Eunhan Ka

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Education

Purdue University *United States*
Ph.D., Lyles School of Civil and Construction Engineering *Dec. 2025*
- **Dissertation: Physics-Informed Neural Networks for Secure Connected and Autonomous Traffic Modeling**
- Committee: Satish V. Ukkusuri (Chair), Ludovic Leclercq, Yiheng Feng, Z. Berkay Celik
- Specialties: Physics-Informed Neural Networks, Traffic Dynamics, Network Resilience, User Behavior, Cybersecurity in Transportation Systems

Seoul National University *South Korea*
M.S., Department of Civil and Environmental Engineering *Feb. 2018*

Seoul National University *South Korea*
B.S., Department of Civil and Environmental Engineering *Feb. 2016*

Selected Publications & Awards

Selected Publications

1. **Ka, E.** and Ukkusuri, S. V. (2025). Route Guidance Attacks in Cyber Transportation Networks: A User-Centered Study of Behavioral Sensitivity. ***Transportation Research Part F: Traffic Psychology and Behaviour***, 115, 103354.
2. Xue, J., **Ka, E.**, and Ukkusuri, S. V. (2024). Network Macroscopic Fundamental Diagram-Informed Graph Learning for Traffic State Imputation. ***Transportation Research Part B: Methodological***, 189, 102996.
3. **Ka, E.**, Xue, J., Leclercq, L., and Ukkusuri, S. V. (2024). A Physics-Informed Machine Learning for Estimating Traffic State with a Generalized Bathtub Model in Large-scale Urban Networks. ***Transportation Research Part C: Emerging Technologies***, 164, 104661.
4. **Ka, E.**, Sharma, S., and Ukkusuri, S. V. (2022). Leveraging Location-Based Data for Assessing Network-Level Traffic Impact of Lane Management: A Case Study of Alex Fraser Bridge. *Journal of Transportation Engineering, Part A: Systems*, 148(12), 04022105. **[2022 Editor's Choice Collections]**

Selected Awards

1. **Google Cloud Research Credits** - Cloud computing grant, *Google Cloud*. Aug. 2025
2. **2025 ITE Great Lakes District Student Paper Award** - First Place in regional student paper competition, *Great Lakes District of ITE (GLITE)*. June 2025
3. **Honorable Mention, 2025 Clifford Spiegelman Student Paper Competition**, *The Transportation Statistics Interest Group of the American Statistical Association*. Jan. 2025
4. **Kinnier Graduate Scholarship & STV Civil Engineering Graduate Assistantship Endowment**, *Lyles School of Civil and Construction Engineering, Purdue University*. Oct. 2024

Research Interests

Physics-informed and data-driven modeling of network traffic dynamics and resilience, integrating behavioral models, game theory, and scientific discovery across traffic engineering and machine learning.

- **Themes**: Network Traffic Dynamics, Network Resilience and Reliability, Large-Scale State Estimation, Connected and Autonomous Mobility, Transportation Cybersecurity, Human Behavior and Safety
- **Methods**: Physics-Informed Learning, Graph & Network Learning, Game-Theoretic Modeling, Symbolic Learning and Scientific Discovery, Optimization and Simulation, Spatiotemporal Data Analytics

Research Experience

Postdoctoral Researcher *Jan. 2026 - Present*

Purdue University, United States

- **Design a resilience-based prioritization framework** for a submitted INDOT proposal (**$200,000**, **Co-PI**), enabling cooperative UAV-UGV teams to automate road maintenance.
- Develop modeling and decision-support methods for **network resilience under compound climate and cyber disruptions**, quantifying disruption propagation, reliability loss, and recovery at the city scale.
- Build a **Resilient Mobility Digital Twin** that couples traffic-flow theory with physics-informed learning and data assimilation to estimate network states, quantify uncertainty, and forecast performance under disruptions.
- Design **behavior-aware threat and defense models** for connected/autonomous mobility (e.g., route guidance manipulation), enabling robust detection and mitigation focused on network-level outcomes.
- Develop **scalable algorithms and reproducible pipelines** (multi-resolution modeling and graph-based spatiotemporal inference) to support publication-quality evaluation and proposal-ready deliverables.

