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Editorial

Modeling and Quantification of Resilience in Complex Engineering Systems

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The identification of criticalities is an important aspect for any engineering systems. Such identification plays a central role for safety and security analyses of modern socio-technical systems. Nowadays, electrical network as well as information and transportation networks can be enhanced in reliability, efficiency, safety and security through the adoption of automation solutions, and cyber-physical systems. In this regard, it becomes even more important to model and quantify the resilience of such systems with respect to a variety of disruptions. In response to this target, this special issue aims at providing a forum to present recent developments in terms of models and metrics for understanding, assessing, and enhancing system's resilience. Main challenges in the field include identification of vulnerability features, component importance measures, cascading failures modelling, environmental modelling, and overall performance assessment. Such aspects are managed through innovative approaches combining reliability engineering, network theory, social sciences, Bayesian network, genetic algorithms, and artificial intelligence.

This special issue has attracted high-quality submissions from scholars worldwide in the areas of resilience engineering, industrial engineering, business management, systems engineering, civil and environmental engineering, electrical engineering, energy, logistics, social sciences, and computer sciences. The researchers utilized their expertise and competences and match up to the challenges of developing solutions for managing the ever-increasing complexity of modern systems.

The total number of submissions is 16. After single-blind peer-review by at least two reviewers, 8 papers were finally accepted to be published. The acceptance rate is 50%. The average number of authors for each accepted paper is 4.1. The affiliated institutes of authors are from China (20 contributors), USA (8 contributors), and UK, Spain, and Italy (2 contributors each). These accepted papers can be organized into two major groups, which in reality are also inter-related.

The first group of papers is about resilience modeling. The paper titled "A Resilience Toolbox and Research Design for Black Sky Hazards to Power Grids" by D. Borisoglebsky and L. Varga presents a simulation model utilizing a resilience assessment equation for iteratively selecting the most appropriate tool for power grids. The paper titled "Sink-Convergence Cascading Model for Wireless Sensor Networks with Different Load-Redistribution Schemes" by X. Fu et al. proposes a realistic sink-convergence cascading model for wireless sensor networks with two load-redistribution schemes (i.e., idle redistribution and even redistribution). About cascading models, T. Wang et al. focus on cascading failures in interdependent systems from the perspective of cyber-physical security for smart grids in the paper titled "Cascading Failures Analysis Considering Extreme Virus Propagation of Cyber-Physical Systems in Smart Grids." The paper titled "Stability and Complexity of a Novel Three-Dimensional Environmental Quality Dynamic Evolution System" by L. W. Zhao and C. O. A. Otoo describes an environmental quality dynamic system based on Bayesian estimation and neural network to effectively

identify the system parameters for calibration of various variables and official data. The paper titled "Simulating Environmental Innovation Behavior of Private Enterprise with Innovation Subsidies" by H. Guan et al. adopts a social science perspective to model behaviors of private enterprises and simulate their evolution process in different market mechanisms, product competitions, and innovation subsidies.

The second group focuses more specifically on metric definition and quantification. In the transportation domain, the paper titled "Metrics for Assessing Overall Performance of Inland Waterway Ports: A Bayesian Network Based Approach" by N. U. I. Hossain et al. discusses a novel multidimensional metric to assess maritime port resilience. The paper titled "Identification of Two Vulnerability Features: A New Framework for Electrical Networks Based on the Load Redistribution Mechanism of Complex Networks" by X. Wei et al. describes a new framework to analyze two vulnerability features, impactability and susceptibility, in electrical networks by the perspective of load redistribution mechanisms. Lastly, the paper titled "Measuring Component Importance for Network System Using Cellular Automata" by L. He et al. concentrates on component importance measures of a network whose arc failure rates are not deterministic and imprecise.

In summary, the research papers cover a wide range of applications for resilience modelling in complex networks, as well as for metric definition able to support decision-making processes at different organizational levels. Based on the outcomes of this special issue, more research is still required to further progress the scientific field, especially considering more in detail the cyber-physical aspects, as well as combining the proposed technocentric approaches with a dominant sociotechnical perspective. In practical terms, such targets call for the development of efficient algorithms and frameworks to solve larger and more dynamic models.

Conflicts of Interest

The editors declare that they have no conflicts of interest.

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