

## Responsible consumption and production (RCP) in corporate decision-making models using soft computation

### Introduction

RCP is critical to a sustainable world. Human and environmental systems interact through the economic system in various ways that have caused many unsustainable issues to arise. Solving these problems is a non-trivial exercise and could be considered one of the world's "wicked" problems (Churchman, 1967). Wicked problems are complex, intractable, conflicting, and multidimensional problems many times with unforeseen and unintended consequences. It is within this context that the use of soft computation may be a valuable set of tools to handle wicked problems from an RCP perspective.

The United Nations' Sustainable Development Goals (SDGs) have been developed to set an agenda to transform nations, businesses, and society to become more sustainable by 2030 (Griggs *et al.*, 2013). In total, 17 goals were set in various social, economic, and environmental issues. SDG 12 titled, "Responsible consumption and production," has a long history in various international conferences and actions. RCP is meant to ensure sustainable consumption and production (SCP) patterns. This SDG sets the stage by stating that a strong national framework for Achieving Goal 12 requires a strong national framework for SCP be integrated into regulatory plans and policies, business practices and consumer behavior, together while adhering to international norms on hazardous chemicals and waste management (United Nations Development Programme (UNDP), 2016). Essentially, the goal here is focusing on various elements of the supply chain ranging from deep in the supply chain and extractive industries, to individual consumer needs. Green supply chains and green consumerism are evident in many of the considerations and research streams necessary to more fully understand how progress can be made on SDG 12.

RCP in business usually contains the qualitative and quantitative information as well as complex phenomena for decision-making processes (Roy and Singh, 2017). In this context, soft computing attempts to study, model, and analyze complex situations for which conventional methods, such as single criteria financial measures such as return on investment or payback, have not yielded complete solutions to these complex and strategic problems (Presley *et al.*, 2016). This special issue (SI) exploits SCP in corporate decision-making models' tolerance for imprecision, uncertainty, and partial truth to achieve tractability, robustness, and better rapport with reality. Applying soft computing can potentially eliminate noise to ensure SCP development. Soft computing can have a variety of definitions, but a common theme is to taking into consideration the human mind, imprecision, and differing behavioral issues that are not considered in "hard computing" optimization approaches (Zadeh, 1997; Magdalena, 2010). Hence, there is a need to further explore how soft computing is positioned, conceptualized, and applied in current RCP developments.

Viewpoints and tools from management science, operations research, economics, engineering, and other relevant domains are needed. These multiple disciplines exemplify the need for interdisciplinary and transdisciplinary research to investigate SCP topics (Schaltegger *et al.*, 2013). Transdisciplinary research goes beyond the traditional academic disciplines such as basic sciences as chemistry and social sciences as management science to incorporate policy makers, industrial practitioners, and even consumers (Sahamie *et al.*, 2013). This environment sets the stage for some aspects of soft computing that can integrate



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multiple disciplines, and even industry practitioners and other stakeholders, in both the modeling and application of soft computing models and frameworks (Reisch *et al.*, 2016).

This SI sought to encourage research that: broadens our understanding of RCP; addresses and tracks how research on sustainable resource and utilities management has evolved in light of accumulated knowledge or in response to specific critiques; and deepens theoretical and practical insights into how RCP or sustainable resource and utilities management are successfully addressed at corporate, industrial, and sectoral levels. The RCP strategies and tools in this SI cover industrial ecology, green supply chain management, and sustainable operations strategies geared toward SCP pattern; all of which rely on various transdisciplinary characteristics whether it is using inputs and data from multiple disciplines, or considering the needs and applications with multiple stakeholders.

Sharing some examples of the latest research and investigation is what this SI provides. With these purposes in mind, the SI includes several studies that draw on different theoretical streams and apply diverse empirical approaches. Interest in these studies have gained exponentially, showcasing substantial RCP themes identified in this SI as evidenced in various literature reviews (e.g. Roy and Singh, 2017; Brandenburg *et al.*, 2014).

### **Corporate decision-making models**

Although multiple levels of analysis can be utilized, commerce, industry and business operations, and strategies are critical to RCP success. RCP can lead to SCP practices in business by promoting resource and energy efficiency, sustainable infrastructure, and providing access to basic services and green and decent jobs. Furthermore, RCP helps achieve overall sustainable development plans, reduce future economic, environmental and social costs, and strengthen economic competitiveness (UNDP, 2016; Lin and Tseng, 2016; Tseng *et al.*, 2016).

The papers in this SI present multiple perspectives in the business field. For instance, product deletion is as critical as new product introduction to firms as seen from a unique sustainable production and consumption perspective. Bai, Shah, Zhu and Sarkis (2017) utilized soft computing to derive a ranking system that can assist in the product deletion decision making. This is the first time that rough set theory, fuzzy cluster means, and cumulative prospect theory have been integrate in the context of green product deletion in a supply chain. This hybrid multistage technique has the advantage of being able to incorporate many factors that have a variety of quantitative and qualitative characteristics. The contribution of such work is the introduction of green product deletion decisions in the supply chain management field. They do provide a rigorous set of tools that take advantage of multiple soft computing tools, but warn about the difficulties in extending this work to a practical setting due to some of the complexities of the techniques.

