and policymakers as they highlight the broader implications of metro disruptions.

Robin Gaborit, *Evelien van der Hurk*, *Yu Jiang*, *Konstantinos Zografos*, *Ahmed Kheiri* and *Otto A. Nielsen*

A Model for Passenger Oriented Integrated Frequency Setting, Timetabling, and Vehicle Scheduling

ABSTRACT. Passenger service depends on line frequencies and the resulting timetable. Operating costs are largely defined by the vehicle schedule. Traditionally, the frequencies, timetable and vehicle schedule are determined sequentially, which may lead to suboptimal solutions. Moreover, pre-assignment of passengers to routes could lead to further suboptimality. To avoid this, we integrate frequency setting, timetabling, and vehicle scheduling to create a-periodic full-day timetables for medium-to-large urban bus networks, where passenger route choice depends on the final timetable. Another specificity of our model is the division of the daily timetable into a few periods with different frequencies. This allows for the adaptation of the number of bus services to the time dependency of the demand. Headways are regular within each period to make the timetable easier to memorise for passengers. To solve this problem, we develop problem-specific low-level heuristics and a hyper-heuristic algorithm based on sequences of low-level heuristics. We present computational results derived from real-life data on the Odense bus network in Denmark. We focus on demonstrating the value of integrating frequency setting, timetabling, vehicle scheduling, and passenger route choice. We also measure the impact of the set of allowed frequencies on passenger and operation costs.

Zhi Li, *Ning Zhang* and *Xu Dong Guo*

A Public Transportation Network Optimization Method Based on Reinforcement Learning

ABSTRACT. The line planning problem has been well studied in the literature. Most models aim to minimize the costs or to maximize the number of direct travellers. But the new bus system Nova Xarxa in Barcelona proves that properly designed transfer-based networks can be very appealing and even attract more demand than their conventional counterparts. This design is based on the analytical model proposed by Daganzo (2010), which has two main limitations. First, the model assumes that origins and destinations are uniformly and independently distributed, and second it produces conceptual plans for particular road network topology in the city such as a grid, hub-and-spoke systems, and a hybrid of both. This paper presents a two-stage discrete model to construct transfer-based bus networks for any demand distribution and for any road network topology. We take a new approach maximizing the passenger flow intensity (PFI) to keep the costs low for the public transportation company. Additionally, this approach considers transfer from one line to another at the same stop to reduce the walk distance. To tackle our problem, we present a reinforcement learning method and suggest a solution approach using MCTS for finding the optimal bus network. Numerical results of real-world instances are presented.

Mina Nasab and *Rajan Batta*

Optimization Approach for Emergency Evacuation Using Public Transit

ABSTRACT. Effective evacuation planning is essential for disaster management, especially in urban areas with vulnerable populations that rely on public transit. This paper introduces an optimization framework for transit-based evacuation planning, focusing on multi-trip bus routing under capacity and time constraints. The model incorporates regional balance to ensure equitable service distribution across evacuation zones. Using a column generation approach and a bucket graph-based labeling algorithm, the study dynamically generates feasible routes, improving operational efficiency and equity. Results from synthetic datasets highlight the model ability to maximize evacuee coverage while balancing resource allocation, demonstrating its potential for real-world disaster preparedness.

Xin Li, *Sai Zhang*, *Huaiyue Li* and *Yun Yuan*

Robust Collaborative Timetabling and Bus Interlining Optimization Under Travel Time Uncertainty

ABSTRACT. Uncertain travel time may break the linkage between interlining bus shifts and lead to low bus service punctuality and unreliable bus utilization. To address this issue, a two-stage robust bus timetabling and scheduling optimization model is proposed. The effectiveness of the model and algorithm is verified through a case study of five bus lines. Results show that compared with the traditional fixed schedule-based interlining scheduling plan, the proposed method shorten the stand-by time by 29.55%. Analysis finds that TCPs reduce the arrival time deviation of buses and the total cost of vehicle use, and improve vehicle work efficiency and punctuality.