Graduate Research Assistant *Aug. 2020 - Dec. 2025*

Purdue University, United States

- Developed an integrated framework that enhances road network resilience against cyber threats using physics-informed deep learning for large-scale transportation cyber-physical systems, enabling more precise traffic state estimation (published in **Transportation Research Part B and Part C, 2024; Transportation Research Part F, 2025**). *(Sponsor: USDOT University Transportation Center-TraCR)*
- Conducted a statewide workforce needs assessment to identify skill gaps and designed training strategies to improve engagement and performance (presented at **Purdue Road School, Mar. 2025**). *(Sponsor: INDOT)*
- Analyzed network-level impacts of a movable median barrier on the Alex Fraser Bridge using mobile location data (Journal of Transportation Engineering, Part A, 2022; **Editor's Choice**). *(Sponsor: Lindsay Corporation)*
- Led **proposal development** and managed **project execution** from initiation through major milestones and closeout when applicable **in the capacity of a Graduate Research Assistant** under the supervision of Dr. Satish V. Ukkusuri (Principal Investigator). **Selected Projects**:
  1. Attracting and Retaining the Transportation Workforce and At Risk Targeted Areas (Sponsor: INDOT. October 1, 2024 to September 30, 2026. $225,000. Technical leadership share: 50%).
  2. A Multi Resolution Simulation Platform for Transportation System Security Testing and Evaluation (Sponsor: USDOT University Transportation Center TraCR. January 1, 2024 to December 31, 2024. $340,000 including cost share. Technical leadership share: 25%).
  3. Training Gap Analysis for INDOT Workforce (Sponsor: INDOT. October 15, 2023 to October 14, 2025. $213,500. Technical leadership share: 35%).

Researcher *Mar. 2018 - Aug. 2020*

Seoul National University, South Korea

- Designed cluster-based routes for demand-responsive transport using multi-capacity vehicles to serve passengers with disabilities (presented at **99th TRBAM**). *(Sponsor: T-Money Welfare Foundation)*
- Modeled lane-changing on freeways and gap-acceptance behavior at roundabouts using real-world data and virtual reality simulations (published in **Journal of Advanced Transportation, 2018**). *(Sponsor: Ministry of Land, Infrastructure and Transport, South Korea)*

Graduate Research Assistant *Mar. 2016 - Feb. 2018*

Seoul National University, South Korea

- Designed a real-time vehicle relocation strategy and an event-based simulation for one-way car-sharing services (presented at **multiple conferences, 2016-2018**). *(Sponsor: National Research Foundation of Korea)*
- Developed a methodology to evaluate driver behavior using surrogate safety measures (published in **Journal of Advanced Transportation, 2020**). *(Sponsor: Ministry of Land, Infrastructure and Transport, South Korea)*

Publications

Submitted for Publication

1. **Ka, E.**, Yeke, D., Celik, Z. B., and Ukkusuri, S. V. (In Revision, Second Round). Fake Rush Hour: Exploring Bounded Rational Route Guidance Attacks on Urban Navigation Systems. *47th IEEE Symposium on Security and Privacy*.

2. **Ka, E.** and Ukkusuri, S. V. (In Revision). Driver Behavior-Aware Resilience of Traffic Networks under Route Guidance Attacks. *Transportmetrica B: Transport Dynamics*.
3. **Ka, E.**, Leclercq, L., and Ukkusuri, S. V. (Under Review). Adaptive Spatial-Temporal Domain Decomposition in Physics-Informed Neural Networks for Traffic State Estimation. *Transportation Research Part C: Emerging Technologies*.
4. **Ka, E.**, Mittal, S., and Ukkusuri, S. V. (Under Review). Investigating Career-Stage Variations in Skill Proficiency and Workforce Development Support at a State Department of Transportation. *Journal of Transportation Engineering, Part A: Systems*.