Wang (2017) apply the diffusion of innovation theory and customer perceived value to develop a theoretical model on closed-loop supply chains model, which was empirically tested using consumer data. In particular, the perceived value of remanufactured products is measured as a function of perceived benefits (environmental benefits; price advantage) and perceived sacrifices (perceived quality; perceived risk), all of which are shown to impact perceived value. Also, perceived risk is found to partially mediate the relationship between perceived quality and perceived value. This multidimensional aspect is central to many soft computing methodologies. As evidenced by the “perception” consideration of decision makers, it addresses some of the uncertainty concerns that soft computing is able to integrate into the decision-making process. A concern with soft computing models and papers in this complex environment, not just this paper, is at what point do you bound the number of factors and dimensions to consider in a decision. Theoretically, authors and researchers can argue for certain dimensions, as do these authors, but whether management accepts these dimensions is a realistic behavioral concern.

Using a more formal analytical model, Shukla (2017) demonstrate the use of strategic planning scenario-based analysis. In understanding the sustainability perspectives of e-commerce channels, the authors used value focused thinking to identify related fundamental objectives, assisting in the creation of dynamic scenarios based on fuzzy cognitive maps of the different e-commerce channels for additive manufacturing. In this case, two emergent technologies add complexity to the decision process; electronic commerce as part of the “Internet of Things” and additive manufacturing. The technological focus of these applications is on critical ecological modernization initiatives that some companies and policy makers seek to achieve in RCP concerns (Sarkis and Zhu, 2017).

Alternatively, instead of a more formal soft computing prescriptive model, Sagnak (2017) illustrate the use of causal relationships and criteria prioritization in performance assessment of cement industry operations coupled with fuzzy decision-making trial and evaluation laboratory (DEMATEL) technique. Their analysis of performance in green supply chains took an approach that combines environmental, economics, logistics, operational, and organizational and marketing aspects in the framework with cause-effect relationships. DEMATEL, with its fuzziness characteristics, does not necessarily lead to decision making, but is critical in helping to make sense of relationships amongst a variety of factors and dimensions. This work builds on DEMATEL applications that have been utilized in RCP topics as a standalone tool with methodological advances (e.g. Tseng *et al.*, 2017), or as a supplemental soft computing tool integrated with other behavioral and analytical tools (e.g. Bai, Sarkis and Dou, 2017).

There is still a need to ensure the proper development of RCP in the business field. In the Chinese construction industry, Wu *et al.* (2017) adopted a fuzzy interpretive structural modeling approach to understand RCP in the second paper on the built environment industry (the other paper focused on cement), and allow the consideration of multi-hierarchical structures for its implementation. In the process, authors were able to develop a precise evaluation of social economy and triple bottom line framework. Interpretive structural modeling is another soft computing tool that focuses on evaluating relationships amongst a series of factors, developing a mapping of the relationships of factors. This tool is applied more as a descriptive tool of the relationships amongst factors, again using perceptual information and human decision makers. This paper advances application of the tool implementation that has seen application in other RCP environments (Cui and Cui, 2017).

In many studies on RCP, China as a nation takes center stage in many studies (see Bai *et al.*, 2015, for research related to corporate sustainability in China, for example). This focus should not be surprising given China’s production, supply chain, and consumption networks are the largest in the world. Expanding the focus of China’s situation to go beyond the corporate boundaries and evaluating the performance of the Chinese Government regulations on recycling, and the construction of a resource-saving and environmentally friendly society, is what Song (2017) try to achieve. They used L-R fuzzy numbers to transform the evaluation decision perception into triangular fuzzy numbers, which improves the practical performance of trapezoidal fuzzy data envelopment analysis. An  $\alpha$ -slack-based measurement model is used to evaluate environmental efficiency, and it is confirmed in the study to be stable and sustainable evaluation method for environmental regulation. This SI publication fits within the growing and broader regulatory-exchange theoretic perspectives that consider the relationships between governmental regulations and their exchanges with corporations (Zhu *et al.*, 2017). This study is unique by further developing and applying soft computing techniques to understand this relationship, once again providing evidence of the flexibility of soft computing methods for evaluation purposes.

As we have seen in some of the previous papers in this SI, technologies, core to ecological modernization theory, are major enablers to RCP in business. Within this context, Lin *et al.* (2017), the final paper in this SI, evaluated an efficient Organic Rankine Cycle system from both sustainable energy reservation and cost effectiveness approaches using particle swarm optimization algorithm. In their evaluation, they sought to determine proper installation locations and feasible generator sets for this technology. The proposed system is constructed to facilitate converting the low- and medium-grade waste heat in factories into electricity, and yields optimal profit. The application of this technology within an RCP framework fits in utilizing wastes of a process as byproduct inputs for another set of industrial activities. This RCP idea is at the core of industrial symbiosis and industrial ecology principles (Klassen and McLaughlin, 1993). Expanding the decision environment to incorporate location decisions with the technology adds complexity to the situation.

