NSF AWARD 2119691

EPSCoR RII Track-2 FEC

AI SUSTEIN

NEWSLETTER

VOLUME #3

Theme 1

Dr. Eakalak Khan- UNLV
Co-PI of AI SUSTEIN,
Team member of Research Theme 1

Greetings from University of Nevada, Las Vegas (UNLV)! It is my honor to pen the opening remarks for Research Theme 1 of AI SUSTEIN titled "Understand and Quantify the Interdependency in Infrastructure Networks and Perform Risk and Economic Impact Assessment in both the Industrial and Economic Worlds Using AI." Theme 1 of AI SUSTEIN addresses several crucial aspects of energy networks in an interdisciplinary manner. Our Theme 1 team has worked on applications of AI technologies to harness the complex interdependencies and potential vulnerabilities of heterogeneous energy and economic networks. We have evaluated public perception, economic risk, and social impact of energy network failure, which are more prevalent in rural areas with harsh weather conditions. Through Theme 1, we have also conducted analyses of vulnerability of cascading failures in energy networks and vulnerable nodes clustering. We have made great progress on our research, some of which are showcased later in this newsletter such as one on sustainability with 3 Rs for oil and gas infrastructure.

It has been my privilege and pride as a member of Theme 1. I have enjoyed learning from my Theme 1 colleagues on a variety of energy network aspects outside my environmental engineering background. I hope you will enjoy reading this newsletter particularly the showcases tied to Theme 1. If you have any feedback, suggestions, and comments related to our Theme 1, please feel free to reach out to me, I am all ears.

Very truly,
Eakalak Khan - UNLV

Theme 2

Dr. Ying Huang- NDSU
PI of AI SUSTEIN,
Team member of Research Theme 2

The objective of the Education/Workforce Development Theme is to create and spread knowledge of AI to build a diverse workforce with the skills to further enhance industries that can or have incorporated AI.

The four institutions that are part of AI SUSTEIN, North Dakota State University (NDSU), Nueta Hidatsa Sahnish College (NHSC), University of Arkansas (UARK), and University of Nevada, Las Vegas (UNLV), have been working towards creating classes, certificates, and an AI minor to offer their students. In Yr 3, NDSU offered IME 796: Graph Based Data Analytics by Harun Pirim, which provides students opportunities to learn the skills to analyze and interpret data from complex networks using descriptive and predictive analysis.

In addition, NDSU started offering AI minor to students, and the first year of its offering attracted 12 enrollments to this minor program, showing a strong interest in the AI education. UNLV approved their AI minor, and it is now available to all UNLV students! Also, NHSC hired an instructor for computer science associated degree, Joseph Forson, and students started to receiving trainings with focuses on AI.

In Yr 4, we will continue offering the AI related education to the students.

Ying Huang - NDSU

Theme 2

Dr. Di Wu - NDSU
Co-Principal Investigator
Team Member of Research Theme 2

Research Theme 2 is centered on the development of an AI-based health monitoring and predicting system that can capture the degradation/failure behavior and changes in the topology of multiple networks indicative of cascading failures in energy infrastructure. To this end, we have developed new methods and algorithms by leveraging multi-dimensional heterogeneous data provided by our industry partners. To monitor and manage anomaly events for reliability and resilience improvement in power systems, we developed a robust approach to characterize anomaly events in electric power networks by employing a customized autoencoder with two hidden layers. Also, a graph-based method was developed for detecting anomaly events and locating their sources by the spatiotemporal analysis of synchrophasor data. To enhance the reliability of natural gas pipeline networks, we investigated the influence of different corrosive environments on the pipeline coating systems, continued developing new distributed fiber optic sensing technology for detecting coupled pipeline damages, and studied the effectiveness of different AI algorithms for predicting failure in pipeline systems. In addition, we developed multilayer networks for monitoring the interdependencies of power and pipeline networks. The synchro-phasor data was been analyzed to study the interdependencies between networks. The cybersecurity of the Internet of Things (IoT) networks was also investigated using publicly available cyber-attacks. We will consolidate and validate these new methods and algorithms for real-time monitoring and predicting failure in realistic large-scale systems to ensure the reliable operation of energy infrastructure.

Di Wu - NDSU

Theme 3

Dr. Haitao Liao - UARK
Principal Investigator
Team member of Research Theme 3

National economic and production activities depend on the reliable monitoring and resilient operations of energy infrastructures. Our research on Theme 3 has been focused on creating a strategic framework for improving the reliability and resilience of energy infrastructure via advanced condition monitoring, and AI-enhanced maintenance planning and network optimalization. The team members at NDSU have been concentrating on developing frameworks for condition-based monitoring that consider weather impacts, as well as creating pattern recognition algorithms utilizing artificial intelligence (AI). Recently, their efforts have been focused on employing the Scenario Analysis Interface for Energy Systems (SAInt) platform for the dynamic modeling of pipelines and interdependent system failure propagation. They have successfully completed steady-state and dynamic simulations for various failure propagation scenarios and are currently analyzing results considering time-dependent changes in gas pressure and flow. Additionally, the team has established an AI-based transfer learning framework that extracts features from oil pipelines to predict failures in gas pipelines and vice versa. Their ongoing work also emphasizes quantifying risk and resilience within the pipeline system to promote energy sustainability. At UARK, the team developed a new framework to assess and improve the reliability of a critical infrastructure network. This framework calculates the network's reliability and identifies the most effective actions to improve it. They have mathematically modeled this decision-making framework and utilized graph neural networks (GNNs) for network reliability calculations and Deep Reinforcement Learning (DRL) to optimize the sequence of network improvement and maintenance actions. Moreover, the team investigated the availability and resilience of a system subject to recurrent and dependent hazards and developed optimal restoration policies for decision makers with different risk preferences. On data analytics, methods for modeling contingencies were developed, and initial results in application to transmission expansion optimization problems were investigated. The results are being applied to developing machine learning assisted approaches to incorporating Grid-Enhancing Technologies (GETs) in achieving resiliency with respect to HOMCA constraints.

