

Preface

We define *Infranomics* as a body of discipline supporting analysis and decision making regarding modern societal vexing issues of sustainability, asset management, energy and safety, ethics, education, and engineering design. While it is in its infancy, *Infranomics* is proposed as a thesis enabling better decision making in an increasing ambiguous, complex, emergent, interdependent, and uncertain world. As modern society contends with rapid technological changes, socioeconomic institutional changes, increased globalization, and scarcity of resources, decision makers (i.e., policymakers and private entity operators, and researchers) are faced with a daunting task of ensuring the well-being of public health, security, and economy. Since no nation has unlimited resources, the time is ripe for a discipline that supports analysis and decision making to increase anticipation in an increasingly uncertain world.

In the next 25 works contributing to this book, we illuminate *Infranomics* in different aspects of modern society. The paper by Gheorghe et al., serves as the introduction to this volume. It addresses the interdisciplinary format of *Infranomics*, highlighting some potential initial areas of applications, and the category of analytical instruments adequately empowered to deal with the complex domain of the new body of discipline.

Part I contains three papers discussing sustainability of infrastructures in modern society. How can we create harmony between people, the planet, and profit? The paper by Emile Broesterhuizen et al., provides a tentative solution to this problem by examining ports, with consideration of clients and contractor vantage points. Continuing the theme of sustainability in ports is the paper written by Martijn P.C. de Jong et al. They provide an alternative design for open water ports and consider coastal impact as well as advantages and disadvantages of the proposed design. This part concludes with work done by Poonam Taneja et al., and discusses the role of flexibility in port development. They argue that flexibility is instrumental in achieving long-term financial viability and reduces environmental and social impact of the port infrastructures in uncertain economic times.

Part II contains three works discussing asset management. Kerry Brown et al., suggest that strategic management of assets requires corporate governance, policy, objectives, and interagency collaboration. A framework that enables asset acquisition, utilization, and maintenance for strategic development is presented. Martin Laue et al., operationalize the various levels of the asset management framework

presented in previous work. This work considers how asset management can be embedded in organizations through the temporal, organizational, and spatial dimensions. We conclude this Part II with a section on multicriteria decision making for real estate portfolio. Monique Arkesteijn and Ruud Binnekamp show how measure asset performance to enable decision making based on decision makers' criteria and preferences.

In Part III, the book discusses safety and energy management topics. In an unpredictable world, we must develop mechanisms that can be used to alarm citizens in harm's way. However, paper by Helena Jagtman shows current approaches has limitations. Framework to enable better communication is developed based on a case study. Paper by Masaki Nishimori et al., discusses policy design for disaster-hit areas. Using the example at Fukushima Daiichi Nuclear Power Plant, authors present a framework of system design by holistically incorporating requirements stakeholders' requirements interactively and bottom-up communications. The world largest oil-imports is now, China. How did we get here and what does the future hold? Yang Saini et al., discusses these questions and how these changes could impact transportation sector.

Part IV is purposefully entitled *equity, ethics, and infrastructures* to project the image that *Infranomics* involved morals and policy. First, Neelke Doorn applies this concept to water. The statistics on water-borne diseases, people living without safe water, and flooding are staggering. To address these issues, Neelke Doorn suggests that modern society integrate governance into water systems. Kien To and John Fernández present a compelling need for designing and implementing low-emitting carbon cities in modern society-based alternative urban technologies enabling efficient use of scarce resources. This part concludes with new and exciting developments in the Engineering Systems Division at MIT concerning instilling motivation to future researcher in solve complex and sociotechnical systems problems.

Modeling and simulation is the subject of five contributions in Part V. Andreas Tolk urges for need for modeling and simulation known as *Serious Gaming* to enable manage systems of systems. An experimental game based on systems dynamic is built to explore the question of sustainability and greenhouse emissions for built environments. The procedure and the results of the game simulation model are provided in the work of Iman Mohammed and Erik Pruyt. Work by Todd Schenk is specifically written to suggest an innovative way (Role Play Simulation) to addressing hazards and threats impacting performance of critical infrastructures. To conclude this paper, Sertaç Oruç and Scott Cunningham introduce propositions regarding engineering design. In this work, the case is made for multi-actor approach that emphasizes game theoretical modeling for optimization in engineering design.

Governance enables regulation of social systems using variety of mechanisms for a better society and is the subject of four contributions in Part VI. First, Behnido Calida and Charles Keating give a new vision on the issues related to governance in the context of complex systems exposed to uncertain and ambiguous environments. Many initiatives fail not because of incompetence of

stakeholders, rather Otto Kroesen and David Ndegwah suggest there is a need to understand ambiguities involved between cultural clash between nations and priorities. This paper explores governance in technology transfer in East Africa. Third, Fei Xue et al., introduce a systematic concept of structural analysis for power grids security assessment to enable governance. Authors provide new measures for criticality to enable ranking for sake of critical component survivability. Fourth, the work done by Aria Iwasawa et al., uses Surrogate Worth Trade-off Method to select technology for design of new systems in a Multiobjective, Mixed-Discrete Nonlinear Programming problem.

The book concludes with Part VII comprises four papers contributing to learning and knowledge dissemination within the larger context of *Infranomics*. First, Christopher Magee et al., describe historical roots of Engineering Systems and methods used in the field at MIT. Next, the researchers at ODU and Universitatea Politehnica Bucharest, Romania provide a methodology that can be used to assess resilience of academic programs. This methodology can be used to assess structural complexity and vulnerability of academic problems meant to address modern society most vexing issues. The paper by Hugo Priemus explores the case for risk analysis and risk management in large-scale infrastructure project in the Netherlands. This paper illustrates how academic theory can be used to advice stronger orientation toward flexibility and the identification of viable options. The concluding paper is about a general framework, Actor-Option Framework, which can be used to model large-scale systems in transition, to enable understanding in different transition cases and integration.

As it is becoming increasingly evident that the space for technology-driven solutions to twenty-first century issues is diminishing, there is a need for multidisciplinary approach involving technical and soft elements of human social, organizational/managerial and policy, and political elements. The discipline of *Infranomics* offers an initiating collaborative effort supporting analysis and decision making in our *modern* society.

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