ZAIRA PAGAN CAJIGAS

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EXECUTIVE SUMMARY

An **applied engineer** with expertise in operations research and advanced data analytics. Experienced in designing and implementing data-driven solutions to improve efficiency, reduce risk, and support strategic decision-making across industry, government, and non-profit sectors. Skilled in developing simulation-based tools to assess system performance, guide investment decisions, and communicate actionable insights to technical and non-technical audiences.

EDUCATION

Ph.D., **Industrial and Operations Engineering,** *University of Michigan, Ann Arbor, MI* 2025
Advisor: Seth Guikema, Ph.D.
GPA: 4.00/4.00

M.S.E., **Industrial and Operations Engineering,** *University of Michigan, Ann Arbor, MI* 2022
GPA: 4.00/4.00

B.S., **Industrial Engineering,** *University of Puerto Rico, Mayaguez, PR* 2020
Academic Honor: Magna Cum Laude
Departmental Honor: Frederick W. Taylor Award
GPA: 3.89/4.00

Faculty of Economics and Business, *Universidad Complutense de Madrid, Madrid, Spain* 2018
Courses: International Relationships, Global Leadership, Psychology of Communication

TECHNICAL EXPERTISE

Methodologies: simulation, simulation – optimization, data analytics, machine learning, predictive modeling, statistical analysis, spatial analysis, parallel high-performance computing, probabilistic risk assessment, infrastructure risk modeling, quantitative risk analysis, decision-support under uncertainty.

Programming Tools: Proficient in R, Python, MATLAB, Simio, EPANET, QGIS, and ArcGIS.

INDUSTRY EXPERIENCE

One Concern Inc., Menlo Park, CA 2022
Data Analyst

- Designed and implemented a scalable synthetic water distribution system using open-source geospatial and infrastructure datasets, enabling data-driven analysis on system performance in the absence of proprietary utility data.
- Applied network reduction techniques (e.g., skeletonization, intersection continuity negotiation) to optimize trade-off between building-level pressure estimations and computational efficiency for larger-scale networks.
- Implemented model to large urban areas (e.g., Seattle, Los Angeles) to support infrastructure risk assessments and inform disaster preparedness strategies.

Techno Plastics Industry, Añasco, PR 2019- 2020
Manufacturing Engineer

- Designed a manufacturing line with the capacity to meet a monthly demand of 15,000 units.
- Developed standardized operating procedures (SOPs) for two new product lines, aligning with FDA regulatory compliance.
- Performed the equipment's capacity analysis to determine the number of employees for each operation.

Edwards Lifesciences, Añasco, PR 2018
Manufacturing Engineer Intern

- Increased the Clips and Clamps manufacturing line's efficiency by 32%.
- Reduced workforce by 33% through the design of a new line balance with an estimated cost reduction of $55,442 per year.

Bearing Buddies, Patillas, PR 2018
Layout Design Intern

- Analyzed the Bearing Buddy Inc. packing station and identified nonvalue-added tasks.
- Designed an efficient packing station subject to the workflow pattern and designed a new layout that reduced the manufacturing line space by 20%.

Medtronic, Villalba, PR 2016- 2017
Operational Excellence Intern

- Transformed 3 traditional manufacturing lines into 3 cell operating systems, reducing the manufacturing line space by 35%, reducing the workforce by 20%, and improving the overall product quality.
- Provided high maturity support to 5 manufacturing cells by implementing Lean Continuous Improvement techniques.

RESEARCH EXPERIENCE

University of Michigan, Ann Arbor, MI
Advisor: Dr. Seth Guikema

Title**:** "AccES: A Framework for Predicting Building-Level Loss of Accessibility to Essential Services Post-Disasters Based on Publicly Available Information" 2024-Present
Submitted to *NPJ Natural Hazards* (2025)

- Design and implemented the AccES framework in R**,** a spatially explicit tool that estimates post-hazard accessibility loss to essential services, by integrating open-source data and local stakeholder knowledge, to support resource allocation and recovery strategies at a community-level.
- Performed probabilistic risk analysis and Monte Carlo simulation to estimate component-level service disruptions across infrastructure systems post-hazard.
- Applied AccES in Cayey, Puerto Rico, to simulate the impacts of a Category 2 tropical cyclone, revealing spatial and social inequities in pre- and post-hazard access to essential services.

