



A supply chain sustainability innovation framework and evaluation methodology

Simonov Kusi-Sarpong, Himanshu Gupta & Joseph Sarkis

To cite this article: Simonov Kusi-Sarpong, Himanshu Gupta & Joseph Sarkis (2018): A supply chain sustainability innovation framework and evaluation methodology, International Journal of Production Research, DOI: [10.1080/00207543.2018.1518607](https://doi.org/10.1080/00207543.2018.1518607)

To link to this article: <https://doi.org/10.1080/00207543.2018.1518607>



Published online: 08 Sep 2018.



Submit your article to this journal [↗](#)



View Crossmark data [↗](#)

A supply chain sustainability innovation framework and evaluation methodology

Simonov Kusi-Sarpong^{a,b*}, Himanshu Gupta^c and Joseph Sarkis^d

^aEco-Engineering and Management Consult Limited, Accra, Ghana; ^bPortsmouth Business School, University of Portsmouth, Portsmouth, UK; ^cDepartment of Management Studies, Indian Institute of Technology Roorkee, Roorkee, India; ^dFoisie School of Business, Worcester Polytechnic Institute, Worcester, MA, USA

(Received 25 April 2018; accepted 23 August 2018)

Sustainability is hinged on innovation. The importance of sustainable innovation management in sustainable supply chain management (SSCM) cannot be underestimated. Studies on SSCM have emphasised the need for sustainable innovation in achieving sustainability but none provide deep insights into sustainable innovation management in SSCM implementation. This lack of research depth stimulates this study to identify and investigate criteria for sustainable supply chain management innovation advancement. This paper proposes a sustainable innovation criteria framework for investigating sustainable supply chains in manufacturing companies. To exemplify the applicability and efficiency of the proposed framework, a sample of five Indian manufacturing companies are used to evaluate and prioritise the sustainable innovation management criteria, using the 'best-worst' multi-criteria decision-making (BW-MCDM) model. The criteria weights for all companies from BWM are aggregated, averaged and used for ranking. The respondent managers viewed 'financial availability for innovation' as the most important sustainable innovation sub-criteria. The results of the study will inform industrial managers, practitioners and decision-makers on which criteria to focus on during the implementation stage, to increase sustainability in manufacturing supply chains, and further advance corporate and supply chain sustainable development. The framework may also serve as a theoretical construct for a future empirical study on sustainable supply chain innovation in the manufacturing sector. This paper sets the stage for further research in sustainable innovation practices in the manufacturing sector and its supply chains.

Keywords: supply chain management; sustainability; innovation management; manufacturing; best-worst method; environment

1. Introduction

Environmental and human system damage, the consequences of industrial activities since the industrial revolution, is a rising global concern (Chen, 2008; Kusi-Sarpong et al. 2015). The debate on sustainable development has grown exponentially and received increasing attention in the sustainability and supply chain management arena (Seuring and Müller 2008; Fahimnia, Sarkis, and Davarzani 2015). Increasing public awareness, stricter government regulatory requirements, and market pressure have forced many firms to integrate sustainability into their supply chains (Kusi-Sarpong, Sarkis, and Wang 2016a, 2016b; Bai, Kusi-Sarpong, and Sarkis 2017). Several policy interventions have been implemented to remedy such damage, but these initiatives are unfortunately mostly internally focused; limiting the scope of addressing comprehensive industrial sustainable management concerns (Chen, 2008). Managing these sustainability issues effectively requires an extended perspective beyond a focal firm to include supply chain partners (Isaksson, Johansson, and Fischer 2010; Kusi-Sarpong et al. 2015). Sustainable supply chain management (SSCM) can be described as managing organisational supply chains to maximise *profitability*, improve the *social* well-being of its stakeholders and reducing negative *environmental* impacts (Hassini, Surti, and Searcy 2012).

For example, the manufacturing sector as a product system relates directly and indirectly to economic wealth creation, impact on the natural environment and social systems along the product's life cycle (Warren, Rhodes, and Carter 2001; Kusi-Sarpong et al. 2015). Responding to these multi-stakeholder pressures and concerns (Badri Ahmadi, Petrucci, and Wang 2017) is important for sustainable development progress.

Achieving sustainable development will require the implementation of sustainable innovations (Horbach 2005; Boons et al. 2013). Sustainable innovation can be defined as introducing novel, or modifications in, production processes, techniques, systems, organisations and products to lessen environmental damage. These innovations should also provide similar or greater value with improved economic, social and organisational performance (Hafkesbrink and Halstrick-Schwenk 2005;

*Corresponding author. Email: simonov2002@yahoo.com

Horbach 2005). Firms can develop innovative strategies for addressing and improving sustainability within their manufacturing processes and supply chains (Seuring and Müller 2008; Isaksson, Johansson, and Fischer 2010; Cai and Zhou 2014). Sustainable Supply Chains are also associated with certain risks, which need to be addressed through risk mitigation strategies or through sustainable innovations (Gouda and Saranga 2018).

