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Jing Zhang
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Information, Models, and Sustainability

Policy Informatics in the Age of Big Data and Open Government

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Jing Zhang is an Associate Professor of Management at Clark University. Her research interests focus on interorganizational information and knowledge sharing, organizational impact of technology and innovation, and the role played by information technology to support sustainable consumption and sustainable supply chain. Her work is supported by National Science Foundation and Mosakowski Institute of Public Enterprises. Professor Zhang holds a Ph.D. in Information Science from the University at Albany, State University of New York.

Information, Policy, and Sustainability: The Role of Information Technology in the Age of Big Data and Open Government

Jing Zhang, Luis F. Luna-Reyes, and Theresa A. Pardo

Abstract Sustainability has become an important focus for government, civil society, and the corporate community worldwide (United Nations Environment Programme 2011). Growing interest in addressing environmental deterioration and associated social inequality and economic challenges is shifting focus to this important issue. The lack of fresh water and arable land, extreme weather, rising cost of relying on fossil fuels, and poverty and regional instability are drawing attention to the need for government intervention and policy instruments that encourage the development of sustainable alternatives.

Introduction

Sustainability has become an important focus for government, civil society, and the corporate community worldwide (United Nations Environment Programme 2011). Growing interest in addressing environmental deterioration and associated social inequality and economic challenges is shifting focus to this important issue. The lack of fresh water and arable land, extreme weather, rising cost of relying on fossil fuels, and poverty and regional instability are drawing attention to the need for government intervention and policy instruments that encourage the development of sustainable alternatives.

This growing attention on sustainability is directly reflected in the United Nation's Millennium Development Goals (UN General Assembly 2000). Set in year 2000 by world leaders, the MDGs constitute a series of targets with a deadline of 2015, ranging from eradicating extreme poverty, achieving universal primary education, to ensuring environmental sustainability. On environment protection, the development

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goals particularly committed to the adoption of a new ethics of conservation and stewardship in all environmental actions, with the purpose to counter the threats of irredeemable environmental damage by human activities and to curb the unsustainable exploitation of nature resources. These goals direct attention to areas such as emissions reduction in greenhouse gases, conservation and sustainable development of forests, preservation of biological diversity, providing adequate and equitable access to water resources and reduction of natural and manmade disasters.

Sustainability can be defined broadly or narrowly, and the definition is context dependent, strongly influenced by the perspectives or domains in which it is applied (Brown et al. 1987). Initially emerged in The Ecologist's (1972) *A Blueprint for Survival*, sustainability and sustainable development have been defined in the perspective of Biology, Economy, Sociology, Urban Planning, and Environmental ethics (Basiago 1995). Although the definitions vary because of differences in disciplinary focus and methods, a commonly accepted definition from the Report of the World Commission on Environment and Development refers to sustainable development as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (Brundtland 1987).

Governments can play very important roles in facilitating sustainable development through better public policies (Dovers 2005). Public investments can be directed toward establishing incentives for renewable energy, energy efficiency, sustainable agriculture, and land and water conservation, or toward leveling the field for sustainable alternatives by phasing out the subsidies directed to unsustainable production and development. In addition, policies can be made to encourage private investment and public–private collaboration in innovation and technological advancement. Moreover, policy incentives for innovations and education development enable nations and regions to lead and capitalize on new technological and economic opportunities.

More importantly, government has been using regulatory and pricing mechanisms to direct resources to support environmental sustainability and solving environmental problems. For example, two types of policy instruments have been used in curbing environmental pollutants. One, characterized as a command-and-control approach, intends to bring down the level of emission through setting emission performance standards. This standard or technology forcing approach is effective in certain contexts, but has been criticized for high levels of cost, inflexibility, and performance uncertainty (Stavins 2007). The effectiveness of such instruments often relies on multiple factors such as the feasibility of targets and an agency's credibility to enforce standards (Gerald and Lave 2005). The second one is a market approach that targets emissions through adding a price to the environmental externalities. This can be in the form of emission tax or a cap-and-trade system (Jaffe et al. 2005). In recent years, cap-and-trade systems have received growing support and are being strongly advocated as the better approach and the one more likely to be adopted in the United States (Stavins 2007). One key argument for this approach is that the costs of achieving emission reduction to those affected can be lower as the distribution of the reduction tends to gravitate toward the sources where emission is least costly to reduce, while giving firms incentives to reduce emissions (Stavins 2007). This type of market approach is also more flexible given that the firms have options to pay for the allowances if targeting toward emission reduction is too costly or difficult for the short term.