Liya Ma, *Yao Chen* and *Xujie Feng*

Emergency Bus Route Optimization for Passenger Evacuation in Response to Metro Disruptions

ABSTRACT. As a primary mode within urban rail transit systems, metro plays a critical role in supporting urban development. However, operational disruptions due to equipment failures, severe weather conditions, or maintenance activities occur periodically. Emergency buses serve as a timely and reliable alternative, effectively mitigating the adverse impacts of metro service disruptions. This study focuses on optimizing emergency bus dispatch in the context of metro operational disruptions. To prevent congestion at turnaround stations and improve passenger evacuation efficiency, we propose a flexible shuttle strategy based on dynamic passenger demand with deadhead routes, considering both turnaround stations and nearby transfer stations in disrupted areas as potential destinations. By adopting rolling horizon optimization, the model can adapt to variations in passenger demand in real time, dynamically adjusting emergency bus dispatch plans. A multi-objective nonlinear optimization model is developed to minimize total evacuation time, passenger travel delay and penalty costs, which is then linearized and solved using Cplex. The feasibility and effectiveness of the model are validated through a simulation of a sudden disruption during the morning peak on Shenzhen metro line segment. Results show that the proposed scheme outperforms traditional approaches in reducing both total evacuation time and passenger delay.

Xinyu Liu, *Jing Zhao* and *Xiaoguang Yang*

Transit Route Network Planning from the Societal Perspective: a Particle Swarm Optimization Based Algorithm

ABSTRACT. Urban transit is facing challenges on ridership decline in recent years, sparking debate on the appropriate extent of transit service provision. To incorporate internal and external effects of transit, this study proposed a planning framework to minimize total social monetary cost integrating decisions of network design, frequency setting, fleet size, and government subsidies in the multimodal system with transit and automobiles. A Particle-Swarm-Optimization-based algorithm was designed to solve the problem, which exhibited effectiveness on saving social cost and improving transit service quality. Effects of transit speed and value of time were analyzed to better understand transit provision under different scenarios.

Juho Lee, *Sion Kim*, *Ryujeong Lee*, *Ilho Jeong*, *Minje Choi* and *Seungjae Lee*

Temporal Cascading-Failure Dynamics in Seoul's Coupled Urban Transit Network Under Event-Induced Disruptions

ABSTRACT. Seoul's bus and subway system was modelled as a time-dynamic multiplex graph to simulate cascading failures. Validation against strike and protest logs shows buses are fragile to random shocks, whereas subways are vulnerable to centrality-targeted attacks. When vulnerabilities overlap, a boundary section triggers abrupt network fragmentation. The model accurately reproduced passenger rerouting and segmentation patterns observed in smart-card data. A tiered response protocol integrating timed detours, real-time information and adaptive schedules offers actionable guidance for operators to reinforce resilience and reduce disruption costs.

Enoch Lee, *Manzi Li* and *Yue Huai*

Co-Modality in Transit: a Stochastic Elastic Framework for Integrating Freight and Passenger Services

ABSTRACT. The integration of freight and passenger transit within flexible urban transportation systems offers significant opportunities for enhancing vehicle utilization and service reliability. This paper introduces a two-stage stochastic model to optimize co-modality transit services under uncertain demand and service times. By considering elastic stochastic demand, the model addresses the trade-off between operational cost, service quality and travel time cost. Results demonstrate that integrating freight with passenger transit improves efficiency, reduces ad hoc service costs, and promotes sustainability in urban mobility.

Tygo Nijsten, *Aliki Pouliasi* and *Michael Sederlin*

Bus Rapid Transit Network Design: Planning Routes and Upgrading Stops Among Multiple Municipalities

ABSTRACT. Bus Rapid Transit (BRT) lines provide a fast and reliable alternative to regular bus systems at a lower cost than building rail infrastructure. They can enhance public transportation and thus support more sustainable travel. However, BRT lines often require upgraded stops, meaning additional

investments are necessary. BRT lines typically span multiple municipalities responsible for the investments, often with varying interests. In this paper, we address the problem of selecting optimal routes and stops for BRT lines considering municipal interests. Moreover, we evaluate our proposed model through a case study in Greater Copenhagen, highlighting the relevance of considering the different municipalities.

Filippos Alogdianakis and *Loukas Dimitriou*

Designing Joint Fixed and Flexible Public Transit Networks for the X-Minute City

ABSTRACT. Modern urban areas face growing mobility challenges, with transit systems crucial to addressing congestion but often insufficient compared to private cars. Extending fixed-route transit with flexible services like Demand -Responsive Transit (DRT) is a promising solution for multi -modal systems. This study proposes a multi objective transit network design problem (TrNDP) combining fixed and flexible transit via hierarchical optimization. A network morphogenesis module designs fixed routes, while DRT is integra ted as a Capacitated Vehicle Routing Problem (CVRP). The approach optimizes network configurations and coverage in Nicosia, showcasing the synergy between transit modes. This robust method supports pre-tender planning for achieving efficient, X-minute cities.