Dr. Haitao Liao - UARK

Meet Our 2024 Seed Awardees!

Dr. Jiale Xu
Assistant Professor at NDSU
Civil, Construction and
Environmental Engineering

Dr. Jiale Xu is currently an Assistant Professor at North Dakota State University, a position he began in 2022. Prior to this role, he gained experience as a postdoctoral research associate at the University of Arizona and as a postdoctoral fellow at Georgia Tech. Dr. Xu completed his PhD in Civil Engineering at the University at Buffalo in 2020, with research interests focusing on the application of environmental and analytical chemistry to evaluate and mitigate the impact of emerging contaminants in drinking water and treated wastewater. Dr. Xu was awarded the seed funding to address critical environmental challenges posed by toxic organic micropollutants (OMPs) in wastewater generated by energy industries. His project aims to innovate water treatment methods by coupling artificial intelligence with quantum chemistry to predict essential photochemical properties of these pollutants, particularly for UV treatment applications. This funding supports the development and validation of predictive models, enabling cost-effective and scalable solutions for cleaner water systems. The project aligns with sustainability goals and provides preliminary results essential for future larger-scale funding applications, such as the NSF CAREER Award.

Dr. Armstrong Aboah
Assistant Professor at NDSU
Civil, Construction and
Environmental Engineering

Dr. Armstrong Aboah, is an Assistant Professor at North Dakota State University since 2024. He earned hs PhD from the University of Missouri-Columbia.Dr. Aboah's research includes Transportation Planning, Intelligent Transportation Systems, Autonomous and Connected Vehicles, Big Data Analytics in Transportation, Travel Demand Modeling and Forecasting, Transportation and Traffic Safety Research, Public Transportation, Congestion Management, Digital Twins and Smart Cities, Pavement and Asset Management, and Agriculture Technology (AgTech).Dr. Armstrong Aboah received seed funding from AI SUSTEIN to develop a lightweight deep learning framework for real-time fault detection and continuous monitoring of power grid systems. This project addresses the critical need for proactive and predictive maintenance in increasingly complex power grids, enhancing reliability and resilience, especially under adverse weather conditions. By leveraging UAV and in-situ camera data alongside deep learning models, the project aims to reduce disruptions and improve the safety and efficiency of grid operations, aligning with AI SUSTEIN's mission to support sustainable technological advancements.

Dr. Lei Guo
Assistant Professor at UARK
Civil Environmental

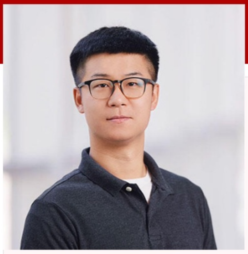
Dr. Lei Guo pursued her Ph.D. in chemistry at UC Berkeley focusing on reticular chemistry and advancing new synthetic and modification methods for covalent organic frameworks (COFs). With growing interest in the applications of these porous crystalline nanomaterials, Dr. Guo undertook postdoctoral training at Caltech, concentrating on wastewater treatment. In August 2022, she joined the University of Arkansas, Fayetteville, as an assistant professor in the Department of Civil Engineering.

Dr. Guo won the Seed Award for her project, "Clean Water for Clean Energy: AI-Based Water Treatment Solution for Lithium-Ion Battery Manufacturing." The project addresses the environmental impact of PFAS pollutants, specifically lithium bis(trifluoromethylsulfonyl)imide (LiTFSI), in battery production. Guo developed a nanofiltration membrane integrated with AI to remove these contaminants efficiently, reducing energy consumption and improving water safety near manufacturing sites. This project aligns with sustainable energy goals and contributes to innovative water treatment technology.

Meet Our 2024 Seed Awardees!

Dr. Sumitha George
Assistant Professor at NDSU
Electrical & Computer Engineering

Sumitha George, an assistant professor of electrical and computer engineering at NDSU. She received seed funding to develop an innovative computing system that leverages emerging memory technologies, such as multi-level cell (MLC) architectures, to address the rising data and energy demands of AI applications. Her project aims to create high-efficiency, flexible radix computing circuits and cache architectures that enhance data processing speed and energy conservation, making current systems better suited for large-scale AI workloads.



Dr. Zuobin Xiong
Assistant Professor at UNLV
Computer Science

Zuobin Xiong is an assistant professor in the Department of Computer Science at the University of Nevada Las Vegas, with a Ph.D. from Georgia State University (2023). His research spans cybersecurity and privacy, particularly in privacy-preserving machine learning, data mining, IoT, and data security.
Dr. Zuobin Xiong won the seed award to support his research in developing a Generative AI-enhanced anomaly detection system for distributed sustainable energy networks. This project addresses Nevada's unique energy challenges, such as dispersed populations, extreme weather, and infrastructure vulnerabilities. By applying a generative AI approach to augment anomaly data and employing a graph neural network model for improved anomaly detection and classification, Dr. Xiong's work aims to enhance the reliability and resilience of sustainable energy systems, aligning with AI-driven advancements for critical infrastructure improvements.