Refereed Journal Publications

1. **Ka, E.** and Ukkusuri, S. V. (2025). Route Guidance Attacks in Cyber Transportation Networks: A User-Centered Study of Behavioral Sensitivity. *Transportation Research Part F: Traffic Psychology and Behaviour*, 115, 103354.
2. Ukkusuri, S. V.*, Hamim, O. F.*, Lei, Z.*, **Ka, E.***, Salek, M. S., Chowdhury, M., Amini, M. H., Cardenas, A., and Thuraisingham B. (2025). Cybersecurity for Next-Generation Road Transportation: A Review. *ACM Journal on Autonomous Transportation Systems*. (*Contributed equally to this research).
3. Xue, J., **Ka, E.**, and Ukkusuri, S. V. (2024). Network Macroscopic Fundamental Diagram-Informed Graph Learning for Traffic State Imputation. *Transportation Research Part B: Methodological*, 189, 102996.
4. **Ka, E.**, Xue, J., Leclercq, L., and Ukkusuri, S. V. (2024). A Physics-Informed Machine Learning for Estimating Traffic State with a Generalized Bathtub Model in Large-scale Urban Networks. *Transportation Research Part C: Emerging Technologies*, 164, 104661.
5. **Ka, E.**, Sharma, S., and Ukkusuri, S. V. (2022). Leveraging Location-Based Data for Assessing Network-Level Traffic Impact of Lane Management: A Case Study of Alex Fraser Bridge. *Journal of Transportation Engineering, Part A: Systems*, 148(12), 04022105. **[2022 Editor's Choice Collections]**
6. **Ka, E.**, Kim, D. G., Hong, J., and Lee, C. (2020). Implementing Surrogate Safety Measures in Driving Simulator and Evaluating the Safety Effects of Simulator-Based Training on Risky Driving Behaviors. *Journal of Advanced Transportation*, 2020(1), 7525721.
7. Lee, D., Hwang, S., **Ka, E.**, and Lee, C. (2018). Evaluation of the Rain Effects on Gap Acceptance Behavior at Roundabouts by a Logit Model. *Journal of Advanced Transportation*, 2018(1), 2726732.

Refereed Conference Proceedings

1. **Ka, E.** and Ukkusuri, S. V. (2025). Analytical Framework for Network-Level Traffic Flow under Route Guidance Attacks: An Extension of the Generalized Bathtub Model. *104th Annual Meeting of the Transportation Research Board*, Washington, D.C., United States.
2. **Ka, E.** and Ukkusuri, S. V. (2025). Comparative Analysis of Sampling Methods in Physics-Informed Neural Networks for Traffic State Estimation in Large-Scale Road Networks. *104th Annual Meeting of the Transportation Research Board*, Washington, D.C., United States.
3. **Ka, E.**, and Ukkusuri, S. V. (2024). Impact of Cyber Attacks on Traffic State Estimation for Connected and Autonomous Vehicles Systems. *The Inaugural USDOT Future of Transportation (FoT) Summit*, Washington, D.C., United States.
4. Xue, J., **Ka, E.**, and Ukkusuri, S. V. (2024). Network Macroscopic Fundamental Diagram-Informed Graph Learning for Traffic State Imputation. *ISTTT25: 25th International Symposium on Transportation and Traffic Theory*, Ann Arbor, MI, United States.
5. **Ka, E.**, Xue, J., and Ukkusuri, S. V. (2024). PIDL-PedFlow: A Physics-Informed Deep Learning Approach for Macroscopic Continuum Pedestrian Flow Modelling. *103rd Annual Meeting of the Transportation Research Board*, Washington, D.C., United States.
6. Xue, J., **Ka, E.**, Mondal, W. U., and Ukkusuri, S. V. (2024). Generating Network-Level Dynamic Traffic Equations Using Symbolic Regression. *103rd Annual Meeting of the Transportation Research Board*, Washington, D.C., United States.
7. Sharma, S., and **Ka, E.** (2024). Leveraging Location-Based Data for Assessing Network Level Traffic Impact of Lane Management: A Case Study of Alex Fraser Bridge. *103rd Annual Meeting of the Transportation Research Board*, Washington, D.C., United States.
8. **Ka, E.**, and Ukkusuri, S. V. (2023). Dynamic Routing Games for Connected and Autonomous Vehicles with Traffic Congestion: A Mean Field Game Approach. *2023 INFORMS Annual Meeting*, Phoenix, AZ, United States.