Yuxuan Wang, *Catherine Morency* and *Martin Trépanier*

Examining Transit Reliability Using an Origin-Destination Reliability Matrix

ABSTRACT. Transit reliability is important for the agencies and passengers. Most of the existing literature focused on the reliability experienced by actual passengers or on the accessibility of destinations for potential passengers. However, we can still ask the question what would have been the service reliability for passengers traveling on low-demand origin-destination pairs, and what would be the potential reliability for potential passengers making regular trips across the whole service area? We propose to analyze the potential transit reliability by simulating passenger trips across the entire service area using a routing engine and archived service delivery data. Then we evaluate the planned against the delivered travel times to determine the potential reliability across the region using discrete metrics similar to on-time performance and continuous metrics like buffer times. Finally, we try to discover potential spatial and temporal variations of these calculated potential transit reliability.

Aman Sharma and *N Nezamuddin*

Resilient Electric Bus System Design Considering Power Grid Disruptions

ABSTRACT. Transit operators worldwide are transitioning to electric buses to mitigate greenhouse gas emissions. This introduces new challenges for the operators and policymakers as electric buses depend on electricity, increasing the significance of a city's power grid infrastructure. Any power grid failure has the potential to disrupt the advertised schedule of the electric bus service by introducing delays and trip losses, leading to unmet passenger demand. This study proposes a methodology to design an electric bus system considering the relationship between a city's power grid and its electric bus system. The proposed framework is formulated as a Mixed Integer Linear Program (MILP) and attempts to minimize the worst-case trip losses in the network with the possibility of spatial failure of power grid substations in a city.

The framework is then applied to the bus and power grid network of Delhi, India. Results indicate that the proposed methodology can reduce the potential trip loss in the network by 30 % with marginal additional costs from a cost-optimal electric bus system. The study highlights the need to diverge from the typical cost-optimal design and leads to policy recommendations regarding the power grid infrastructure and electric bus system design of a city.

Seyedehsima Madani, *Kris Braekers* and *Imre Keseru*

Optimising the Design of a Hybrid Urban Mobility System

ABSTRACT. Although traditional public transportation, known as a fixed-route transit (FRT) system, is a cost-efficient transit mode in areas with high demand, it is often perceived as inconvenient due to the lack of flexibility. On the other hand, demand-responsive transit (DRT) systems, known as a flex-route transit system, have a high per-capita operating cost due to their personalized nature. This research proposes a bi-level optimization approach to design a hybrid transit system integrating FRT and DRT systems. At the upper level, the FRT network design is optimized, incorporating the optimized routes and schedules of DRT vehicles determined at the lower level.

Zain Ul Abedin

Trade-Offs Between Coverage and Ridership Maximization in Transit Network Design: an Empirical Analysis

ABSTRACT. This study examines the trade-offs between ridership-maximization and coverage-maximization approaches in transit network design. Using historical ridership data, smart card fare collection, and service patterns, two network scenarios were developed under constant resource constraints. The ridership-maximization scenario projects 9% ridership growth while serving 48% of the population, whereas the coverage-maximization scenario maintains 74% population access with 6% ridership growth. Both scenarios demonstrate a 4.5% immediate revenue loss compared to the existing network, with potential ridership growth of 9% and 6% respectively, suggesting that network optimization requires careful balancing of efficiency and accessibility objectives.

Julia Bickel, *Maxim Meijers* and *Niels van Oort*

Evaluating Transfer Reliability in Public Transport Route Choices Based on Smartcard Data

ABSTRACT. This study investigates the reliability of bus-to-bus transfers in the network of Dutch regional bus operator EBS based on anonymized smartcard, GTFS and AVL data. The reliability of a transfer is calculated by evaluating both the cancellation rate of trips and the punctuality of the two buses. More than 50% of transfers are made within 5 minutes while there are little synchronized transfers in the area. Unreliable transfers are less common while more than 50% of made transfers are feasible in more than 80% of the time. Unreliable transfers have the highest potential waiting time when missing the transfer.

Yijing Dai, *Rong Cheng*, *Tao Liu* and *Yu Jiang*

Route Optimization for Demand-Responsive Connector Service with Multi-Passenger Requests and Route Travel Time Constraint

ABSTRACT. This study proposes an integer programming model to optimize demand-responsive connector (DRC) vehicle routing, incorporating multi-passenger requests and route travel time constraints. The model aims to minimize total costs, including fleet size, vehicle operating expenses, and penalties for deviations from passengers' desired boarding times. A tailored meta-heuristic algorithm is developed to solve the model efficiently, ensuring scalability for real-world applications. The model and algorithm are validated through a real-world DRC case study, demonstrating its effectiveness in balancing operational efficiency and passenger satisfaction. The results highlight the model's potential to enhance DRC systems by reducing costs and improving service quality.

