Statement of Purpose

Renlong Wang PhD Program in Construction Engineering and Management

I am deeply motivated to pursue a PhD degree in Construction Engineering and Management. My current research experiences center on developing quantitative methodologies for modeling, evaluating, and optimizing complex systems under uncertainty, drawing on advanced techniques in system simulation, network analysis, and operations research. These experiences have deepened my commitment to advancing the field by developing innovative methodologies for infrastructure resilience.

Undergraduate Training in Practical Innovation.

I earned my bachelor's degree in Civil Engineering from Nanjing Tech University, where a rigorous curriculum and research projects sparked my interest in infrastructure resilience. During this period, I engaged in several innovation projects on complex system modeling and analysis, particularly in prefabricated building safety and infrastructure resilience, which strengthened my skills in discrete-event simulation, network analysis, and multi-attribute decision analysis. As my research progressed, I faced challenges that drove me to improve my ability to translate real-world problems into mathematical models. To this end, I participated in mathematical modeling competitions and received top honors such as the *Outstanding Winner Prize* (Top 0.16%) and *SIAM Award* (six teams worldwide) in the *American Undergraduate Mathematical Contest in Modeling*, as well as the *First Prize* (Top 0.65%) in the *China Undergraduate Mathematical Contest in Modeling*. These accomplishments enriched my research and sharpened my ability to connect abstract modeling techniques with real-world challenges. A representative example is my development of an enhanced cellular automata–based framework for simulating the resilience of hospital Power-Water-Firefighting-Space nexus systems, which was published in *Simulation Modelling Practice and Theory*. This framework integrates micro-level component behaviors with macro-level interdependencies and external disruptions such as demand surges during COVID-19. As a recognition of my academic performance, I was honored as a *Distinguished Graduate of Jiangsu Province in Civil Engineering*. Together, coursework, research projects, and mathematical modeling equipped me with both practical insights and a rigorous first-principles approach, preparing me for advanced research in complex system modeling and infrastructure resilience.

Postgraduate Training in Mathematical Skills.

My undergraduate research experience made me deeply aware of the pivotal role mathematics plays in solving complex engineering problems, motivating me to pursue a master's degree in Industrial Engineering and Management at the University of Chinese Academy of Sciences. Through advanced coursework, such as *Operations Research*, *Stochastic Operations Research*, *Game Theory*, *Applied Statistics*, and the PhD-level course *Optimization: Model, Theory, and Algorithm*, I gained strong analytical skills. Building on this foundation, I conducted research on optimization-based multi-attribute decision analysis by integrating advanced paradigms of decision-making under uncer-

tainty, such as robust optimization, stochastic programming, and distributionally robust optimization, which served as a bridge connecting my theoretical knowledge in mathematics with practical innovations. My key contribution was Preference Robust Ordinal Priority Approach (OPA-PR), which extends the classical OPA by embedding preference elicitation into a two-stage optimization framework. OPA-PR systematically handles both parametric and preference uncertainty, eliciting worst-case marginal utility functions and optimizing decision weights under ambiguity sets. This work demonstrated how preference robust optimization can be translated into practical tools for multi-attribute ranking and selection. I further addressed issues such as expert consensus and Pareto optimality in multi-criteria decision-making. My research outcomes have been published in journals, such as *Expert Systems with Applications*, *Information Sciences*, and *Energy*. I actively engaged in academic forums, delivering presentations and sharing research outcomes, which earned me multiple awards for excellent papers. My efforts were recognized with the *Excellent Prize for the President Scholarship of the Chinese Academy of Sciences* (Top 1%) and the *National Scholarship for Postgraduates (Master)* (Top 1%). This stage consolidated my mathematical and optimization skills and cultivated a rigorous research mindset. It also strengthened my communication abilities, laying a solid foundation for advancing research on decision-making under uncertainty in infrastructure resilience.

Research Interests and Long-Term Goals.

My research interests center on enhancing infrastructure resilience under uncertainty, particularly through mathematically sound decision criteria and optimized recovery strategies in disaster-affected systems. Building on my prior research in optimization-based decision-making and complex system modeling, I aim to view resilience not only as structural robustness but as an emergent property shaped by system conditions and governance. Specifically, I plan to model recovery decision-making under uncertain disturbances by integrating simulation-based methods with probabilistic frameworks, using tools such as reinforcement learning, stochastic programming, and distributionally robust optimization. I am also interested in contextual optimization-leveraging side information to better predict perturbation distributions-and in jointly designing protective measures and recovery policies. Beyond technical modeling, I am motivated by the prospect of bridging theory with practice, developing decision frameworks that are both computationally tractable and practically implementable for disaster management agencies. Overall, I aim to advance from modeling analytics to predictive analytics and ultimately to prescriptive analytics–bridging digital twin techniques with statistics and machine learning, together with operations research–to establish a comprehensive paradigm in which these approaches function synergistically rather than in isolation. In the long term, I aspire to pursue an academic career that contributes both theoretically and practically to infrastructure resilience. My goal is to develop widely applicable methodologies that not only advance the theory of decision-making under uncertainty but also inform the design of resilient infrastructure planning, ultimately enabling urban systems to better withstand and recover from disruptions while fostering safer and more sustainable communities.