

School of Systems Science and Industrial Engineering

Healthcare Accessibility – Challenges and Solutions

Ph.D. Dissertation Defense

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03:00 PM to 04:30PM

Monday, May 12, 2025

<https://binghamton.zoom.us/my/hirokisayama>

ABSTRACT

Persistent disparities in healthcare accessibility reflect challenges embedded within the geographic, structural, and workforce dimensions of the healthcare system. This research presents a systems science approach to evaluate healthcare access not as a static indicator, but as a dynamic, emergent property shaped by the interaction of spatial isolation, infrastructure limitations, and provider distribution.

To address these challenges, a multi-method framework was developed that integrates geospatial analysis, agent-based modeling (ABM), and workforce outcome evaluation. Geospatial methods were used to assess hospital accessibility across New York State, identifying isolated facilities and underserved regions through spatial isolation indices and catchment area modeling. These results provide a quantifiable basis for targeting infrastructure investment and resource planning in high-risk areas.

Building on this foundation, an agent-based simulation was designed to evaluate system behavior under stress conditions, such as during infectious disease surges. The model captures interactions between infection spread, hospital capacity constraints, patient displacement, and mortality. Simulations reveal that even moderate stress scenarios can lead to rapid system overload and elevated excess mortality, emphasizing the importance of travel time and care delays in system outcomes.

The dissertation then explores how the spatial distribution and composition of the healthcare workforce influence access and population health. Using multivariate statistical methods, the analysis demonstrates that increased deployment of non-physician providers correlates with improved access and outcomes in underserved regions.

Together, these contributions offer a scalable and policy-relevant framework for diagnosing and addressing healthcare access disparities across multiple domains of access. The findings provide actionable insights for health system resilience, rural health planning, and workforce optimization, advancing a data-driven foundation for care delivery.