Dr. Shengjie (Patrick) Zhai
Assistant Professor at UNLV
Electrical and Computer Engineering

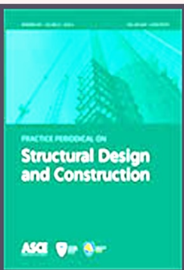
Shengjie (Patrick) Zhai, who joined UNLV as a doctoral student in 2009, is now an assistant professor deeply committed to both his students and his research. Zhai's professional work focuses on nanomaterials and biomaterials, a field that intersects with his curiosity about natural formations. He won the Seed Award for his project "Revolutionizing Wildfire Detection," which developed an AI-driven model using CNN and multi-color imaging to improve wildfire detection in the western U.S. The model, with a 95.95% accuracy, utilizes CCTV, UAVs, and satellite images in real-time, enhancing wildfire response and management. Aligned with AI SUSTEIN's sustainability goals, the project also fosters opportunities for underrepresented STEM students.

Dr. Andrew Jang-ho Bae
Assistant Professor at UNLV
Mechanical Engineering

Andrew Jang-ho Bae won the Seed Award for his project on developing a dynamic rolling locomotion algorithm for the Variable Topology Truss (VTT) system aimed at optimizing energy consumption. The VTT, a modular truss structure with linearly actuated truss members and passive spherical joints, is designed to adapt to complex environments such as disaster sites and space exploration. However, its high energy demands during fast movements have limited its efficiency. Bae's project focuses on creating an efficient, high-speed rolling control algorithm that maintains momentum, thereby reducing energy use. This project aligns with AI SUSTEIN's goals, and supporting Bae's career through interdisciplinary collaboration, future research opportunities, and potential publications.

Research Theme 1

SHOWCASE #10 :



[Practice Periodical on Structural Design and Construction Volume 29, Issue 4]

Nov 2024

ARTICLE

Enhancing Risk Assessment in Natural Gas Pipelines Using a Fuzzy Aggregation Approach Supported by Expert Elicitation

View article page

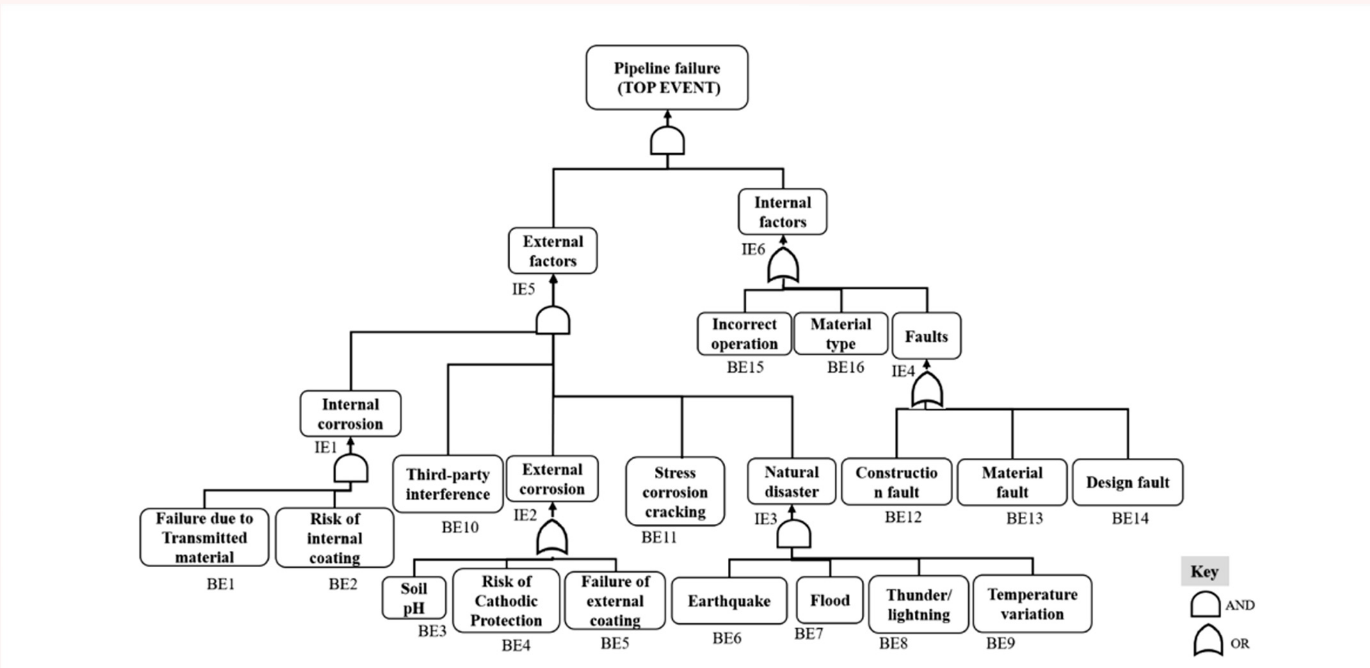
Yasir Mahmood, Ying Huang, Nita Yodo and Eakalak Khan

Following the showcases from the last newsletter , we have our 10th showcase called “**Enhancing Risk Assessment in Natural Gas PipelinesUsing a Fuzzy Aggregation ApproachSupported by Expert Elicitation”.**

This study, conducted by Yasir Mahmood, Ying Huang, Nita Yodo, and Eakalak Khan, focuses on enhancing risk assessment in natural gas pipelines using a fuzzy aggregation approach supported by expert elicitation. The methodology involves gathering expert opinions through a structured questionnaire, applying fuzzy set theory (FST) to handle uncertainties, and using T- and S-Norm operators to aggregate failure probabilities.

