Jose Tupayachi (Jose Alberto Tupayachi Silva)

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I am a researcher at Oak Ridge National Laboratory and the University of Tennessee, Knoxville, focused on integrating AI agents, large language models (LLMs), and edge computing to build intelligent, distributed systems. My work combines simulation-based experimentation and machine learning with practical applications in health-support platforms, IoT-based monitoring, and decision support systems for transportation and logistics. Skilled in developing scalable solutions using retrieval-augmented generation, vector databases, and optimization techniques. My research enhances autonomy, scalability, and real-world applicability of modern AI systems, leveraging sensor data, real-time analytics, and advanced modeling to support high-impact decision-making and operational performance across diverse domains.

Education

University of Tennessee, Knoxville USA |PhD Candidate in Industrial Engineering — May 2024 - Present
Advisor: Dr. Xueping Li

University of Tennessee, Knoxville USA |MS in Industrial Engineering — Aug 2022 - May 2024
GPA: 3.9

Pontifical Catholic University of Peru, Lima Peru |BS in Industrial Engineering — March 2014 - May 2020

Publications

- **Design and Usability Testing of SmartSHOTS: A Mobile App to Reduce Vaccine Barriers for Children 0-24 Months** Wyatt Tami, Taylor Penny, Li Xueping, Lowe Sarah, Sharmin Aliza, Tupayachi Silva Jose, Wang Xudong, Mcneely Clea, Niederhauser Victoria
  Proceedings of the 58th Hawaii International Conference on System Sciences (2025)
- **A Simulation-Based Real-Time Deep Reinforcement Learning Approach for Fighting Wildfires**
  J Tupayachi, MM Ferguson, X Li
  2024 Annual Modeling and Simulation Conference (ANNSIM), 1-12 (2024)
- **Drone-aided delivery methods, challenges, and the future: A methodological review**
  X Li, J Tupayachi, A Sharmin, M Martinez Ferguson
  Drones 7 (3), 191 (2023)
- **Towards next-generation urban decision support systems through AI-powered construction of scientific ontology using large language models—A case in optimizing intermodal freight**
  J Tupayachi, H Xu, OA Omitaomu, MC Camur, A Sharmin, X Li
  Smart Cities 7 (5), 2392-2421 (2024)
- **Automating Bibliometric Analysis with Sentence Transformers and Retrieval-Augmented Generation (RAG): A Pilot Study in Semantic and Contextual Search for Customized Literature**
  H Xu, X Li, J Tupayachi, JJ Lian, OA Omitaomu
  Proceedings of the 2nd ACM SIGSPATIAL International Workshop on Advances in Urban-AI (2024)
- **Better Efficiency on Non-performing Loans Debt Recovery and Portfolio Valuation Using Machine Learning Techniques**
  J Tupayachi, L Silva
  Production and Operations Management: POMS Lima, Peru, December 2-4, 2021 (2022)

Pre-Prints:

- **Empowering Cognitive Digital Twins with Generative Foundation Models: Developing a Low-Carbon Integrated Freight Transportation System**
  X Li, H Xu, J Tupayachi, O Omitaomu, X Wang
  arXiv preprint arXiv:2410.18089 (2024)
- **Towards Next-Generation Urban Decision Support Systems through AI-Powered Generation of Scientific Ontology using Large Language Models: A Case in Optimizing Intermodal Freight Transportation**
  J Tupayachi, H Xu, O A Omitaomu, M C Camur, A Sharmin, X Li
  arXiv preprint arXiv:2405.19255 (2024)
- **Scalable Decentralized Prognostics for Industrial Systems under Data Heterogeneity**
  J Tupayachi, AN Khan, X Li
  https://papers.ssrn.com/sol3/Delivery.cfm?abstractid=5433957 (2025)
- **Predicting Electric Vehicle Charging Station Demand: Using Spatial-Temporal Graph Neural Networks with Integrated Weather and Traffic Data**
  JoseTupayachi, Mustafa C.Camur, Kevin Heaslip, Xueping Li
  https://arxiv.org/abs/2510.09048