Title: "Estimating Tropical Cyclone-induced Power Outages in Future Climate Scenarios." 2023 – 2024
In collaboration with **Industrial Economics Inc.** and **U.S. Environmental Protection Agency**
Submitted to *Proceedings of the National Academy of Sciences* (2025)

- Developed predictive models in MATLAB and R to estimate projected tropical cyclone-induced power outages along the U.S. Atlantic and Gulf Coast under a 3°C warming scenario, utilizing projections from seven global climate models (GCMs), to inform long-term mitigation, and adaptation strategies in the energy sector.
- Assessed regional power outage risk and forecasted outage shifts under future climate scenarios, identifying socio-demographic disparities in power outage vulnerability.

Title: "Water outage predictions for natural hazards using synthetic water distribution systems." 2021 – 2023
In collaboration with **One Concern, Inc**.
Published in *Risk Analysis* (2025)

- Developed a simulation tool in Python that generates synthetic, pressure-feasible water distribution systems using only publicly available data, scalable for application to any U.S. community.
- Simulated building-level water outages from seismic events by integrating the synthetic water distribution system, hazard loading models, and component-specific fragility curves using Monte Carlo simulations to support resilience planning and infrastructure risk analysis without proprietary data.

Title**:** "Are Existing Frameworks Effective in Identifying and Prioritizing Critical Services and Infrastructures at a Local Level? Establishing Standardized Evaluation Criteria." 2021 – 2023
In collaboration with the **University of Stavanger**
Submitted to *Civil Engineering and Environmental Systems* (2025)

- Developed evaluation criteria for frameworks dedicated to identifying critical services and infrastructures, enabling analysis across frameworks varying in geographical scale and focus of evaluation.
- Identified existing frameworks' strengths and limitations and assessed whether these frameworks aligned with the needs and preferences of the communities.

Title**:** "Equitable Assess to Essential Services: A community-level assessment of essential services in the Caribbean." 2020 – 2021
To be submitted to *International Journal of Disaster Risk Reduction*

- Led a community-level survey in the Caribbean region to assess the perception of essential services amongst different socio-demographic groups, highlighting the importance of integrating community insights into disaster models and emergency management decisions.
- Applied logistic regression techniques to evaluate how demographic and socio-economic factors, such as age, family composition, and income, influence essential service restoration preferences.

Title**:** "Illicit Massage Business: Laws and Regulations in South-East Michigan" 2020
In collaboration with the **University of Michigan Law School**

- Applied machine learning techniques to identify which legal measures are most effective in preventing illicit massage businesses in the state of Michigan, utilizing scraped web data, census information, and local laws and regulations.

University of Puerto Rico, Mayaguez, PR
Advisor: Dr. Francisco Monroig

Title**:** "Design and Ergonomic Evaluation of a Coffee Harvesting Method to Improve Worker Efficiency and Reduce Musculoskeletal Strain in Post-Disaster Contexts" 2019 –2020
In collaboration with the **University of Puerto Rico Agriculture Department**

- Evaluated the impact of natural disasters on the coffee industry, focusing on employment rates and the prevalence of musculoskeletal disorders among workers.
- Designed a new coffee harvesting method incorporating an integrated support mechanism to reduce muscle strain and increase efficiency.
- Utilized 3DSSPP ergonomic software to assess the ergonomics, efficiency, and performance of traditional field techniques against the proposed harvesting method, demonstrating ergonomic benefits while maintaining the coffee quality.

University of Florida, Gainesville, FL
Advisor: Dr. Boyi Hu

Title**:** "Evaluating Musculoskeletal Variations Under Visual, Motor, and Cognitive Distractions" 2019

- Evaluated the reliability of Xsens sensors and Tobii Pro Glasses for integration into the D Lab system.
- Integrated advanced tools to facilitate 3D character animation and motion analysis.
- Analyzed musculoskeletal variables to identify trends in pelvis sensor data under varying conditions of visual, motor, and cognitive distractions.

