

Eunhan Ka

POSTDOCTORAL RESEARCHER · LYLES SCHOOL OF CIVIL AND CONSTRUCTION ENGINEERING, PURDUE UNIVERSITY
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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

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.**, 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.
2. **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.
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.**, 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

Modeling of network traffic dynamics, resilience, and large-scale state estimation, using physics-informed and data-driven methods that integrate behavioral models, game theory, and optimization across traffic engineering and machine learning.

- **Themes:** Network Traffic Dynamics, Large-Scale Traffic State Estimation, Network Resilience and Reliability, Connected and Automated Mobility, Human Behavior and Safety, Transportation Cybersecurity.
- **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.**, Leclercq, L., and Ukkusuri, S. V. (Under Review). Adaptive Domain Decomposition Physics-Informed Neural Networks for Traffic State Estimation with Sparse Sensor Data. *Transportation Research Part C: Emerging Technologies*.

2. **Ka, E.** and Ukkusuri, S. V. (Under Review). Day-to-Day Traffic Network Modeling under Route-Guidance Misinformation: Endogenous Trust and Resilience in CAV Environments. *IEEE Transactions on Intelligent Transportation Systems*.
3. **Ka, E.**, Mittal, S., and Ukkusuri, S. V. (Under Review). Career-Stage-Specific Training Priorities for State DOT Workforce Development: An Integrated Regression and Importance-Performance Analysis. *Transportation Research Record: Journal of the Transportation Research Board*.
4. **Ka, E.**, Yeke, D., Celik, Z. B., and Ukkusuri, S. V. (Under Review). Fake Rush Hour: Exploring Bounded Rational Route Guidance Attacks on Urban Navigation Systems. *ACM Journal on Autonomous Transportation Systems*.
5. **Ka, E.** and Ukkusuri, S. V. (Under Review). Trust-Gated Information Sharing in Day-to-Day Traffic Dynamics: When Does Degraded Guidance Amplify or Neutralize Network Performance?. *14th Symposium of the European Association for Research in Transportation – hEART 2026*.
6. Ali, A., Liu, L., Ojeme, B., Anadozie, C., Agyemang, F., Ukkusuri, S., **Ka, E.**, and Mittal, S. (Under Review). Strengthening the Transportation Cybersecurity Workforce: A Mixed-Methods Analysis of Workforce Development, Organizational Preparedness and Cross-Sector Collaboration. *Future Transportation*.

REFEREED JOURNAL PUBLICATIONS

1. **Ka, E.** and Ukkusuri, S. V. (2026). Resilience of Traffic Networks to Route Guidance Attacks: The Role of Driver Behaviour Heterogeneity. *Transportmetrica B: Transport Dynamics*, 14, 1.
2. **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.
3. 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).
4. Xue, J., **Ka, E.**, Feng, Y., and Ukkusuri, S. V. (2024). Network Macroscopic Fundamental Diagram-Informed Graph Learning for Traffic State Imputation. *Transportation Research Part B: Methodological*, 189, 102996.
5. **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.
6. **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]**
7. **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.
8. 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.**, Yeke, D., Celik, Z. B., and Ukkusuri, S. V. (2026). MIRAGE: Detecting Fake Emergency Electronic Brake Light Attacks in V2X Networks via Event-Gated Behavioral Analysis. *4th USENIX Symposium on Vehicle Security and Privacy (VehicleSec'26)*. Baltimore, MD, United States
2. **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.
3. **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.
4. **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.
5. 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.

6. **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.
7. 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.
8. 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.
9. **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.
10. **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.
11. **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.
12. 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]**.
13. **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.
14. **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.
15. 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 Press). Chapter 5. 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 Press). Chapter 1. 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*.

PATENTS AND INTELLECTUAL PROPERTY

1. Ukkusuri, S. V. and **Ka, E.** (2026). System and Method for Trusted Route Guidance with Anomaly Detection. *U.S. Provisional Patent Application No. 63/989,950, filed February 24, 2026. Purdue Research Foundation. Patent pending.*

Awards, Fellowships & Grants

Google Cloud Research Credits (Cloud Computing Grant) Google Cloud	Aug. 2025
2025 ITE Great Lakes District Student Paper Award & GLITE Endowment Fund Great Lakes District of Institute of Transportation Engineers (GLITE)	June 2025
Honorable Mention, 2025 Clifford Spiegelman Student Paper Competition The Transportation Statistics Interest Group of the American Statistical Association	Jan. 2025
2025 KOTAA Travel Grant Award Korean Transportation Association in America (KOTAA)	Jan. 2025

Student Paper Award ITE Indiana	Dec. 2024
Kinnier Graduate Scholarship Lyles School of Civil and Construction Engineering, Purdue University	Oct. 2024
STV Civil Engineering Graduate Assistantship Endowment Lyles School of Civil and Construction Engineering, Purdue University	Oct. 2024
2024 KOTAA Travel Grant Award Korean Transportation Association in America (KOTAA)	Jan. 2024
Crooks Travel Scholarship Lyles School of Civil Engineering, Purdue University	Sep. 2023
Outstanding Paper Award 78th Conference of Korean Society of Transportation, Korean Society of Transportation	Mar. 2018
Outstanding Paper Award 74th Conference of Korean Society of Transportation, Korean Society of Transportation	Feb. 2016

Presentations - Keynotes, Plenary Talks, Invited Seminars _____

1. Physics-Informed AI for Transportation Systems. *CGN 6425: Applied Data Science in Civil and Environmental Engineering, University of Florida*. April 2, 2026.
2. Needs and Gap Assessment of INDOT Workforce Development. *2025 Purdue Road School Transportation Conference and Expo*. March 18, 2025.
3. A Physics-Informed Machine Learning for Generalized Bathtub Model in Large-Scale Urban Networks. *TRBACP50 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; Electric Power Systems Research; 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):** Member (May 2025 - Current)
- **Institute for Operations Research and the Management Sciences (INFORMS):** 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)

Hubert and Audrey Kleasen Professor,
Lyles School of Civil and Construction
Engineering; courtesy appointment in Computer
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Purdue University
West Lafayette, IN, USA
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Z. Berkay Celik

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Yiheng Feng

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Lyles School of Civil and Construction
Engineering,
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Ludovic Leclercq

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