Submitted Papers:

- **Towards Autonomous Urban Logistics Optimization via Generative AI and Agentic Digital Twins**
  H Xu, Y Sun, J Tupayachi, O Omitaomu, S Zlatanova, X Li
  Submitted to *Computers & Industrial Engineering*
  Submission ID: CAIE-D-25-05889
- **Scalable Decentralized Prognosis for Industrial Systems under Data Heterogeneity**
  J Tupayachi, A Kham, X Li
  Submitted to *Computers and Electrical Engineering*
  Submission ID: COMPELECENG-D-25-05978
- **Design and Usability Testing of SmartSHOTS: A Mobile App to Reduce Vaccine Barriers for Children Aged 0-24 Months**
  Tami Wyatt, Penny Taylor, Xueping Li, Sarah Lowe, Aliza Sharmin, Jose Tupayachi Silva, Xudong Wang, Clea Mcneely, Victoria Niederhauser
  Submitted to *Health Informatics Journal*
  Submission ID: HIJ-25-0257
- **Context-Aware Visual Prompting: Automating Geospatial Web Dashboards with Large Language Models and AI Agents for Decision Support**
  Haowen Xu, Jose Tupayachi, Xiao-Ying Yu
  Submitted to *International Journal of Applied Earth Observation and Geoinformation*
  Submission ID: JAG-D-25-04850

Graduate Researcher – Oak Ridge National Lab / Oak Ridge Institute for Science and Education

AI-Augmented Literature Retrieval and Exploration for Materials Research |LLM-Powered Query Pipeline with BERT Tagging May 2025 – Present

- Supported Proposal writing: “DE-FOA-0003592 Rapid, On-site Chemical Analyses of Rare Earth Element Ore Deposits” [UI interface] and “Artificial Intelligence (AI) Project: Advanced Physics-Based AI/ML Testbed for Discovery of High-Performance Structural Materials” - FY26 Artificial Intelligence for Nuclear Security (AI4NS) Project Proposals [Database, UI Visualization and Chat Interface]
- Designing an AI-driven pipeline using large language models (LLMs) to enhance keyword-based search and retrieval for ion-irradiation research, with applications in nuclear reactor (LWR) materials.
- Developing a modular, three-phase system composed of user query intake, automated data scraping and tagging with BERT, and a responsive Q&A interface for literature distilation.
- Applying natural language processing (NLP) techniques to analyze, cluster, and summarize domain-specific research articles.
- Coordinating with nuclear materials scientists to ensure system alignment with research needs and DOE standards.
- Translating complex technical methods for multidisciplinary research teams and contributing to user-centered tool development.

Hosted Researcher - Oak Ridge National Lab

ML-Assisted Atmospheric Hazard Modeling for Effective Geospatial Risk Analysis |Frontend generation based on React and Tailwind CSS using LLMs March 2025 – May 2025

- Fine tuning Large Language Models to generate automated, interactive dashboards for data visualization.
- Implementing an automated continuous deployment and integration system using web-based frameworks, with React for the front end and Python for backend processing and analytics.

Graduate Research Assistant - Funded Projects Developer

RECOIL |Cognitive Freight Transportation Digital Twin for Resiliency and Emission Control Through Optimizing Intermodal Logistics Jul 2024 – Present

- Designed ontology-guided optimization models for large-scale freight transportation networks, integrating data from diverse GIS-based transport modes, including road, rail, and waterways, to minimize costs and emissions while enhancing operational efficiency.
- Leveraged Convolutional Neural Networks and Graph Neural Networks to analyze the impacts of weather, traffic, and demand on EV charging behavior, enabling data-driven, real-time optimization of EV charging station operations.
- Applied large language models to power a chatbot that provides domain-specific responses for non-technical users, enabling accurate trade-off analysis between cost, time, and CO_2 emissions.
- Designed a real-time feedback loop for digital twins, utilizing “Simulated" sensor data and scrapping techniques to continuously optimize intermodal system performance based on real-world conditions.
- Investigating the use of BERT and setence tranformers to further refine provide a domain literature for QA providing accurate and reproducible reponses supported by LLM and similarity based search.