Iowa State University, Ames, IA 2017
Advisor: Dr. Eugene S. Takle and Dr. David Peterson

Title**:** ″Carbon or Cash: Evaluating the Effectiveness of Environmental and Economic Messages on Attitudes About Wind Energy in the United States″
In collaboration with the **Department of Geological and Atmospheric Sciences and Department of Political Sciences**
Published in *Energy Research & Social Science* (2019)

- Analyzed wind characteristics at varying heights above the surface by developing a Python-based wind rose algorithm to evaluate wind speed frequency and directional trends, identifying stronger and steadier winds at higher levels and key temporal patterns.

- Collaborated on interdisciplinary research to evaluate the impact of persuasive and priming messages on the public's acceptance of wind generation, wind farms, and renewable energy using statistical analysis.

TEACHING EXPERIENCE

University of Michigan, Ann Arbor, Michigan

***Instructor**: IOE 202, Operations Research & Analytics* Jan 2024 – Apr 2024

- Delivered 14 lectures on Operations Research to **80+ undergraduate students**, achieving a 3.6/4 in student assessments.
- Developed the course curriculum focused on optimization, simulation, risk analysis, and data analytics; integrating lectures, hands-on exercises, homework assignments, and exams to enhance student learning outcomes.
- Facilitated interactive discussions and exercises to reinforce theoretical concepts and analytical techniques.

***Graduate Student Instructor**: IOE 543, Scheduling* Sep 2022 – Dec 2022

- Developed quizzes and assignments, and graded assignments, quizzes, and exams.
- Facilitated small group discussion sessions during class and held weekly office hours, providing support and mentorship in one-on-one and small-group settings.

***Graduate Student Instructor**: IOE 561, Risk Analysis* Jan 2022 – Apr 2022

- Delivered 2 lectures on Infrastructure Risk Analysis to a hybrid audience of 100+ graduate students.
- Developed quizzes and assignments, and graded assignments, quizzes, and exams.
- Facilitated small group discussion sessions during class and held weekly office hours, providing support and mentorship in one-on-one and small-group settings.

Guest Lecturer

Lecture: Interconnected Critical Infrastructure Networks April 2025
University of Michigan, Ann Arbor, MI

- Graduate level 1-hour lecture to over 10 graduate engineering students on infrastructure risk analysis and modelling interconnected infrastructure networks using open-source data.

Lecture: Risk Analysis – Infrastructure Risk Analysis Feb 2025
University of Michigan, Ann Arbor, MI

- Graduate level 1-hour lecture to over 30 graduate engineering students on infrastructure modeling and risk assessments.

Lecture: Risk Analysis – Infrastructure Risk Analysis Mar 2024
University of Michigan, Ann Arbor, MI

- Graduate level 2-hour lecture to over 60 graduate engineering students on infrastructure modeling and risk assessments.

Lecture: Infrastructure Risk Analysis and Machine Learning Techniques Sept 2023
University of Stavanger, Stavanger, Norway

- Graduate level 2-hour lecture to over 25 graduate engineering students on infrastructure risk analysis, and provided a high-level course on how to perform machine learning regression analysis in R.

PUBLICATIONS

Pagan-Cajigas, Z. P., Guikema, S., Otaduy-Ramirez, R., Woolley, V., Smith, K., Hu, T., Chen, T. Water outage predictions for natural hazards using synthetic water distribution systems. *Risk Analysis*, Volume 2, 2025, DOI: 10.1111/risa.70004

Peterson D, Carter K, Wald D, Gustafson W, Hartz S, Donahue J, Eilers J, Hamilton A, Hutchings K, Macchiavelli F, Mehner A, **Pagan Cajigas Z**, Pfeiffer O, Van Middendorp A, *Carbon or cash: Evaluating the effectiveness of*

environmental and economic messages on attitudes about wind energy in the United States, Energy Research & Social Science, Volume 51, 2019, Pages 119-128, ISSN 2214-6296

Pagan-Cajigas, Z. P., Guikema, S., *AccES: A Framework for Predicting Building-Level Loss of Accessibility to Essential Services Post-Disasters Based on Publicly Available Information.* Submitted to *NPJ Natural Hazards* in May 2025.

