Making real progress toward more sustainable societies using decision support models and tools: introduction to the special volume

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ABSTRACT

Academics, politicians, professionals and the general public are aware that without stewarding our planet's natural resources, man is on the pathway towards a global collapse. Over the next three decades mankind is expected to consume an estimated 140 billion tons of minerals, ores, fossil fuels and biomass per year — three times current consumption. Social welfare and human wellbeing are threatened with the scarcity of natural resources; consequently, nations and their societies are also at risk of collapse. The readers of this special volume will find a compilation of scholarly research papers with real-life applications that take the challenge of proposing decision-making models and tools to address sustainability challenges in integrative ways. The main focus of this special volume is integration of sustainability dimensions (economic, social, environmental, ethical and time) into decision-support models and to identify pathways to achieve more sustainable societies. The majority of the research in this special volume, 74 percent, focuses on environmental and economic dimensions. Only 26 percent integrated social dimensions with them. Methodologically, a range of mathematical models and tools are presented to support prescriptive decision-making, with some descriptive models integrated, to support decision-makers in solving practical problems across a variety of industries and scenarios. The breadth and complexity of issues facing organizations and society requires innovative applications of these methodologies. The concerns cover a spectrum ranging from energy to solid waste management. A multitude of levels from broad-based policy concerns to strategic inter-organizational sustainable supply chain management and significantly, shop floor operational issues are also covered. The variety of problems and solutions exemplifies the potential for modelling and operations research for addressing some of our world's most pressing concerns.

1. Introduction

Sustainability has been a concern of various actors for decades, with its most visible and early incarnation from the Brundtland Report (United Nations, 1987). Since then interest in the topic has seen exponential growth in scholarly research and publications (e.g. Wilkinson et al., 2001; Brandenburg et al., 2014; Carter and Rogers, 2008). The advent of utilizing decision-support and analytical tools has recently seen this growth, as evidenced papers published in the *Journal of Cleaner Production* during its 23-year publishing history.

Sustainability is not only good for the environment and society, but also for organizational economic health. Sustainable corporate practices can help organizations reduce risks, avoid or reduce waste generation, increase material and energy efficiency, and innovate by creating new and environmentally friendly products and services (Gunasekaran and Spalanzani, 2012). Sustainability has been defined in the triple-bottom-line context where organizations

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should integrate economic, social and environmental objectives into their business strategies and seek to optimize the balance amongst these three dimensions (Székely and Knirsch, 2005). Various actors, academics, politicians, professionals and the general public, have arrived at the realization that managing natural resources such as biodiversity, air, water, energy and other natural resources risk of social, economic, and human health collapse is inevitable.

By 2050 it is expected that mankind will probably consume three times its current annual consumption, or an estimated 140 billion tons of minerals, ores, fossil fuels and biomass per year (UNEP-IRP Report, 2011). To responsibly address this unsustainable consumption issue the economic growth rate needs decoupling from the rate of natural resource consumption. Not only are environmental concerns an issue, but social welfare and human well-being are also threatened from scarcity of natural resources. Nations and their societies are at risk of collapse due to these scarcities and inequities of access.

Given these realities, this special volume (SV) presents a compilation of high quality scholarly research papers. These papers and their research targeted practical applications using sustainable decision-making models and tools to aid in green growth, decoupling of economic growth and from environmental burdens, and other sustainability challenges. The main focus of this SV was to encourage researchers and practitioners integrate all sustainability dimensions (economic, social, environmental, ethical and temporal) into decision-support systems to identify, propose and test pathways for achieving more sustainable societal patterns.

2. Reasons for this special volume

Given the complex, social, political and economic interactions with natural systems, the need for tools to aid managers and decision-makers is urgent. Practical mathematical models coupled with technological and analytical solutions can be important tools for these real-world decision-makers. It is increasingly evident for many that it is essential to have the right models, tools and methodologies to support decision-making. Going beyond conceptual mathematics and analyses is needed to identify improvement in approaches for implementing real-world solutions.