9. **Ka, E.**, Ka, D., Jung, Y., and Lee, C. (2020). A Cluster-Based Route Design of Multi-Capacity Vehicle in Large-Scale Demand Responsive Transport Service for the Disabled. *99th Annual Meeting of the Transportation Research Board*, Washington, D.C., United States.
10. **Ka, E.**, Hong, D., Na, Y., and Lee, C. (2018). Analysis of Status in DRT Service for the Disabled in Seoul and Comparison Domestic and Foreign Cases. *International Conference for Road Engineers*, Jeju, South Korea.
11. Hong, D., **Ka, E.**, Ha, S., and Lee, C. (2018). Selection of Appropriate Hyperparameter for Waiting Time Prediction Model for Demand Responsive Transport for the Disabled in Seoul Using Long Short-Term Memory (LSTM) Network. *78th Korean Society of Transportation Conference*, Wonju, South Korea. **[Outstanding Paper Award]**.
12. **Ka, E.**, Kim, S., Hong, J., and Lee, C. (2017). A Preliminary Study of Comparison with Lane Changing Model Parameters in Merging Area between Normal and Raining Conditions. *12th International Conference of Eastern Asia's Society for Transportation Studies (EASTS)*, Ho Chi Minh, Vietnam.
13. **Ka, E.**, Kim, S., Woo, D., and Lee, C. (2016). An Estimation of Critical Gap for Gap Acceptance Model Applied to Lane Change of Surrounding Vehicles in Driving Simulator. *2016 Fall Korea Institute of ITS Conference*, Jeju, South Korea.
14. Lee, S., Lee, H., Lee, J., **Ka, E.**, and Lee, C. (2016). Analysis of Traffic Flow Impacts of Highway Traffic Accidents Using Survival Analysis. *74th Korean Society of Transportation Conference*, Jeju, South Korea. **[Outstanding Paper Award]**.

Books and Technical Reports

1. **Ka, E.** and Ukkusuri, S. V. (In Revision). Misdirected Guidance and Urban Traffic Network Resilience (*Book Title: Advances in Transportation Cybersecurity and Resilience*). *World Scientific Publishing*.
2. Hamim, O. F., Lei, Z., **Ka, E.**, and Ukkusuri, S. V. (In Revision). Understanding Cyber Threats in Cyber-Physical Mobility Systems (*Book Title: Advances in Transportation Cybersecurity and Resilience*). *World Scientific Publishing*.
3. Verma, R., Luo, H., Deodhar, S., **Ka, E.**, Chahine, R., Natu, P., Malhotra, H., Polisetty, V., Thakkar, D. J., Ukkusuri, S. V., Cai, H., Dunlop, S. R., Iyer, A. V., Gkritza, K. (2023). Forecasting Shifts in Hoosiers' Travel Demand and Behavior. *FHWA/IN/JTRP-2023/28, SPR-4608*.

Awards, Fellowships & Grants

Google Cloud Research Credits (Cloud Computing Grant) *Aug. 2025*
Google Cloud

2025 ITE Great Lakes District Student Paper Award & GLITE Endowment Fund *June 2025*
Great Lakes District of Institute of Transportation Engineers (GLITE)

Honorable Mention, 2025 Clifford Spiegelman Student Paper Competition *Jan. 2025*
The Transportation Statistics Interest Group of the American Statistical Association

2025 KOTAA Travel Grant Award *Jan. 2025*
Korean Transportation Association in America (KOTAA)

Travel Grant *Dec. 2024*
Purdue Graduate Student Government and the Graduate School

Student Paper Award *Dec. 2024*
ITE Indiana

Kinnier Graduate Scholarship *Oct. 2024*
Lyles School of Civil and Construction Engineering, Purdue University

STV Civil Engineering Graduate Assistantship Endowment *Oct. 2024*
Lyles School of Civil and Construction Engineering, Purdue University

2024 KOTAA Travel Grant Award *Jan. 2024*
Korean Transportation Association in America (KOTAA)

Crooks Travel Scholarship *Sep. 2023*
Lyles School of Civil Engineering, Purdue University

Outstanding Paper Award *Mar. 2018*
78th Conference of Korean Society of Transportation, Korean Society of Transportation

Outstanding Paper Award *Feb. 2016*
74th Conference of Korean Society of Transportation, Korean Society of Transportation

Presentations - Keynotes, Plenary Talks, Invited Seminars

1. Needs and Gap Assessment of INDOT Workforce Development. *2025 Purdue Road School Transportation Conference and Expo*. March 18, 2025.
2. A Physics-Informed Machine Learning for Generalized Bathtub Model in Large-Scale Urban Networks. *TRB ACP50 Committee on Traffic Flow Theory and Characteristics General Webinar Series*. March 17, 2023.