A similar role that can be played by government is to use information as a policy instrument for the development for sustainable consumption (Huq and Wheeler 1993; Robinson et al. 2009). Traditional production models dominate because externalities detrimental to social and environmental sustainability are largely unaccounted for by existing pricing mechanisms. Government policy in regulating prices, certification, or information can send correction signals to the market and play key roles in establishing a favorable condition for sustainable products (Sayogo et al. 2014).

Delivering on the many promises of government interventions grounded in or enabled by such policies hinge, to a great extent, on the quality of those policies. Such policy decisions related to investments in sustainable development are situated in complex environments and involve large numbers of heterogeneous stakeholders (Helbig et al. 2012b). Understanding enabling conditions and trade-offs between long-term benefits and short-term impacts, or between environmental sustainability and economic progress is challenging, in large part due to historical gaps between how and when information and information technology became a part of the policy informing, development, and evaluation process.

These gaps, are however, according to Dawes and Janssen (2013), closing. The availability of large quantities of data, growth in computing power, and advanced analysis and presentation tools are changing the relationship between information and information technology and the policy-making processes. This change is giving rise to the field of policy informatics, which involves groups of policy makers and other stakeholders in using models, data, and other technical tools to analyze problems and policy alternatives. Policy informatics is especially suitable to the domain of sustainability: understanding the interactions of job growth and investing in environmental sustainability under certain regulatory framework, projecting the effectiveness of sustainable agricultural regime, monitoring climate change, and understanding the impact of emerging technologies on capability to understand and pursue policy priorities, among other complex issues.

Concomitant with these new opportunities are new challenges, such as engaging stakeholders, interpretation of results, understanding the limitation of models and analytical tools (Dawes and Janssen 2013). The sections below outline some of the latest thinking on the building blocks, or pillars, of policy informatics and the chapters themselves provide the reader with new insights into their use. The book reflects on emerging trends, developments, and challenges of sustainability policies and information technology and puts forward new and valuable insights to both research and practice communities.

Policy Informatics

Applying mathematical models and empirical data to solve complex problems is not new. In fact, using quantitative models to support the public policy-making process promoted the development of the area of Policy Modeling in the 1970s (Ruiz Estrada and Yap 2013). This traditional view of policy modeling emphasizes understanding causes and effects of policy choices and has been dominated in the last 40 years by an economics orientation (Ruiz Estrada 2011). New approaches to policy

modeling, such as policy informatics, made possible through new and emerging technologies, and the concomitant innovations in data capture, management, and use have enabled a move from this traditional perspective into a broader understanding of causes and effects of policy problems using a broad range of modeling and analytical techniques (Puron-Cid et al. 2012, 2014). Further, advances in modeling and visualization techniques have made it possible to gain new insights into the importance of including groups of policy makers and other stakeholders in using models, data, and other technical tools to analyze problems and policy alternatives. Throughout the last decade, we have witnessed a renewed interest in policy modeling (or better, policy informatics) with a broader approach (Barrett et al. 2011; Johnston and Kim 2011; Sonntagbauer et al. 2014; Dawes et al. 2014). Further, beyond recognition of the importance of modeling and empirical data, contemporary policy informatics promotes stakeholder involvement as well as interdisciplinary approaches to policy analysis (Cockerill et al. 2009; Eden et al. 2009; Klievink and Janssen 2010; Ackermann et al. 2011).

This renewed interest in policy informatics has been promoted, at least partially, by two independent movements: open government and open data, and the development of technologies that enable the use of traditional, and the creation of novel, analytical techniques (Puron-Cid et al. 2012, 2014). New imperatives for more open governments, including increased transparency, accountability, and engagement, are driving investments in initiatives designed to make government data increasingly "open." To fully leverage these investments in open data, governments and other stakeholders are turning to policy informatics as the means to gain expected public value from the newly available data. In this sense, policy informatics relies on four main pillars: analytical methods, data, technology tools that facilitate the use of methods, and the engagement of stakeholders.

The increasing variety of modeling techniques, analytical tools, and data resources creates both new opportunity for those engaged or interested in policy informatics and new complexity. Designing a particular policy modeling and analysis effort requires a deep level of understanding of the policy question, the available data resources, and the tools and techniques available to both gain new insight and to ensure that new insight is consumable to stakeholders and policy makers as part of the policy-making process. The sections below and the chapters that follow are designed to reduce this complexity by helping to fill the gaps in what academics and practitioners know about policy informatics. The sections on analytical methods and techniques, data and open data, information technologies, and stakeholder involvement outline some of the latest thinking about the building blocks, or pillars, of policy informatics and the chapters themselves provide the reader with new insights into their use.

Analytical Methods and Techniques

A model, in general, is a conceptual representation of a problem, and it helps policy makers and other stakeholders structure the inquiry process (Bryson et al. 2004; Pidd 2010). In many cases, policy analysis requires the use of many different