The research integrates both qualitative insights and quantitative data from expert elicitation and historical records to assess risk factors such as corrosion, material faults, and operational errors. The findings reveal that internal factors, notably material faults and operational errors, are the most critical contributors to pipeline failure. The study highlights the need for future improvements, including sensitivity analyses and data refinement, to enhance the reliability and applicability of the risk assessment framework.

Graphical Represenation of Fuzzy Logic



Application of the Study

The proposed fuzzy aggregation framework can serve as a decision-support tool for policymakers and industry leaders, guiding the development of proactive safety protocols and long-term infrastructure resilience strategies.

Research Theme 2

SHOWCASE #11 :

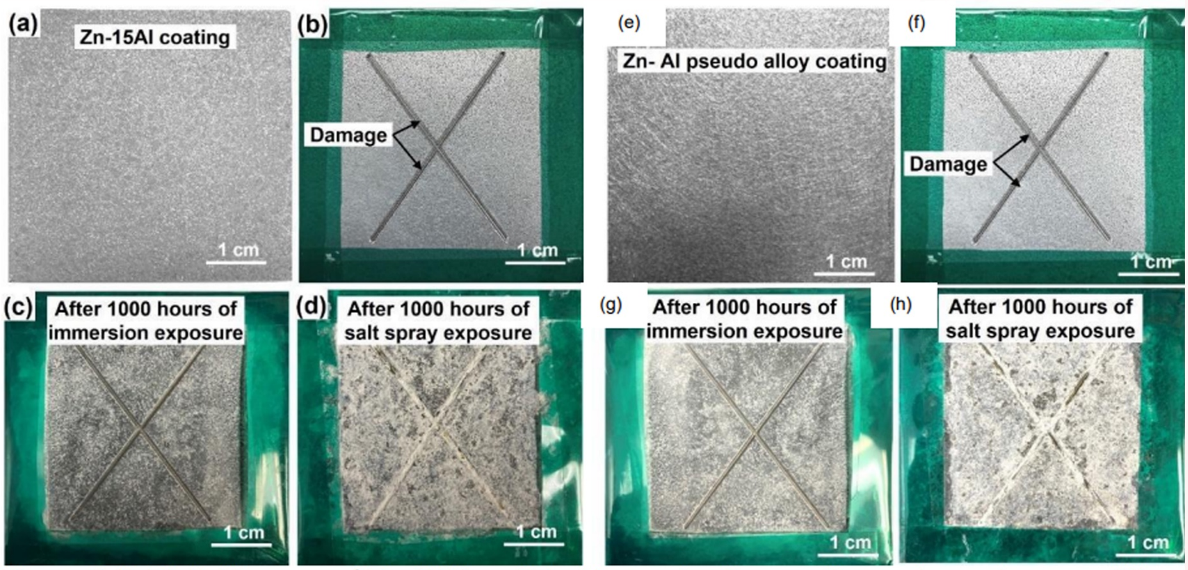
The 11th showcase called "The Effect of Exposure on the Long-term Performance Evaluation of Undamaged and Damaged Wire-arc Spraying Zinc-Aluminum Alloy Coatings".

This study, conducted by Ratna Divya Yasoda, Ying Huang, and Xiaoning Qi, investigates the long-term performance of wire-arc-sprayed zinc-aluminum (Zn-Al) alloy coatings under salt spray and immersion conditions.

The methodology involves subjecting Zn-15Al and Zn-Al pseudo-alloy coatings to 1000 hours of exposure and assessing their corrosion resistance through electrochemical impedance spectroscopy (EIS), scanning electron microscopy (SEM), energy-dispersive X-ray spectroscopy (EDS), and X-ray diffraction (XRD).

Findings reveal that Zn-Al pseudo-alloy coatings, with higher aluminum content, offer superior protection in salt spray environments by forming a protective $Al(OH)_3$ layer. In contrast, Zn-15Al coatings perform better under immersion conditions due to stable corrosion product accumulation. The study highlights the importance of selecting appropriate coating systems tailored to specific environmental conditions for long-term durability.

Digital images of Zn-15Al and Zn-Al pseudo alloy coating under various conditions:



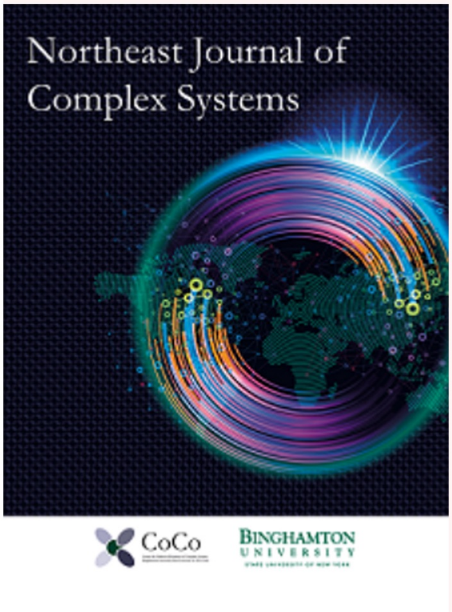
(a, e) Initial as-sprayed condition
(b, f) As-sprayed condition with intentionally machined damage
(c, g) Condition of the coating and associated damage after 1000 hours of immersion exposure
(d, h) Condition of the coating and damage with accumulated corrosion products after 1000 hours of salt spray exposure.

