Restoration of Services in Disrupted Interdependent Infrastructure Systems

Joshua Guevara Díaz

Department of Industrial and Management Engineering

Universidad Ana G. Méndez – Recinto Gurabo

Jvguevara10@gmail.com

José A. Santiváñez

Department of Industrial Engineering

Universidad de Ingenieria y Tecnologia- UTEC, Lima – Perú

jsantivanez@utec.edu.pe

Raúl Valerio

National Autonomous University of Honduras

raulvalerio@gmail.com

Lizzette Pérez-Lespier

Congdon School of Supply Chain, Business Analytics, & Info. Systems

University of North Carolina, Wilmington

perezlespierl@uncw.edu

Abstract:

Understanding the fragility induced by multiple interdependencies is one of the major challenges in the design of resilient infrastructures. These rippled failures greatly increase their vulnerability to disruptions along with delays in their restoration efforts. Networks feature a bidirectional dependence such that power stations depend on communication nodes for control, and communication nodes depend on power stations for their electricity supply. This research investigates the effects of disruptions on the interdependent infrastructures of electric power and telecommunications networks and performs an empirically based analysis to understand their interdependence and its effects in restoration efforts. The aftermath of extreme events such as hurricanes, earthquakes, and pandemic outbreaks provide a unique opportunity to obtain experimental evidence that the critical infrastructures are indeed interdependent. Empirical analysis including Granger causality tests are performed to assess interdependency between the networks following the event. After interdependency and its duration are properly assessed, a system dynamics model is proposed to provide insights on how to reduce restoration times by appropriate selection of model parameters.

Keywords

Critical infrastructures, disaster restoration, resilience, decision analysis, system dynamics

Biography:

Joshua Guevara is a knowledgeable Industrial Engineer skilled in process improvements, equipment design, and waste reduction. Strategic planner and analytical problem solver. History of improving production and maximizing efficiency. He currently is a master's degree student in Engineering Management at the University of Turabo- Recinto Gurabo in Puerto Rico. He earned a BS in Industrial & Management Engineering in the same university years ago. His Research interests include system dynamics, simulations, optimization, resiliency and decision making. He also participated in the ASEM engineering conference of 2020 presenting his research while representing the university.

José A. Santiváñez is Department Chair of Industrial Engineering at Universidad de Ingeniería y Tecnología - UTEC, Lima, Perú. He earned a B.S. in Industrial Engineering from Pontificia Universidad Católica del Perú, Perú, MS in Operations Research and PhD in Industrial Engineering both from Northeastern University, Boston, MA. His research interests include critical infrastructure systems, complex networked systems, network reliability and survivability, and locational theory. His areas of expertise include operations research, service systems, stochastic modeling, and quantitative and statistical analysis. He is a member of IISE and INFORMS.

Lizzette Pérez Lespier is an Assistant Professor at the Congdon School of Supply Chain, Business Analytics, and Information Systems at the University of North Carolina Wilmington. She received her Bachelor of Science in Industrial Engineering from the University of Puerto Rico- Mayagüez Campus. Afterwards, Dr. Pérez received her Master of Science and her PhD degrees in Engineering Management and Systems Engineering from Missouri University of Science & Technology. Her research work focuses on issues related to sustainable development; value added decision-making and supply chain risks using interdisciplinary approaches to problem solving. She is a Board Member of SEMS at IISE, and an active member at ASEM and DSI.

Raúl l Valerio earned a BS in Mathematics and a BS in Electrical Engineering both from National Autonomous University of Honduras and a MS in Mathematical Statistics form Universidad de Puerto Rico-Recinto de Mayagüez. His current research interests are Generalized Mixed Linear Model, Statistical Learning, and Pattern recognition.