Yuhan Tang, *John Attanucci*, *Jinhua Zhao* and *Haris Koutsopoulos*

Fine-Tuning Bus Running and Cycle Times by More Carefully Addressing the Tradeoffs Among Passenger Delays, Reliability, and Operating Costs

ABSTARCT. Current bus scheduling often relies on static and high-percentile runtimes, ignoring demand variations and delay propagation. Using robust optimization, this research proposes a flexible approach that allocates extra cycle time to bus trips whose delays propagate to downstream high-demand trips, aiming to enhance reliability and minimize passenger delays. By allowing minor lateness on some runs that won significantly impact subsequent high-demand trips, the method avoids extra operating costs while improving overall service. Focusing on CTA routes, the study examines schedule gaps and runtime variability to guide improved recovery times, resulting in more dependable, efficient, and passenger-centered bus scheduling approach.

P5B: Transit Modeling

Lin Lin, *Orlando Rivera Letelier*, *Xinyu Wang* and *Andrés Fielbaum*

Scheduling an Electrified Public Transport Ferry System via a MILP

ABSTRACT. The electrification of ferry systems introduces substantial operational challenges due to high energy demands, charging requirements, and berth limitations. This paper proposes a Mixed Integer Linear Programming (MILP) model to optimize vessel scheduling and timetabling for electrified public transport ferries. The model minimizes a convex combination of fleet size and unproductive rebalancing time, while explicitly incorporating charging constraints, berth capacities, and crew rest periods. To ensure scalability, we develop problem-specific heuristics and apply them to a real-world case study in Sydney, Australia. The model generates feasible, efficient itineraries that outperform the benchmarks. Notably, results show that with sufficient charging infrastructure, fleet size can be reduced without significantly increasing idle time. On the other hand, electrification of the Sydney ferry network could be unfeasible depending on the charging technology. This framework supports strategic planning for electrified public transport ferries, contributing to the decarbonisation of the transport sector.

Chuhan Yin, *Zhiyuan Lin* and *David Watling*

A Hybrid Heuristic Approach for Integrated Railway Train Unit and Driver Scheduling

ABSTRACT. In passenger rail operations, train unit and driver scheduling are typically solved separately in a sequential way. This research proposes an integrated model combining these tasks for optimal schedules. A pre-generation strategy for driver shifts is used, but the vast number of potential shifts complicates solving large instances. To address this, a hybrid heuristic iteratively activates key empty-running trips and relief opportunities, reducing complexity while retaining critical solution components. Tests on synthetic timetables compare heuristic results with a direct ILP solver and sequential scheduling. The integrated model achieves cost savings, while the heuristic improves computational efficiency.

Jun Gong, *Wai Yuen Szeto* and *Sin Cheung Ho*

An Enhanced Artificial Bee Colony Algorithm for Multiperiod Asymmetric Transit Frequency Design

ABSTRACT. A multi-period asymmetric transit frequency design problem is formulated for a bus operation strategy, in which a class of buses serves both directions while the other class only serves one direction with high travel demand for each route, to address demand variation and demand asymmetry. An enhanced artificial bee colony algorithm is proposed to solve it. Numerical experiments demonstrate that the proposed algorithm can produce better solutions compared with the modified genetic algorithm and the proposed design outperforms the existing design with less passenger travel time and greater demand satisfaction, operating profit, and social welfare.

Yanjun Liu and *Huiyuan Lu*

How to Promote the Implementation of Mobility as a Service (Maas) in China: an Analysis Based on a Tripartite Game Analysis

ABSTRACT. In China, the government-led approach to Mobility as a Service (MaaS) implementation presents unique challenges and opportunities. This study examines the dynamics between government, bike-sharing companies, and metro operators in China's MaaS implementation using evolutionary game theory, analysing how to balance stakeholder interests. The findings reveal government leadership is essential for stable cooperation, while subsidies speed up but don't determine final outcomes. Increased regulation promotes faster operator cooperation. The study provides policy recommendations including proactive government strategies, targeted subsidies, and public-private partnerships, which are valuable for policymakers with government-led transportation initiatives, offering a framework to balance public oversight with market.