Application of the Study

This study has significant applications in the protection and maintenance of steel infrastructure, particularly in marine and highly corrosive environments. The findings provide guidance for selecting optimal Zn-Al alloy coatings based on environmental conditions; recommending Zn-15Al coatings for long-term immersion settings and Zn-Al pseudo-alloy coatings for salt spray or splash zones. Industries involved in bridge construction, offshore platforms, pipelines, and other critical steel structures can apply these insights to improve corrosion resistance, enhance durability, and reduce maintenance costs through tailored protective coating systems.

Research Theme 2

SHOWCASE #12 :

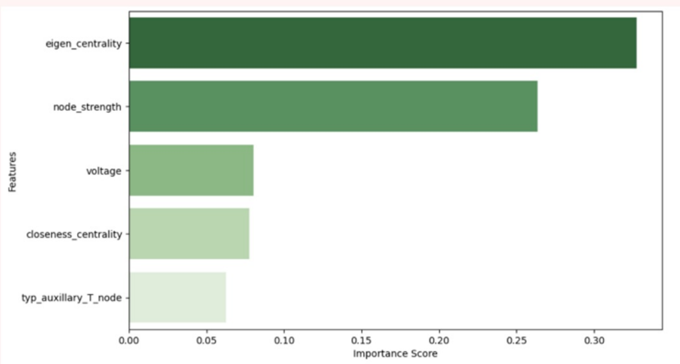


The 12th showcase titled **"Enhancing Electrical Network Vulnerability Assessment with Machine Learning and Deep Learning Techniques "**. This study, authored by M. Mishkatur Rahman, Ayman Sajjad Akash, Harun Pirim, Chau Le, Trung Le, and Om Prakash Yadav, focuses on enhancing the vulnerability assessment of electrical power grids using advanced machine learning (ML) and deep learning (DL) techniques.

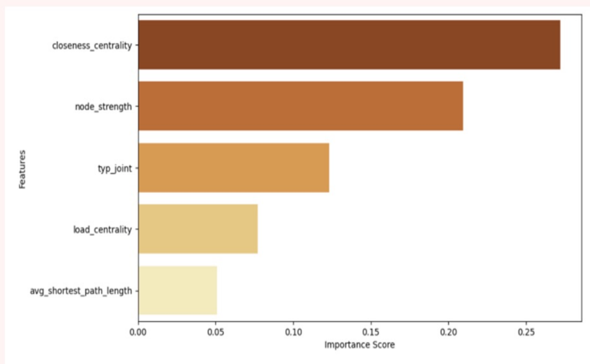
The methodology integrates data from the SciGRID and GridKit datasets, representing European and North American electrical networks, respectively. Centrality metrics, such as degree, PageRank, and betweenness, are combined using an entropy-weighted scoring system to categorize nodes into criticality levels. The study compares traditional ML models (XGBoost, SVM, and Multilayer Perceptron) with graph neural networks (GNN, GCN, and GAT) to predict critical nodes.

The findings reveal that traditional models, particularly XGBoost, outperform GNNs in smaller datasets, but GNNs show improved performance with larger and more complex networks. The study highlights the importance of dataset size, feature engineering, and model selection in developing robust vulnerability assessment frameworks for power grids, with practical implications for improving infrastructure resilience and operational reliability.

Feature importance for XGBoost algorithm to predict vulnerability classes



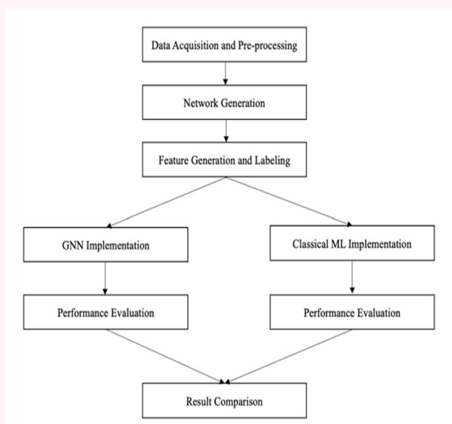
Features for SciGrid Data



Features for GridKit Data

Application of the Study

This study has critical applications in enhancing the resilience and reliability of electrical power grids. By identifying vulnerable nodes and critical network points using advanced machine learning and deep learning techniques, power grid operators can implement targeted maintenance strategies, optimize resource allocation, and prioritize infrastructure upgrades. The insights from this study also support real-time monitoring and proactive decision-making to prevent cascading failures during natural disasters, cyberattacks, or equipment failures. Additionally, the findings inform policy development, ensuring robust cybersecurity measures and system-wide safety standards for modern, interconnected power grids.