Guikema, S., **Pagan-Cajigas, Z.P.**, Fant, C., Boehlert, B., Maier, C., Emanuel, K., Hartin, C., Sarofim, M., Climate Change Impacts on Tropical Cyclone-Induced Power Outage Risk: Inequities in Outage Risk Economic Burdens, Submitted to *Proceedings of National Academy of Science* in February 2025. *

Pagan-Cajigas, Z. P., Guikema, S., Flage, R. *Are Existing Frameworks Effective in Identifying and Prioritizing Critical Services and Infrastructures at a Local Level? Establishing Standardized Evaluation Criteria*. Submitted to *Civil Engineering and Environmental Systems* in February 2025. *

Doehring, C., **Pagan-Cajigas, Z. P**., Guikema, S., Orosz, G., Bagian, J., Bordley, R., Shen, M., *Necessary conditions for a holistic risk analysis framework for autonomous vehicles*. Submitted to *Risk Analysis Journal* in December 2024. *

***** *Manuscripts under review*

WORKING PAPERS

Doehring C., Feeny N., Liu A., **Pagan-Cajigas Z.,** Toruno C., Zeng M., Flage R., Guikema S., *Improving How the IPCC Addresses Uncertainty through Knowledge Decomposition.*

Abbasi, D., **Pagan-Cajigas, Z. P**., Guikema, S., Reilly, A., *Assessing Future Hurricane-Related School Closures: A Multi-Scenario Analysis*.

Pagan-Cajigas, Z. P., Guikema, S., White, A., Carr, B., *Laws and Regulations Against Illicit Massage Business: A Data-Driven Analysis of Regulatory Impacts in South-East Michigan.*

CONFERENCE PRESENTATIONS

Pagan-Cajigas, Z. P., Guikema, S., *"AccES: A Framework for Predicting Building-Level Loss of Accessibility to Essential Services Post-Disasters Based on Publicly Available Information" 2025* European Safety and Reliability Conference & Society of Risk Analysis - Europe, Stavanger, Norway — June 2025

Pagan-Cajigas, Z. P., Guikema, S., *"Enhancing Community Resilience: Assessing Post-Disaster Access to Essential Services through a Community-Driven Evaluation"*, 2025 UM Latine Research Week, Ann Arbor, Michigan — Feb 2025

Pagan-Cajigas, Z. P., Guikema, S., *"Enhancing Community Resilience: Assessing Post-Disaster Access to Essential Services through a Community-Driven Evaluation"*, *2024* Society of Risk Analysis Annual Meeting, Austin, Texas — Dec 2024

Pagan-Cajigas, Z. P., Guikema, S., *"Estimating Tropical Cyclone induced Power Outages in Future Climate Scenarios' Impact on Socio-economically Vulnerable Populations and Racial Minorities", 2023* Society of Risk Analysis Annual Meeting, Washington, District of Columbia — Dec 2023

Pagan-Cajigas, Z. P., Guikema, S., *Fant, C., Boehlert, B., "Estimating Tropical Cyclone induced Power Outages in Future Climate Scenarios.", 2023* INFORMS Annual Meeting, Phoenix, Arizona — Oct 2023

Pagan-Cajigas, Z. P., Guikema, S., *Fant, C., Boehlert, B., "Estimating Tropical Cyclone induced Power Outages in Future Climate Scenarios.", 2023* European Safety and Reliability Conference, Southampton, United Kingdom — Sep 2023

Pagan-Cajigas, Z. P., Guikema, S., *"Water outage predictions for natural hazards using synthetic water distribution systems.", 2022* Society of Risk Analysis Annual Meeting, Tampa, Florida — Dec 2022

Guikema, S., **Pagan-Cajigas, Z. P.,** *"Measuring Equity in Access to Services.", 2022* INFORMS Annual Meeting, Indianapolis, Indiana, Oct 2022 — Oct 2022

Pagan-Cajigas, Z. P., Guikema, S., *"Equitable Access to Essential Services: A community-level assessment of essential services in the Caribbean. ", 2022* IISE Annual Conference & Expo, Seattle, Washington — May 2022

Pagan-Cajigas, Z. P., Guikema, S., Flage, R., *"A Framework Comparison for Community Level Risk Assessments"*, Risk Analysis Specialty Group (FRASG) Student Merit Award winner, 2021 Society of Risk Analysis Annual Meeting, Virtual — Dec 2021

PROFESSIONAL CONTRIBUTION

Teaching: **Instructor**: Operations Research & Analytics (IOE 202)
Graduate Student Instructor: Scheduling (IOE 543), Risk Analysis (IOE 561)

Reviewer: Peer reviewer for the *Society for Risk Analysis (SRA) Journal*, providing critical evaluations and constructive feedback on academic manuscripts to ensure publication quality and contribution to the field.