Rubén Jiménez, *Manuel Fuentes* and *Luis Cadarso*

Refleeting Tail Assignment-Driven Aircraft Routing Model

ABSTRACT. Airline planning involves complex, large-scale combinatorial optimization problems that are typically addressed sequentially. However, disruptions in operational conditions introduce new constraints, requiring adjustments to aircraft rotations, tail assignments, and fleet allocation. This study proposes a dynamic assignment model that integrates these elements to enhance operational flexibility

while maintaining cost efficiency. The problem is formulated as a mixed-integer linear program using a directed acyclic graph representation. Computational experiments over a two-day planning horizon, based on data from a European airline network, show that the model ensures routing feasibility, meets maintenance requirements, and effectively optimizes refleeting decisions.

Shabnam Dabagh, *Lory Michelle Bresciani Miristice* and *Guido Gentile*

Doubly Constrained Gravity Models for Accessibility Analysis by Public Transport: a Comparative Evaluation of Two Approaches

ABSTRACT. This study evaluates accessibility via public transport and satisfaction levels to hospitals in urban environments using doubly constrained gravity approaches. By balancing origin demands and destination capacities, these approaches offer a realistic assessment of accessibility. A web-based application was developed to compute and visualize results for Rome, Italy. Findings reveal significant disparities, with central areas having higher accessibility and satisfaction. Moreover, the relaxed approach demonstrated higher satisfaction levels compared to the strict approach by allowing partial utilization of destination capacities and better accounting for real-world constraints. These results highlight the need for targeted interventions to improve equity in underserved zones.

Nien-Tzu Han, *Yi-Chen Lin*, *Cheng-Chung Young* and *Yung-Cheng Lai*

Multi-Level Programming Model for Revenue Analysis in Vertically Separated Rail Networks

ABSTRACT. Sustainable revenue balance is a critical issue for the global railway industry, requiring collaboration among all organizations. This research develops multi-level programming models based on market roles: the infrastructure manager sets access charges, the train operator determines ticket pricing and service plans, and passengers generate demand. A case study demonstrates the models' suitability for current market conditions, providing valuable insights for revenue analysis and future railway reforms.

Tara Saeidi, *Babak Mehran* and *Ahmed Ashraf*

Rl Guided Genetic Algorithm for Zoning a DRT Service

ABSTRACT. This study presents a service zoning framework that integrates Reinforcement Learning with a Genetic Algorithm within a Demand-Responsive Transit network. The objective is to demonstrate the model's effectiveness, particularly in adapting to varying travel demand patterns and improving upon initial solutions. The reward function is designed considering key elements of the DRT cost function, ensuring alignment with operational goals. Evaluation on a 10x10 grid network demonstrates the framework's convergence and adaptability across different scenarios, with optimized zones aligning closely with demand patterns. This data-driven approach offers a practical solution for improving transit operations and holds promising potential for real-world applications.

Nastaran Tork and *Alireza Khani*

A Last-Mile Delivery Approach Using Public Buses and Bicycle Crowd- Shipping Systems

ABSTRACT. The rapid growth of online shopping has led to an increase in delivery vehicles on urban roads, exacerbating traffic congestion and greenhouse gas emissions. This study introduces the Bus-to-

Bicycle (B2B) delivery framework, which integrates parcel transportation into existing public bus networks and leverages reward-based participation from bicyclists for last-mile delivery. The proposed framework addresses a complex multi-agent matching problem involving the assignment of packages to buses, allocation of locker space, and coordination with available bicyclists for final delivery. To reduce computational complexity, the model restricts its search to a set of pre-identified feasible matches. Results demonstrate that the B2B framework reduces vehicle miles traveled, enhances the utilization of underutilized bus capacity, and promotes the use of active transportation modes.

Homero Larrain

Optimizing Express Service Design: the 'Go Big or Go Home' Rule

ABSTRACT. This study introduces a simplified model to analyze the operation of express services in public transportation corridors. The model provides a straightforward method to determine when implementing an express service is worthwhile and at what frequency it should operate. Building on the "go big or go home" hypothesis, the study demonstrates that express services are only efficient when operating above a critical frequency to avoid congestion in the "danger zone." Through numerical experiments across diverse scenarios, the results confirm the validity of this approach and propose a formula to estimate potential savings from implementing express services.