Methodology Steps

Research Theme 3

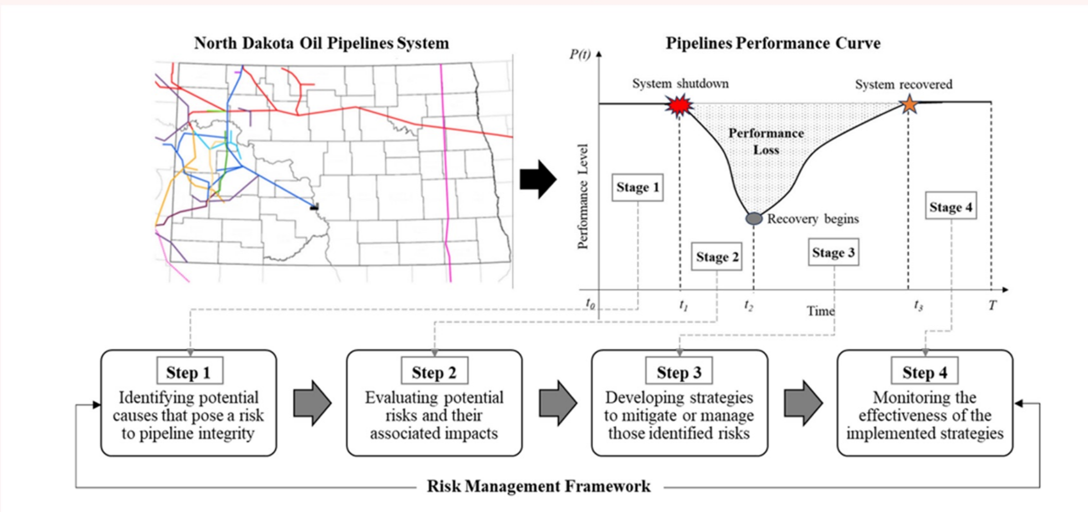
SHOWCASE #13 :

The 13th showcase titled **"A Quantitative Approach of Measuring Sustainability Risk in Pipeline Infrastructure System"** was conducted by Labiba Noshin Asha, Ying Huang, Nita Yodo, and Haitao Liao, presents a quantitative framework for assessing sustainability risks in pipeline infrastructure systems by integrating failure probabilities and cumulative consequences across social, environmental, and economic dimensions.

The methodology utilizes 20 years of pipeline incident data from the Pipeline and Hazardous Material Safety Administration (PHMSA) to identify primary failure causes such as corrosion, equipment malfunction, and incorrect operations. Failure probabilities are calculated based on historical failure rates, while consequences are quantified using social, environmental, and economic metrics.

The findings showed that corrosion failure and equipment malfunction contribute significantly to sustainability risks, accounting for nearly 84% of overall incidents. The study underscores the importance of data-driven, tailored risk mitigation strategies, such as enhanced inspections, maintenance routines, and stakeholder collaboration, to ensure the long-term sustainability and resilience of critical pipeline infrastructure systems.

The general representation risk management framework



Application of the Study

This study has critical applications in improving the sustainability and resilience of pipeline infrastructure systems. By quantifying sustainability risks across social, environmental, and economic dimensions, it provides pipeline operators and policymakers with a comprehensive framework to identify high-risk areas, such as corrosion and equipment failure.

The findings can guide targeted maintenance, enhance resource allocation, and optimize risk mitigation strategies, including improved inspections, emergency response plans, and public safety measures. Additionally, the study supports informed decision-making aligned with Sustainable Development Goals (SDGs), ensuring environmentally responsible and economically viable energy transportation systems.

Sustainability Risk Matrix (Social, Environmental and Economic Risks)

Cause	Failure Probability	Consequences		
		Social	Environmental	Economic
1	0.281	0.321	0.358	0.212
2	0.411	0.322	0.231	0.082
3	0.033	0.053	0.062	0.057
4	0.148	0.145	0.099	0.094
5	0.041	0.065	0.099	0.316
6	0.042	0.048	0.057	0.141
7	0.023	0.018	0.042	0.027
8	0.020	0.028	0.053	0.071

Resulting Risk Matrix

Potential Failure Cause	Social Risk	Environmental Risk	Economic Risk	Sustainability Risk
1. Corrosion Failure	0.090	0.101	0.060	0.250
2. Equipment Failure	0.132	0.095	0.034	0.261
3. Excavation Damage	0.002	0.002	0.002	0.006
4. Incorrect Operation	0.021	0.015	0.014	0.050
5. Material Failure of Pipe or Weld	0.003	0.004	0.013	0.020
6. Natural Force Damage	0.002	0.002	0.006	0.010
7. Other Incident Cause	0.000	0.001	0.001	0.002
8. Other Outside Force Damage	0.001	0.001	0.001	0.003

Research Theme 3

SHOWCASE #14 :

The 14th showcase titled "**Assessing Mobility under Inclement Weather Using VISSIM Microsimulation - A Case Study in U.S**" was conducted by Ying Huang, Melika Ansarinejad, and Pan Lu. The Research Work investigates the impact of inclement weather on traffic mobility using VISSIM microsimulation, focusing on a case study in Saratoga Springs, Utah, USA.
The methodology involves modeling and simulating driving behaviors under various weather conditions, including clear skies, rain, heavy dense fog, and snow, by adjusting key parameters of the Wiedemann 99 car-following model to reflect weather-specific values. Traffic flow metrics such as average delay, stops, and speed were analyzed through ten simulation runs for each weather scenario.