In this broader social and academic context, the operations research/management science (OR/MS) research community is ready to lead in developing models to deal with various tangible and intangible measures, such as the "people" performance measure. This context increases the OR/MS research opportunity to make important and timely contributions to help organizations and managers achieve holistic, triple bottom line objectives (Tang and Zhou, 2012). In this SV OR/MS is viewed as a scientific approach to support decision-making in complex systems (Altay and Green, 2006).

Assessing and evaluating progress towards more sustainable, green growth societies, can be greatly supported through the proper environmental–economic–social monitoring and analytical support tools. These tools are necessary to guide key decision-makers to make the right actions and improvements towards sustainable societal lifestyles (Klemeš et al., 2012). In this context, mathematical models and solution methods were reviewed and used to provide quantifiable information for the decision-makers to provide them structured opportunities to evaluate, propose, test and implement actions that balance the complex economic–environmental–social interactions with a variety of man-made and natural systems.

Triple bottom line (TBL) impacts of managerial and policy decisions and practices can be effectively analysed and managed through appropriate use and development of quantitative formal modelling assessment methodologies to support decision-making. The need for suitable analytical, formal, and simulation models of sustainable business development decisions and making optimal decisions based upon full quantification of the short and long-term various costs and benefits of their actions has become increasingly evident. The relative scarcity of sustainable business development in this arena has been recognized (Gunasekaran and Spalanzani, 2012) and this SV helps to fill this gap in this research area.

To effectively envision, propose and implement solutions for making progress on forming more sustainable societies requires the capacity of increasingly complex mathematical models and decision-support systems. This theme is consistent with requirements identified by various researchers' articles in this SV. It is expected that increasingly complex mathematical tools need to be utilized to 'solve' sustainability challenges. Yet, the complexity should not undermine their usefulness and practical feasibility. From a practical viewpoint, the transition to using these concepts and tools by businesses, institutions and governments will be based on how user-friendly and effective decision-support models and tools can be integrated into their practice.

Another, implicit, reason for this SV was that much of this work establishes the foundation for future research. The complexity of the problems documented by the researchers in this SV requires that they address all sustainable issues in a comprehensive way. Yet, clearly there are limitations to all models that pursue such an ambitious goal. Each model has its limitations and these limitations identify further gaps in the research that need to be bridged. In addition, these works set the foundation for additional future research. This SV is a modest contribution to construct a fruitful bridge for knowledge exchanges between operations researchers, operations managers, decision analysts, and decision-makers. Alas, as a research community, we need to be able to stand on each other's shoulders to help us achieve the goal of a sustainable world. In terms of historical timelines, we are still very early in this process, especially when it comes to sustainable societal transformations.

3. Overview of the papers in this special volume

The 38 papers for this SV are summarized and evaluated using two major thematic areas: (1) sustainability approaches and (2) methods and tools for decision-support. The first categorization focuses on an overview of the articles and how they address sustainability dimensions. The second summation category focuses how the papers utilize analytical models and their contributions. Most of the papers have contributed to multiple aspects, as shown in Table 1. Each paper shown in Table 1 is also classified based on the general analytical approach used. The remainder of this section highlights how each article of the SV contributed to sustainability (in Section 3.1) and to new tools and methodologies (in Section 3.2).

3.1. Sustainability approach – dimensions

In this section papers that used sustainability perspectives were divided into two sub-categories: (1) those, which focused on all three dimensions of sustainability; and (2) those, which addressed various organizational, environmental dimensions including, energy, greenhouse gas emissions, solid waste management, and miscellaneous environmental topics.

As can be seen from the categorizations, social dimensions, as a general category, were the least explored and were also the least integrated into the impact analyses of firm's planning and performance. Recently, authors have argued for the importance embracing social issues has for firms' image and productivity (e.g.