Jinyi Pan, *Ronghui Liu* and *Zhiyuan Lin*

ADMM-Based Optimization Method for Scheduling Extra Trains on a High-Speed Rail Corridor

ABSTRACT. This paper studies the problem of scheduling extra trains into an existing timetable where the existing timetable is allowed to change and the schedule for the extra trains has constraints on their departure-time windows. The objectives are to minimise alterations to the existing timetable and the total travel time of extra trains. We model the problem as an Integer Linear Program (ILP) using a space-time network and employ the Alternating Direction Method of Multipliers (ADMM) framework to decompose it into subproblems per train, each solved using a time-dependent shortest-path algorithm. Computational tests on a real-life double-track high-speed railway network demonstrate the effectiveness and efficiency of the proposed approach.

Min-Ci Sun and *Luca Quadrifoglio*

A Multi-Objective Model for Shared-Ride Automated Services to Reduce the Price of Anarchy

ABSTRACT. The emergence of Automated Mobility-on-Demand (AMoD) services, such as Waymo and Zoox, is reshaping urban transportation. Yet, the increasing demand and expanding robotaxi fleets may worsen traffic congestion. This study presents a novel centralized ride-matching framework designed to improve the scheduling efficiency of Shared-Ride Automated Mobility-on-Demand Services (SRAMODS). The proposed adaptive, multi-objective model incorporates the perspectives of on-site, in-vehicle riders, as well as robotaxi operators, by minimizing on-site waiting times, in-vehicle travel durations, and detour distances. The model operates dynamically within each time epoch, with each robotaxi able to serve up to four riders concurrently. A case study using the 2019 Chicago taxi data demonstrates that varying objective weights yield different match outcomes, while a balanced weighting

configuration minimizes total time expenditure. Compared to conventional decentralized approaches, the SRAMODS framework reduces the price of anarchy, measured by distance traveled per rider, by up to 24%. These results underscore the value of centralized coordination in promoting shared robotaxi adoption, offering policy guidance to enhance urban mobility and reduce system inefficiencies and congestion.

Yuto Obata, *Toshiyuki Nakamura*, *Satoshi Sugiura*, *Masahiro Kuwahara* and *Fumitaka Kurauchi*

Designing Community Transit Network Systems Using Spanning Tree-Based Method

ABSTRACT. Designing routes for community transit systems operated by municipalities often faces the challenge of limited data availability due to constrained budgets and human resources. This study applies the Transit Network Design Model, which assumes a spanning tree structure, and investigates whether the model, initially developed for urban areas, can also be effectively applied to less populated regions. Furthermore, it explores the use of Mobile Device Location (MDL) data to simulate scenarios where conventional usage records are unavailable. The results reveal that network designs derived from MDL data closely resemble those based on actual usage records.

Ming Zhu, *Yihui Wang*, *Kun Ji* and *Yanzhang Zhao*

Foreign Object Detection and Comparative Analysis at Railway Crossings

ABSTRACT. In order to reduce the probability of accidents caused by the intrusion of foreign objects at railway crossings, there is great potential for foreign objects detection in advance. This paper uses cameras to collect images of foreign objects at railway crossings and divides the objects around the track into 10 categories through a self-made dataset. In addition, the popular YOLO series models are used for foreign object detection and comparative analysis based on the self-made image dataset. In the experimental results of the dataset proposed in this paper, the mAP50-95 and mAP50 can reach more than 70% and 90% respectively.

Hanna Vasiutina, *Olha Shulika*, *Michał Bujak*, *Farnoud Ghasemi* and *Rafał Kucharski*

Methodology for Identifying the Most Suitable Urban Area for Implementing on-Demand Feeder Bus Services

ABSTRACT. Successful implementation of on-demand feeder bus services requires thorough analysis to ensure their effectiveness and public acceptance. However, policymakers lack tools to identify suitable locations for introducing such services. This study proposes a utility-based simulation framework to evaluate area attractiveness by assessing service key performance indicators under uncertain demand. We report a case study comparing Bronowice and Skotniki areas in Krakow, Poland, where such services are planned. Based on the results of the simulation experiment, Skotniki area demonstrated greater potential for feeder attractiveness and added value across a wide range of alternative-specific constants, which we assume unknown.

Yu-Kai Huang, *Jun Toyotani*, *Chung-Cheng Lu* and *Jyun-Kai Liang*

Balancing Act: Kyoto's Quest to Manage Overtourism Through Ai-Powered Traffic Distribution

ABSTRACT. This study examines the competition for transportation resources between residents and tourists in Kyoto City, with a focus on the complex dynamics arising from overtourism. Utilizing the cusp catastrophe model and the theory of planned behavior, this rese arch investigates the nonlinear relationship between behavioral intentions and critical thresholds, providing insights into the impacts of overtourism on local residents. To address these issues, the study proposes AI-driven diversion strategies designed to balance the transportation demands of both tourists and residents, reduce tourism -related environmental pressures, and promote a sustainable and harmonious coexistence between tourism and local communities. The findings of this research aim to serve as a reference framework for other tourism destinations facing similar transportation challenges associated with overtourism.