Project Site- Saratoga Springs, Utah

Modeled Vissim Layout

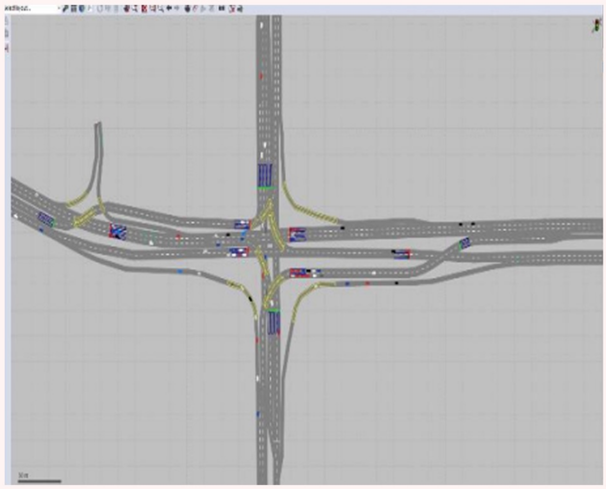


Table 3. Results of traffic flow in a traditional network under different weather scenarios

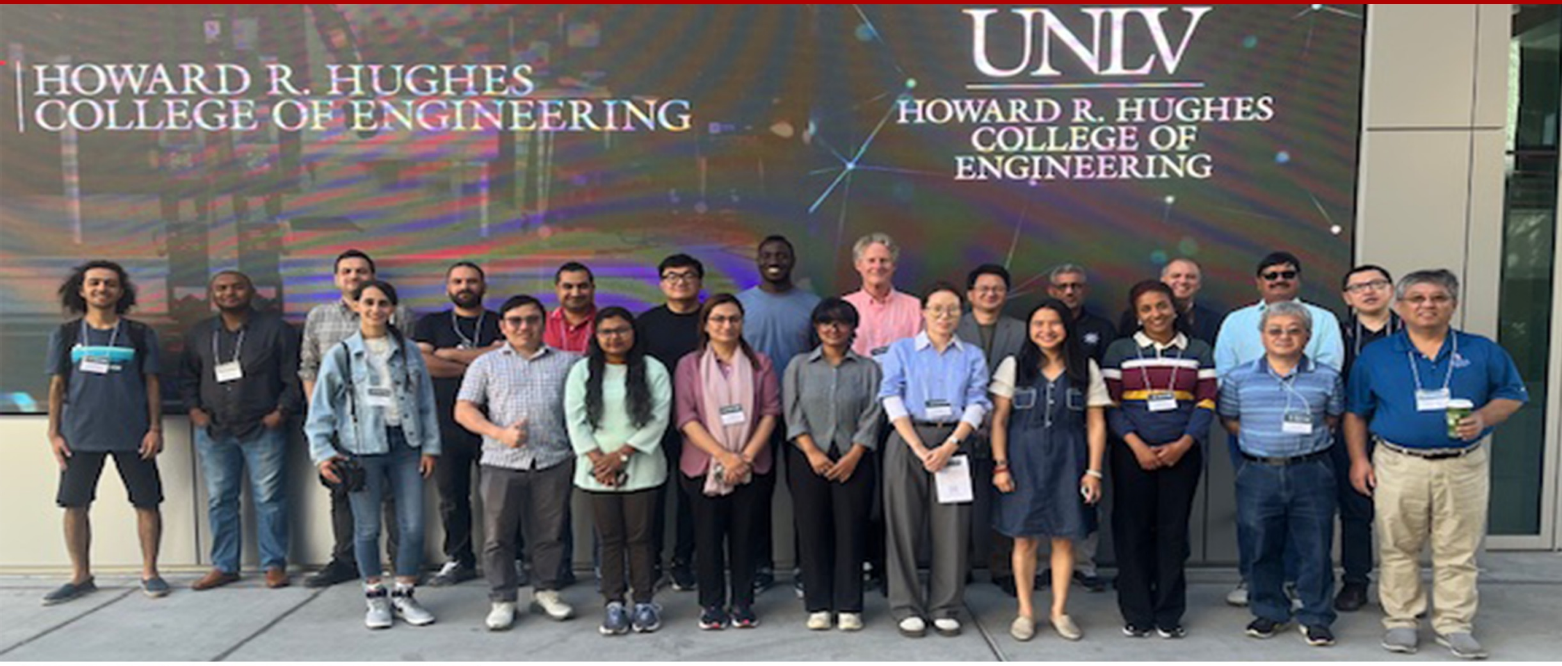
Weather Scenarios	Clear	Rain	Heavy Dense Fog	Snow
Average Delay (s)	440.42	565.27	808.21	1113.73
Average Stop (-)	23.71	56.25	70.66	176.76
Average Speed (km/h)	62.38	48.86	35.08	23.11

Snowy weather caused the most severe impact, with increased delays and stops, followed by dense fog and rain. The study stresses integrating weather impacts into traffic management for safer, smoother mobility.

Application of the Study

The application of this study lies in improving traffic management, road safety, and transportation planning under adverse weather conditions. By using VISSIM microsimulation to quantify the impact of different weather scenarios on traffic flow, transportation engineers and policymakers can develop targeted strategies to mitigate delays and reduce traffic congestion. The insights gained can guide the deployment of weather-responsive measures, such as adaptive traffic signal controls, dynamic speed limit adjustments, and proactive warnings during extreme weather. Additionally, the study supports infrastructure planning and road maintenance by identifying critical conditions requiring intervention, ultimately enhancing mobility and safety for drivers during adverse weather events.

AI SUSTEIN 2024 Meeting at UNLV



The third annual AI SUSTEIN meeting was held at the University of Nevada, Las Vegas, on October 10-11, 2024, bringing together the external advisory board, faculty, and students from NDSU, UNLV, and UARK.

1st Place:Lemlem Asaye

2nd Place:Karuna Bhaila

3rd Place:Yasir Mahmood

4th Place:Nof Yasir

10th October 2024

On the first day, graduate students presented their research, and four were recognized with the Best Graduate Student Presentation Award, selected by the external advisory board. Photos of the award recipients were displayed in the left side.