Several studies have proposed sustainable supply chain management frameworks (see Chardine-Baumann and Botta-Genoulaz 2014; Fabbe-Costes et al. 2014; Esfahbodi, Zhang, and Watson 2016; Gopal and Thakkar 2016; Ansari and Kant 2017; Dubey et al. 2017; Genovese et al. 2017; Paulraj, Chen, and Blome 2017; Sauer and Seuring 2017; Li and Mathiyazhagan 2018; Mathivathanan, Kannan, and Haq 2018) and have emphasised the importance of sustainable innovation in SSCM (Hall 2001; Vergheese and Lewis 2007; Isaksson, Johansson, and Fischer 2010; Boons et al. 2013; Zailani et al. 2015; Costantini et al. 2017; Gao et al. 2017; Gupta and Barua 2017; de Vargas Mores et al. 2018). No studies have specifically attempted to develop sustainable innovation implementation criteria for sustainable supply chains nor have investigated these criteria within an industrial setting. To advance theoretical and practical understanding and address the gap in the literature, this paper proposes a comprehensive sustainable innovation criteria framework for sustainable supply chains. This study further investigates this framework within the Indian manufacturing context providing practical insights and guidelines for implementation. A novel multi-criteria decision-making (MCDM) model called the 'best-worst method' (BWM) (Rezaei 2015, 2016) is utilised to aid in this investigation.

This study targets the Indian manufacturing sector and their supply chains due to their recent and future growth potential (Mehta and Rajan 2017). The manufacturing sector is one of the fastest growing in India with revenue potential reaching US\$ 1 trillion by 2025. Yet, technological improvement and organisational practices in manufacturing processes and methods have not matched this industry's increasing growth; hence, few investments have been made. There is also a need for enhancing sustainable performance in Indian manufacturing supply chains. An important step to achieve this goal is by introducing sustainable innovations and practices into their supply chains. This study aims to aid in this effort.

The objectives of this study are as follows:

- (1) To identify sustainable innovation criteria to propose a sustainable innovation decision framework for sustainable supply chains in the context of manufacturing sectors;
- (2) To determine the relative importance (weights) of the supply chain sustainability innovation criteria, and;
- (3) To further theoretical; managerial/practical and country understanding of sustainability innovation especially within the supply chain context.

To achieve these objectives, this paper initially reviews the sustainable supply chain management and green/sustainable innovation management literature. This initial review identifies sustainable innovation criteria that will initially populate the sustainable supply chain innovation criteria framework; which is then further refined using practitioner and expert opinion. The BWM tool is developed and applied in evaluating the proposed framework within five selected Indian manufacturing companies. Within this evaluation, the paper determines the relative importance weights of the criteria and prioritises them to provide an implementation path according to their levels of impact on overall organisational sustainability.

The contributions of the paper are multifold and include: (1) identifying and developing a multi-level innovation criteria framework of sustainable supply chains in the manufacturing sector; (2) proposing a novel MCDM method for investigating sustainable supply chain innovation criteria and; (3) applying this methodology using empirical data in the context of the Indian manufacturing sector.

The remainder of this paper is organised as follows. Theoretical background of sustainable supply chain management and sustainable innovation management criteria are presented; with research gaps and highlights given in Section 2. In Section 3, the proposed research methodology is presented, and a practical application and evaluation of the framework is provided in Section 4. In Section 5, the results analysis and discussion are presented and academic/theoretical, managerial/practical and country implications given in Section 6. Finally, the conclusion, limitations and future research directions are elaborated in Section 7.

2. Theoretical background

2.1. Sustainable supply chain management

Sustainable supply chain management is supply chain planning and decision-making that incorporates economic, social, and environmental sustainability dimensions (Ahi and Searcy 2013). The integration of sustainability initiatives into organisational supply chain operations derives from social pressures, stricter government policy, corporate image, growing public awareness and market pressures (Tseng, Lim, and Wong 2015; Esfahbodi, Zhang, and Watson 2016).

Sustainable supply chain initiatives support manufacturing companies and industries in their sustainable development. A growing body of literature has investigated sustainable supply chain management from different perspectives (see Fahimnia,

Sarkis, and Davarzani 2015). Sustainability has been defined into three broad categories, environmental, economic, and social dimensions (Carter and Rogers 2008). Organisations can achieve sustainability by integrating these three dimensions and need to go beyond organisational boundaries, including strategising supplier operations transparency, risk management, and improve stakeholder engagement (Carter and Rogers 2008). Recycle, reuse, and reduce for material saving are also important practice criteria for SSCM in manufacturing organisations (Su et al. 2016).

Social sustainability of supply chains has also been gaining traction. Eight refined social criteria, aided by the best–worst method, were investigated in an Iranian manufacturing context. Results indicated that ‘contractual stakeholders influence’ was the most important criteria for social sustainability implementation followed by ‘work safety and labour health’ and ‘Training education and community influence’ in that order (Badri Ahmadi, Kusi-Sarpong, and Rezaei 2017). Transparency in work, social responsibility towards society, and better working conditions have also been established as important factors for SSCM support (Lim et al. 2017).