Haoran Zhao and *Andrés Fielbaum*

A Hybrid Bus Design for Ridership Fluctuation

ABSTRACT. Buses serve a significant portion of public transit ridership. Moving beyond the deterministic ridership, we incorporate online coordination and flexible buses into traditional buses for stochastic ridership, named hybrid model. We apply continuous approximation, which enables studying critical questions such as fleet sizing and frequencies. We find that: 1) Capacity manages the ridership randomness more efficiently than frequency. 2) The incorporation outperforms only traditional bus under high ridership variance. These findings demonstrate to bus operators online coordination and route flexibility can effective manage demand inherent randomness.

Dung-Ying Lin and *Manwo Ng*

A Heuristic for the Driver Scheduling Problem in Passenger Rail Transportation

ABSTRACT. Optimizing driver scheduling in passenger railway systems poses a critical operational challenge with direct implications for resource efficiency and service reliability. Given the problem's NP-complete nature, effective solution strategies must balance computational tractability with practical feasibility. This study proposes a novel three-phase methodology integrating depth-first search, a weight-based selection heuristic, and local search optimization. In the first phase, depth-first search generates feasible driver duties that comply with contractual and operational constraints. The second phase assigns duties using a weight-based heuristic to construct complete schedules that cover all required trips. The final phase applies local search to refine solutions through neighborhood-based improvements. Computational experiments using real-world data from a railway system with over 800 trips demonstrate the approach’s scalability and high solution quality. The results confirm the practical applicability of the proposed method to large-scale railway crew scheduling problems.

Jiahao Wang and *Amer Shalaby*

Transforming Historical Incident Records into Explainable, Experience-Based Decisions: a Knowledge Graph and LLM Approach

ABSTRACT. Urban transit systems frequently experience bus bunching, crowding, and idling, which

degrade service quality. iROAM is an integrated toolbox for anomaly detection, data preprocessing, and visualization that fuses Automatic Vehicle Location (AVL), Automatic Passenger Counting (APC), and General Transit Feed Specification (GTFS) data. Its configurable pipeline allows fast threshold adjustments for labeling multiple anomalies. Through a case study on Toronto's Route 29, iROAM demonstrates enhanced diagnostic capabilities and real-time adaptability, informing timely interventions. Future development integrates predictive modeling to provide proactive alerts, further supporting transit agencies in mitigating service disruptions and improving overall operational efficiency.

Jie Zeng, *Hongxing Ding*, *Xinwei Li* and *Hai Yang*

A Dynamic System Towards Dual User Equilibria Under the Booking Cum Rationing Scheme

ABSTRACT. This study develops a dynamic system under an efficient and equitable reservation-based travel demand management scheme, named booking cum rationing (BCR), designed to converge to dual user equilibria: a daily equilibrium and a periodic equilibrium. Under the BCR scheme, travelers have limited opportunities to book restricted links during a period while facing endogenous uncertainty of failing to use restricted routes due to overbooking, where booking demand exceeds link capacity. Cost-minimization behavior and endogenous uncertainty encourage travelers to strategically budget their booking chances to mitigate periodic travel costs. We formulate travelers' sequential decision-making as a Markov decision process to capture day-to-day flow dynamics within each period. To ensure daily bottleneck capacities, a projection-based quadratic optimization model is proposed to determine the daily success rate for bookings on restricted routes. Additionally, we examine a period-to-period learning method to describe travelers' learning behaviors under this periodic scheme. The existence of the equilibria is established, and we further explore a range of properties of the equilibria, such as the connections with the static equilibria in the BCR system. Preliminary findings indicate that, under mild conditions, the proposed dynamic system converges to the dual user equilibria.