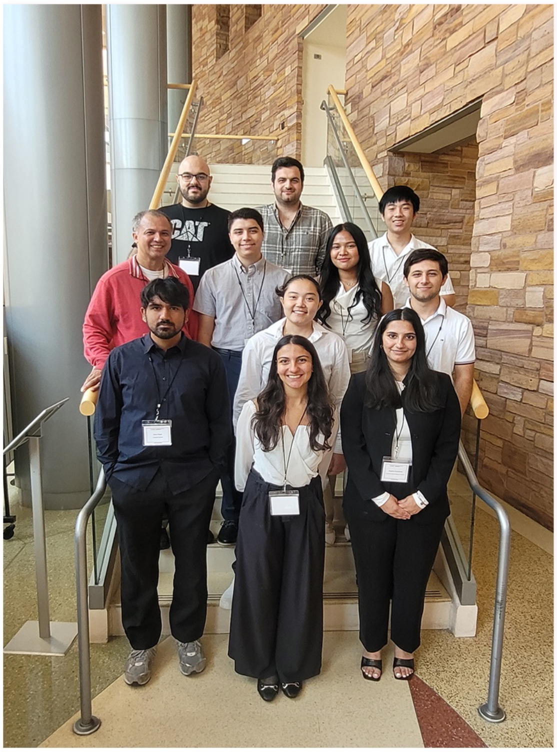
11th October 2024

The second day focused on workforce discussions, external advisory board group observations, planning for year four, and a networking event aimed at strengthening collaboration with the advisory board and industry partners. Numerous actionable solutions emerged from the meeting, set to be implemented in year four.

Future Event:

The next gathering is scheduled for summer 2025 at North Dakota State University in Fargo, ND.

REU Program 2024 at UNLV



This year the 8-week summer REU program was organized by Co-PI Dr. Eakalak Khan and held at the University of Nevada, Las Vegas in Las Vegas, NV.

The mentors of the program were: Dr. Eakalak Khan (Professor, civil and environmental engineering and construction), Dr. Erica Marti (Associate Professor, civil and environmental engineering and construction), Dr. Marie-Odile Fortier (Assistant Professor, civil and environmental engineering and construction), Dr. Ming Zhu (EE Lab Director, electrical and computer engineering), Dr. Shengjie (Patrick) Zhai (Assistant Professor, electrical and computer engineering), and Dr. Zuobin Xiong, (Assistant Professor, computer science).

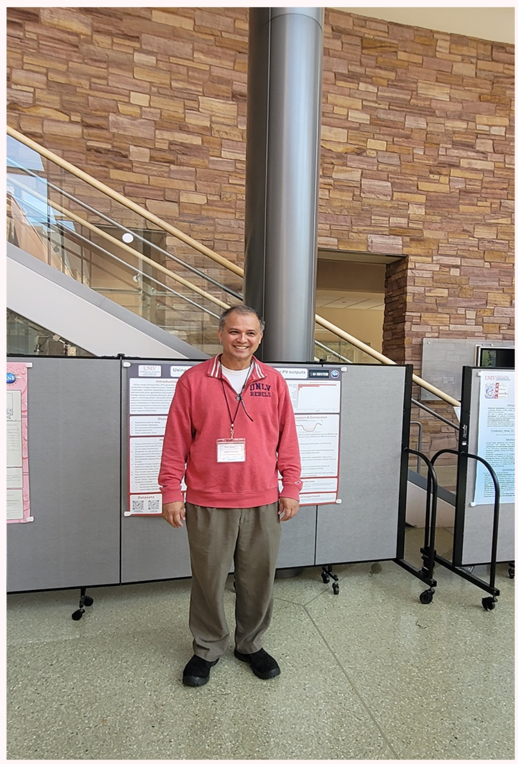
Each REU student had a mentor that accompanied them in their research experience this past summer. During the program, University of Nevada, Las Vegas' office of Undergraduate Research held the following virtual sessions for the students:

June 21, 2024 – 11:00am-11:45am | Nuts and Bolts of Getting Involved in Research
July 5, 2024 – 11:00am-11:45am | How to Effectively Create Posters,
July 12, 2024 – 11:00am-11:45am | Best Practices for Successful Mentor-Mentee Relationships,
July 19, 2024 – 11:00am-11:45am | What is Your Story? Inspiring Undergraduate Researcher Testimonials

There was also a session on UNLV's study abroad program on July 26, 2024. What is unique to UNLV is non-UNVL students can participate in the program. Gregory Stephany, Executive Director of International Programs, was able to customize the presentation and discussion for AI on Sustainable Energy Infrastructure.

Hoover Dam Field Visit

Another unique opportunity offered was a visit to the Hoover Dam to the students. All eight of the REU students, CO-PI, Dr. Eakalak Khan, and graduate students, Ahmadreza Khatamgooya and Morteza Nazarioup, completed the full Hoover Dam tour on July 10, 2024. Although it was extremely hot, there was a lot learned and was a very educational experience on how the dam works, operates, and generates energy.



Poster Symposium

The program ended with a student poster symposium organized by UNLV's Office of Undergraduate Research on Friday, August 9, 2024. Dr. Eakalak Khan welcomed everyone to the poster symposium. Participants were able to view the posters, visit with the presenters, and enjoy some refreshments at the symposium.

Kirstin Saulsbury, Project Coordinator

AI SUSTEIN

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