Teaching & Mentoring Experience

Undergraduate Mentorship *Fall 2024 - Spring 2025*
Lyles School of Civil and Construction Engineering, Purdue University
- Akshit Kumar Bedi, Abrar Ali (resulting in a **poster presentation**, 2025 CERIAS Cybersecurity Symposium)

Teaching Assistant *Spring 2021 - Fall 2024*
Lyles School of Civil and Construction Engineering, Purdue University
- CE 661: Algorithms in Transportation *(Graduate; co-developed new course curriculum)* *Fall 2024*
- CE 597: Network Models for Connected and Autonomous Vehicles (Graduate) *Fall 2021 - Fall 2023*
- CE 597: Smart Logistics (Graduate) *Fall 2021, Fall 2024*
- CE 597: Data Science for Smart Cities (Graduate) *(Developed online course on **edX**)* *Spring 2021, Fall 2023*

Lecturer *Fall 2019*
Dept. of Civil and Environmental Engineering, Seoul National University
- Introduction to Civil and Environmental Engineering (Undergraduate)

Teaching Assistant *Fall 2016 - Fall 2017*
Dept. of Civil and Environmental Engineering, Seoul National University
- Sustainable Transportation Systems (Graduate) *Fall 2017*
- Advanced Transportation Operation (Graduate) *Spring 2017*
- Leadership for Civil Engineers (Undergraduate) *Spring 2017*
- Introduction to Transportation Engineering (Undergraduate) *Fall 2016*

Academic Service and Professional Activities

Academic Service
- **Journal Referee**: Transportation Research Part B: Methodological; Transportation Research Part C: Emerging Technologies; Transportation Research Part F: Traffic Psychology and Behaviour; Transportation Research Interdisciplinary Perspectives; Transportation; Scientific Reports; The Journal of Supercomputing; Journal of Cloud Computing; Transportation Research Record: Journal of the Transportation Research Board; Journal of Transportation Engineering, Part A: Systems; Data Science for Transportation
- **Conference Referee**: Transportation Research Board; IEEE Intelligent Transportation Systems Conference (ITSC); ISTTT25 (Co-reviewer); ISTTT26 (Co-reviewer)

Professional Activities
- **Association for Computing Machinery (ACM)**: Professional Member (Aug. 2025 - Current)
- **American Society of Civil Engineers (ASCE)**: Associate Member (May 2025 - Current); Student Member (Sep. 2022 - Apr. 2025); **AI Committee**: Corresponding Member (Aug. 2025 - Current)
- **Institute of Electrical and Electronics Engineers (IEEE)**: Student Member (May 2025 - Current)
- **Institute for Operations Research and the Management Sciences (INFORMS)**: Student Member (May 2023 - Current)
- **Institute of Transportation Engineers (ITE) Purdue Student Chapter**: Communications Director (Aug. 2024 - July 2025); Member (Aug. 2020 - Current)

Technical Skills

Programming

- **Python (with TensorFlow, PyTorch, Keras, PySpark, and GeoPandas)**: Machine learning and deep learning models based on TensorFlow, PyTorch, and Keras; Massive data (e.g., mobile phone location data) preprocessing for trip data extraction based on PySpark and GeoPandas
- **R**: Time-series analysis; Data preprocessing; Data clustering; Data visualization; Discrete choice modeling; and Statistical analysis
- **Java (with CPLEX)**: Agent-based simulation (demand responsive transport services); Event-based simulation (one-way car-sharing services); Optimization models using the API of CPLEX

Software: MATLAB, CPLEX, SPSS, NLOGIT, TransCAD, LaTeX

References

Satish V. Ukkusuri (Advisor)
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