- Collaborated with Oak Ridge National Laboratory researchers to create industry-ready solution that reduce emissions and enhance the resilience of intermodal freight and supply chain operations.
- Developement of the unified UI using Flutter at `https://portal.recoil.ise.utk.edu`.

Funding Agency: U.S. Department of Energy's Advanced Research Projects Agency-Energy (ARPA-E)
Project Number: #DE-AR0001780

SmartShots |Cross-Platform Application to Improve Childhood Vaccination Rates in Tennessee Dec 2023 – Dec 2024

- Enhanced vaccination tracking with real-time data updates, guardian and dependent updates, notifications, and integrated alerts for users.
- Developed a scalable backend system using Laravel. Used Dart and Flutter based on flutter to ensure smooth functionality across platforms.
- Integrated community health information to offer users real-time access to nearby vaccination providers.
- Collaborated with the Tennessee Department of Health and local health agencies to align the app with state public health objectives and needs.
- `https://play.google.com/store/apps/details?id=com.ilab.smartshots`
- `https://apps.apple.com/us/app/smartshots-tn/id6526502640`

Funding Agency: Tennessee Department of Health

Active Caregiver's Toolkit (ACTAPP) |Mobile Application to Promote Physical Activity Among Rural Appalachian Caregivers at Risk for Cardiovascular Disease (CVD) Jul 2024 - Present

- Development of the ACT APP as a digital solution for rural Appalachian caregivers, aiming to reduce cardiovascular disease risks through targeted physical activity interventions.
- Implemented latest mobile development standars based on Dart 3.0 and material design incluiding custom components and state manangement using GetX.
- Inclussion of ChatBot for FAQ answering.
- Tracking metric for data analysis based on page and interactions metrics.
- `https://testflight.apple.com/join/PehxA8aW`
- `https://play.google.com/store/apps/details?id=com.ilabutk.fe_rich`

Funding Agency: Hillman Emergent Innovation (HEI)

Pathology Cancer Staging - UT Medical Center Jan 2025 - Present

- Development of Flutter UI and web map services for interactive demographic cancer visualization.

Graduate Teaching Assistant

IE406/408: Simulation – Teaching Assistant, Spring 2022

- Assisted students with their final project and Anylogic simulation use and preparation.
- Graded homework assignments and addressed questions during class sessions.

IE483: Introduction to Reliability Engineering – Teaching Assistant, Fall 2022

- Provided in-class support by answering student questions.
- Proposed new homework problems, evaluated and graded homework assignments.

Awards & Scholarships

IISE Future Faculty Fellows
Year: 2025-2026, USA | Selected.

51st Conference on Computers and Industrial Engineering (CIE51) *Best Paper Award: "Emerging AI and Cognitive Digital Twin Technologies Towards Low-Carbon Multimodal Freight Transport Systems – Sustainable Transport Systems"*
Sydney, Australia December 9–11, 2024

IISE Data Analytics & Information Systems (DAIS) Student Mobile App Competition
2024 Winners - SmartShots Project, Montreal | `https://www.iise.org/Details.aspx?id=33697`

Graduate Fellowships and Awards
Holiday Fellowship: 2022, 2023, 2024

HIDA Helmholtz Visiting Researcher - Karlsruhe Institute of Technology (KIT)
Year: 2024, Germany | Awarded.

Industry Work Experience

Data Engineer |INDRA SISTEMAS S.A. – Full-time March 2022 – Aug 2022

- Developed and maintained data pipelines using Python and Shell scripting to streamline big data workflows.
- Worked with Apache Spark, Hadoop, and HQL for distributed data processing, querying, and large-scale data migration, including data migration from Oracle and SaaS to PySpark.
- Implemented Jenkins-based deployment strategies for automating ETL pipeline updates.
- Ensured data quality and performance through data governance practices and code optimization techniques.
- Managed memory allocation for distributed data processing tasks in High-performance computing.