### Learning points on RCP

Collective studies on the integration of soft computing tools within RCP topic are limited. Hence, this SI has purposefully collected quality solutions and models to effectively explore complex situations from multiple levels and to approach the corporate decision-making models from multiple perspectives. As a result, this SI provides various insights into contemporary studies in the field. A central finding indicates that corporate decision-making models are needed to support the RCP business practices within organizations, across industry sectors, and across various organizational boundaries. Soft computing methods proposed in this SI can be helpful to provide feasible managerial and technological solutions, while the identified attributes could provide valuable policy insights to decision makers, who should then be more confident in making appropriate policies to promote and implement RCP.

The research presented in this paper is exemplary, we have only scratched the surface of soft computing tools development and application for RCP study. Apart from the major useful findings presented here, this SI provides possibilities for future enhancements in the field of RCP to encourage more in-depth studies. That is, not all topics in this very broad and complex field could be studied in one SI. In addition to future research identified in each of the SI publications, there are a number of additional and extensible RCP topics and soft computing developments that could be pursued by researchers. We provide a few more examples now of what soft computing can do and what needs to be researched in the RCP environment:

- Investigating further how multi-hybrid soft computing techniques can form better decision-making models for corporate decision making on RCP. In decision-making models, fuzzy set theory is able to aptly interpret the decision maker perceptions. The types of fuzzifications and appropriateness need to be carefully evaluated. We acknowledge that the integration of hybrid techniques adds additional complexity to the modeling effort, which might take additional time in the computing process. So, whether transactional decisions or organizational strategic decisions are to be made may mediate the decision on which model to choose. There is also often a tradeoff between complexity in practical application and effectiveness of the model. RCP-based-organizationally strategic decisions usually involve significant investments, reputation, and time resources. Some of these decisions may take weeks or months to make in response to strategically important dimensions. Thus, computational efficiencies might not be as large a concern since relatively rapid findings can be found, given the length of time and investments of the actual decision. In these environments, solving the computational problem is not necessarily a real time performance concern. Yet, this issue may not be appropriate for decisions that require short-term operational activities.

- Integration and utilization of ecological-based optimization approaches, such as particle swarm optimization analysis, can effectively integrate various ecological performance characteristics. The broader capabilities and efficiencies of these models in increasingly complex decision environments and Big Data need further evaluation. The heuristic characteristics of these soft computing tools may be especially suitable for Big Data environments related to broad social issues across RCP corporate activities. Further investigation of not only solutions (e.g. are manager's happy with the solution?) but also efficiency of solution methodologies (time to arrive at solutions and ease of sensitivity and scenario analyses) require exploration.
- Validation and identification of the performance for multidimensional, human decision supported soft computing is still relatively immature (Wu and Tiao, 2017). Sometimes it is difficult to objectively determine the quality of solutions from soft computing methodologies. For example, the quality and effectiveness of multiple criteria decision-making tools is relatively difficult to determine in a simulation setting since there are many subjective dimensions associated with their evaluation. For example, are manager's happy with decision outcomes, how well is integration of factors considered, the accuracy of solutions, are subjective questions that may determine how well these tools perform.
- Consumption modeling of products that support RCP is needed. Further theoretical understanding can provide management of consumers' role in a closed-loop supply chains. Part of this understanding is consumer willingness to pay and their acceptance of remanufactured products. Consumer modeling using soft computing methodologies is needed for RCP and this is one example. Whether it is barriers analysis, tools supporting marketing strategy, or optimization of decisions to help organizations address these markets are all areas for further investigation (e.g. Wu *et al.*, 2017).
- Uncertainties in RCP, especially within the supply chain all need further examination. These uncertainties can cause supply chain demand risk. Building resiliency in RCP supply chains is necessary for their more complete adoption. Modeling this risk and supporting decision making in this risky environment is especially pertinent for soft computing methodology (Esmailikia *et al.*, 2016).
- There are multiple levels of analysis for RCP (e.g. see Sarkis, 2012 on levels of analysis for sustainable supply chain management). These multi-level characteristics may also relate to each other, and can be properly considered using soft computing methods. As an example, there are issues related to supply chain levels of decision making (regional governmental policy, multiple organizations in a supply chain, an individual organization, and organizational functions) may be integrated in their decision situation. Incorporating, aggregating, and disaggregating levels of decision environments and results. Soft computing tools can be utilized at these multiple levels; requirements, similarities, and differences at these levels of analysis need further research.
- Regulatory and governmental decision-making models can also be utilized to evaluate qualitative data on environmental regulations, integrate practical scenarios, and incorporate suggestions for the improvement of the creditability of soft computing results. Although some of this was modeled in one of the papers in this SI, extensively more research on this topic is needed. Institutional theory, regulatory-exchange theory, and various macro-economic theories can be used to support the modeling of soft computing methodologies and further understanding of RCP at this broader level and integration with corporate-level decision making.

## Conclusion

The publication of this SI is sorely needed in the broader RCP community. We believe that the high-quality contributions published in this SI can provide greater understanding of RCP in corporate decision making. We encourage researchers to build on the ideas and models presented in this SI. We encourage practitioners to carefully consider the various concerns and implement tools that can help them improve their RCP activities.

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**Further reading**

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