Bisheng He, *Fengquan Wang*, *Guangyuan Zhang*, *Andrea D'Ariano* and *Qian Ge*

An Optimization Approach for the Bus-Assisted Drone Routing and Charging Problem in the Last-Mile Delivery Systems

ABSTRACT. The rapid growth of e-commerce has created significant challenges to last-mile delivery, driving the adoption of drones for fast and cost-efficient service. However, the limited battery capacity of drones necessitates collaboration with trucks or access to charging stations to extend their operational range. Although trucks can provide line-haul transportation from distribution centers to customers, they contribute to traffic congestion and often face restricted access in small communities. Charging stations require substantial investment on infrastructure. This paper proposes an alternative solution, i.e., integrating drones with bus networks. Buses can carry drones, recharge their batteries, and deploy them at bus stops nearest to delivery destinations. Integrating drones with buses could help avoid traffic congestion caused by trucks, reduce the total delivery times, and provide additional revenue opportunities for bus operators. This study addresses operational challenges in this integrated system, such as synchronizing drone operations with bus schedules and routes, determining optimal stops for landing and taking off, and managing capacity constraints in terms of bus space and drone battery usage. We introduce

a novel variant of the drone-routing problem, termed the bus-assisted drone routing and charging problem, and develop a branch-and-price-and-check algorithm to find the exact solutions. The proposed method offers a promising solution for deploying drones in last-mile delivery systems.

Giuseppe Perona and *Marta González*

A Simple Electrical Circuit Model for Public Transit

ABSTRACT. Transportation planning in urban areas often relies on understanding and predicting public transit usage patterns. In this work, we present a novel resistive circuit model for public transit systems. By modeling passenger flow as electrical current and travel time as resistance, we provide an interpretable approach to travel flow modeling, accounting for the influence of suboptimal yet feasible routes. Using a toy transit network, we demonstrate the model's ability to predict ridership patterns, and quantify responses to changes in service. Future research will focus on validating the model with real-world data. The codebase for this project is available on Github.

Noriel Christopher Tiglao and *Erris Sanciangco*

Machine Learning-Based Planning and Decision-Making for Paratransit Operations in Developing Countries

ABSTRACT. In developing countries, paratransit refers to informal transportation services which cater to populations that either lack access to public transportation altogether or lack access to sufficient, high-quality service. A variety of paratransit modes operated by small-scale operators, legally or illegally continues to play a significant role in the urban transport systems as these forms of transportation are able to respond to shifting market demands and fill the gaps which are unserved by formal public transport services. While their gradual elimination has been suggested as the way forward, paratransit operations may also support more formal public transportation. The study presents the development of prototype machine learning-based planning and decision-making tool using crowdsourced vehicle tracking and ridership data. This system integrates with the pilot deployment of the SafeTravelPH public transport crowdsourcing and information exchange platform in General Santos City, Philippines to ingest the data feeds into an open dashboard which can quickly and intuitively provide visualizations and querying tools in order to assist local government units and transport stakeholders with public transport policymaking. The initial test of the system has garnered approval and support from local government units and public utility jeepney cooperatives towards greater compliance with the Public Utility Vehicle Modernization Program (PUVMP) which the government launched in 2017.

Prasetyaning Diah Rizky Lestari, *Ronghui Liu* and *Richard Batley*

Joint Optimisation of Line Planning and Timetabling with a Focus on Economic and Societal Benefit

ABSTRACT. Railway line planning and timetabling are closely linked, with their integration improving service quality for operators and passengers. This research focuses on jointly optimising both while considering economic and societal benefits. Beyond operational efficiency, this approach promotes a sustainable, inclusive, and passenger-centric transport system and serves as a decision-support tool for

better planning strategies in new railway service development.

Tarun Rambha

Cyclic Vehicle Scheduling Problem

ABSTRACT. The Vehicle Scheduling Problem (VSP) assigns vehicles to trips in a transit system to minimize the number of vehicles or the cost of deadheading. This problem is usually formulated assuming all vehicles start and end at depots within a specific time horizon (say for 24 hours). Operations are typically assumed to go through a complete reset at the end of the time horizon. However, there are always some active trips (late night and early morning) in real-world settings. This work focuses primarily on scheduling trips that can be periodically executed for such scenarios. A mixed-integer programming formulation is first derived to capture these features and is compared with the classical VSP. Results from airport shuttles in Bengaluru, India, demonstrate the proposed model's utility.

Yu Gu and *Anthony Chen*

Modeling Adaptive Capacity of Urban Rail Transit Network with Complementary Shuttle Buses

ABSTRACT. Adaptive capacity is an important aspect of urban rail transit network (URTN) resilience, indicating the ability to mitigate negative effects of disruptions via emergency actions like the operation of complementary shuttle bus services. Complementary shuttle buses help transport metro passengers stranded at disrupted rail lines, but could lead to even more chaos owing to their limited capacity under severe disruptions. This study develops a multi-modal network capacity model to facilitate understanding the adaptive capacity of URTN. Both supply- and demand-side adaptation stresses will be considered, namely the insufficient capacities of shuttle bus services and the heterogeneous adaptation behaviors of metro passengers.

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