Business Intelligence Analyst |GLOBOKAS PERU S.A. – Full-time Jan 2022 – March 2022

- Developed and optimized Extract, Transform, and Load (ETL) pipelines using Transact-SQL to streamline data processing and improve efficiency.
- Designed and implemented a live platform for real-time revenue and administrative KPI monitoring, enabling data-driven decision-making.
- Leveraged Google BigQuery and custom macros to automate daily data parsing and dashboard updates, ensuring up-to-date insights.
- Enhanced data quality and integrity by applying statistical metrics to detect and mitigate inconsistencies.

Data Analyst Trainee |ENEL DISTRIBUCION PERU S.A.A. – Full-time Nov 2020 – Dec 2021

- Optimized payment collection processes and client segmentation by employing advanced unsupervised clustering techniques, improving efficiency and effectiveness.
- Designed and implemented dashboards using Power BI and Tableau, providing strategic insights and actionable intelligence.
- Administered SQL and T-SQL databases alongside Salesforce, ensuring data integrity and delivering accurate, reliable reporting for Enel's Business Partners.
- Developed a robust desktop application using PyQt to streamline invoice collection verification and automate digital invoice processing, enhancing operational efficiency.

Developer – Portfolio Valuation Project |GPS MANAGEMENT DEL PERU S.A.C. – Machine Learning Consulting Aug 2020 – Nov 2020

- Developed a predictive model for valuing non-secure and secured portfolios of non-performing loans using Machine Learning.
- Conducted data compilation, feature engineering, modeling, and validation.
- Deployed the model on a web platform using Flask.

Professional IT Intern |SUPERINTENDENCIA DE BANCA, SEGUROS Y ADMINISTRADORAS PRIVADAS DE FONDOS DE PENSIONES Sep 2020 – Oct 2020

- Automated PDF reports using Jinja-Python for user service indicators.
- Managed Help Desk tasks and Active Directory access control, complying with ITIL standards.

Plant Intern |MATMACK S.A. – Bottling Company (Brands Bells and Cencosud) Dec 2019 – Mar 2020

- Improved inventory control, supplier coordination, and established reorder points.
- Developed demand forecasting models for products per client.
- Conducted cost analysis of raw materials and determined the Economic Order Quantity.
- Built a planning application based on a Master Production Schedule.

Information Technology Intern |ADMINISTRADORA CLINICA RICARDO PALMA S.A. – Medical and Hospital Services Feb 2019 – Aug 2019

- Structured databases for the "Health and Insurance Plan" and implemented ETL workflows.
- Supported and monitored project development, scheduling, and cost evaluation.
- Developed Power BI dashboards for financial reporting and KPIs.
- Designed and structured the medical staff privilege database.

Community Service

University of Tennessee Graduate Student Senate - Senator, Industrial and Systems Engineering, 2025
Represented students, advocated for academic and professional development opportunities, and fostered graduate student engagement.