Mentorship: **Service Learning for Transdisciplinary Education**: Mentored 2 middle school students, guiding interdisciplinary approaches to learning.
Guikema Lab: Supervised and supported 3 undergraduate students in research projects.
INFORMS Michigan Student Chapter: Mentored 4 master's students and 1 Ph.D. student, offering advice on research, career development, and professional opportunities within operations research and analytics.
IOE Graduate Application Mentoring Program: Guided 4 undergraduate students and 2 master's students through the graduate application process, assisting with application strategies, personal statements, and research proposals.

Leadership: **Society of Hispanic Professional Engineers (SHPE) at UM**: Outreach Chair (2023–2025), organizing initiatives to connect underrepresented students with STEM opportunities, including coordinating seminars, social events, and outreach programs such as DACEP.
Society of Risk Analysis (SRA): Secretary and Treasurer of the Engineering and Infrastructure Specialty Group (2022–2024), managing financial and administrative responsibilities for the group.
University of Michigan Industrial and Operations Engineering: Diversity, Equity, and Inclusion (DEI) Student Representative (2021–2024), collaborating with faculty and staff to provide recommendations for making courses more inclusive and equitable.
INFORMS at UM: Antiracism, Diversity, Equity, and Inclusion Chair (2021–2024), leading efforts to foster an equitable and inclusive environment within the INFORMS student chapter, including organizing seminars, multicultural dinners, fundraisers, free libraries, and workshops.
Alpha Pi Mu Honor Society: Outreach Chair (2017–2020), coordinating events to engage students and promote academic excellence in industrial engineering.
American Society for Quality (ASQ) Student Chapter: Treasurer (2016–2018), overseeing chapter finances and supporting organizational activities.

COMMUNITY ENGAGEMENT

Community Engagement: **SHPE Detroit:** Volunteered as a Spanish-English translator at a college fair supporting high school students from a predominantly Hispanic community, helping facilitate access to higher education.
Food Gathers: Volunteer at a soup kitchen, preparing, and distributing meals.
Xplore Engineering Summer Camp: Provided courses on Industrial Engineering concepts to engage and inspire future engineers.
Kids Who Code: Mentored and facilitated one-year long Python workshops for 10 high school students, providing foundational programming skills.
DACEP: Facilitated an introductory 6-week coding class for a group of 20 elementary school children, sparking interest in technology and programming.
Come Colegial: Organized and led six successful fundraising events to provide food assistance for low-income students at the University of Puerto Rico.

Puerto Rico Humanitarian Relief (Post Hurricane Maria): Coordinated food distribution logistics for central municipalities in Puerto Rico during the recovery period following Hurricane Maria.
Siempre Vivas: Served as a group facilitator supporting women who experienced abuse, fostering a safe space for recovery and empowerment.

SELECTED AWARDS AND GRANTS

William Averette Anderson Fund Fellow	2024
Society of Hispanic Engineers Doctoral Scholar	2023-2024
SRA Engineering & Infrastructure Student Merit Honorable Mention	2022
University of Michigan Student Academic Multicultural Initiative (SAMI) Award	2022
Bonder Travel Scholarship Award	2022
Risk Analysis Specialty Group (FRASG) Student Merit Award winner	2021
University of Michigan Rackham Merit Fellow	2020-2025
University of Puerto Rico Frederick W. Taylor Award	2021
Institute of Industrials Engineers CIAPR Juan A. Torres Gorbea Award	2021
University of Puerto Rico Mayaguez Honor Scholarship	2018-2020
University of Puerto Rico Mayaguez Honor Roll Student	2016-2020