Journal & Conference Reviewer

- **Information Systems Frontiers**(Springer)
  - *Comparing Human-Like and eXplainable AI-based Trust Repair Strategies Implemented by Conversational AI*
- **International Conference on Intelligent User Interfaces (IUI) 2026** (IEEE/ACM)
  - *MimiCo: Learning Human-Robot Collaboration from Human-Human Collaboration*
  - *Are We There Yet? Exploring the Role of Robotic Informational Assistant in Autonomous Vehicles during Successful and Unsuccessful Manoeuvres*
  - *Modeling Intimate Action in HRI: Theoretical Formulation and Predictive Feature Analysis for User Rejection*
- **Journal of Asian Architecture and Building Engineering** (Elsevier)
  - *Advancing Urban Street Perception Research through Large Language Models and Street View Imagery*
- **IEEE Internet of Things Magazine** (IEEE)
  - *Dynamic Mentee FedKD: A Communication-Efficient Federated Knowledge Distillation Framework for Heterogeneous IoT Clients*
- **Software: Practice and Experience** (Wiley)
  - *MAD-KG: A Hybrid Knowledge Graph Construction Framework for Mobile App Development Domain*
- **IISE Transactions** (Taylor & Francis Online)
  - *Physician Scheduling in Hospitals with Online and Offline Services: Optimization with Machine Learning-Based Evaluation*
- **Optimization Letters** (Springer Nature)
  - *Optimal Mass Transport for Dynamical Warehouse Reconfiguration: A Continuum Mechanics Approach*
- **Journal of Robotics** (Wiley)
  - *Autonomous Planetary Rover navigation and crater-based map augmentation for path planning and Rock localization using space ROS*
- **Journal of Sensors** (Wiley)
  - *Manufacturing and testing of novel low-cost and flexible geopolymer-based tactile sensors*
  - *Optimization of excitation coil parameters for PECT of defects in laser welding of power battery pack based on Kriging surrogate model*
- **Winter Simulation Conference 2025 – Reliability Modeling and Simulation**
  - *Simulating the dynamic interaction between fleet performance and maintenance processes based on Remaining Useful Life*
- **Winter Simulation Conference 2025 – Invited Paper Track**
  - *Reliability Assessment of Convolutional Autoencoder-Based Wind Modeling for Autonomous Drone Training*
- **IISE Annual Conference 2025 – Logistics and Supply Chain (LSC)**
  - *Analyzing the Impact of Hurricane Florence on Freight Transportation in North Carolina using Telematics Data*
  - *Distributed Programmatic Demand Forecasting in Modular Construction Through Machine Learning and Simulation*
- **IEOM 2025 – University of Central Florida**
  - *Principal Component Analysis Machine Learning Technique on the Underground Big Diameter Steel Pipelines Condition Assessment and Related Data: South African Bulk Water Distribution Utilities*
  - *Investigation of the Mechanism Failures of High Temperature Components Occurring Inside Boiler Tubes*
  - *Service Model Based on Lean Six Sigma and Queuing Theory to Increase NPS in a Healthcare Company*
  - *Blockchain-enabled Information as a Service (IaaS) for Configuration Tracking and Control of Smart Manufacturing Systems*
  - *Production Model Based on 5S to Increase Productivity in a SME in the Garment Sector*

Conference Presenter:

Federated Learning Fault Detection: Towards a Decentralized Machine Learning Framework - IISE 2023

Rule-based Automated Cancer Staging from Scanned Pathology Reports - IISE 2024

Empowering Simulation Modeling: An Automated Ontology Framework Enhanced by Large Language Models - INFORMS 2024

Conversational Geographic Question Answering: LLMs & Continuous Retrieval-Augmented Generation - SIGSPATIAL 2024

Technologies

Languages: Python, SQL, Bash, Dart, PHP, Java, C++, CUDA
Frameworks: Django, Flask, TensorFlow, PyTorch, Flutter, Laravel, Wordpress
IoT: Arduino, ESP32
Databases: PostgreSQL, MongoDB, MySQL, SQL Server
DevOps: Docker, Git, Jenkins, AWS, Virtualization KVM, Slurm
Optimization: Networkx, Gurobi, cplex, AnyLogic Simulation, NetworkX
Office Tools: Excel, Microsoft Office, Linux
GIS: WMS, GeoSever, OverPass API

Upcoming Publications

- MCP-Driven AI Agents in Agent-Based Simulation for Complex Systems: A Intermodal Transportation Experimental Study
- Toward Conversational AI for Assessing Clinical Competence: ClinicSense
- Literature Survey for New Materials Discovery Powered by AI Agents
- Understanding Extreme Weather Dynamics: Application to the Oak Ridge Reservation