2.2. Sustainable innovation criteria of manufacturing supply chains

Innovation is essential for corporate and supply chain sustainability development and implementation (Schaltegger and Wagner 2011; Klewicz and Hansen 2014). Sustainable innovation can be defined as new or modified processes, techniques, practices, systems and products to reduce social and environmental harm (Kemp, Arundel, and Smith 2001; Beise and Rennings 2005). This definition takes into account product and production process changes (De Marchi 2012). Recycling, waste management, green efficiency, green design and concerns essential to reduce the environmental and social impact of organisational products should also be considered in organisational sustainability innovations. The term green and sustainable innovation has been used interchangeably in the literature, with similar theoretical underpinnings (Hall 2002; Wagner 2008; Klewicz and Hansen 2014; Gupta and Barua 2017). Deeper insight is therefore required for better understanding of these concepts.

Sustainable and green innovation antecedents and characteristics have been studied over the years with a number of findings. Stakeholder engagement, internal and external stakeholders, are important for promoting sustainable innovation in organisations (Ayuso et al. 2011). Drivers for sustainable innovation include strong business networks, seeking to build competitive advantage, R&D organisational support, cost savings, subsidies and tax cuts, compliance with regulations and customer demand (Vasilenko and Arbačiauskas 2012). Applying sustainable innovations can also benefit organisations a number of ways (outcomes) that make the business case including reducing costs, improving profits and social image of the organisation (Aguado, Alvarez, and Domingo 2013). Sustainable innovations can also be industry specific. For example, in the chemical industry, cost reduction, improved feedstock, improved yields and broadly increasing market share occurred from building sustainability into innovations. Risk management, such as in the chemical industry, is also an important aspect for sustainability innovations. Organisations that do not include social factors into their process innovations are at more risk than others (Iles and Martin 2013).

Broadly, knowledge management and learning have also played important roles in sustainability innovation. Systematic reviews of literature and qualitative studies (de Medeiros, Ribeiro, and Cortimiglia 2014, 2016) recently showed that knowledge on government regulations, inter-organisational collaboration, fulfilling customer needs, innovation learning, technology and R&D investments are essential for green innovations. Content analysis reviewing literature from 1991 to 2016 (Tariq et al. 2017) revealed various attributes of sustainable innovation including market factors, stakeholders’ pressure, technological factors, collaborations and networking factors, organisational factors and social, cultural and ethical factors. All these dimensions, as in much literature, for green innovation, result in economic and financial, market and environmental performance outcomes.

Building dynamic capabilities and the resource-based perspective can help explain various drivers and factors in sustainable innovation (Mousavi and Bossink 2017). Entrepreneurial capabilities to gather knowledge related to environmental policies and technologies; transforming opportunities into meaningful innovative processes and products; and reconfiguration to achieve strategic fit through realignment of resources according to requirements, have all been identified as ways for building and adjusting sustainability capabilities.

Based on a review of the literature, some introduced in this section, and several rounds of discussion with industrial managers, sustainable innovation of manufacturing supply chains are categorised into three broad dimensions including economic, environmental and social and are further classified into 20 sub-criteria as summarised in Table 1.

2.3. Research gaps and highlights

Most studies regarding sustainability have focused on sustainable supply chain management (Bai and Sarkis 2010; Amindoust et al. 2012; Govindan, Khodaverdi, and Jafarian 2013; Azadi et al. 2015; Sarkis and Dhavale 2015;

Table 1. Main criteria and sub-criteria for sustainable innovation.

Main criteria	Sub-criteria	Short descriptions	Supporting literature
Economic (EC)	Sustainable product cost reduction (EC1)	Organisations ability to reduce product cost through sustainable innovation practices and to provide products at lower costs.	Van Berkel (2007); Lee (2008); Bai and Sarkis (2010); Chiou et al. (2011); Mathiyazhagan and Haq (2013); Sarkis and Dhavale (2015); Govindan et al. (2016); Luthra et al. (2017); Jia et al. (2018); Zhu et al. (2018)
	Financial availability for innovation (EC2)	Innovative approaches for securing funding from various financial institutions to carry out sustainable innovation practices.	Jenkins and Yakovleva (2006); Mathiyazhagan and Haq (2013); Govindan et al. (2016)
	Return on investment and investment recovery of products (EC3)	Recovery of resources (financial) invested in sustainable practices through various activities such as reuse, recycling, selling of scrap and waste material.	Zhu and Sarkis (2004); Franke et al. (2006); Zhu, Sarkis, and Lai (2008); Wooi and Zailani (2010); Kapetanopoulou and Tagaras (2011); Lee et al. (2014); Li and Mathiyazhagan (2018); Mathivathanan, Kannan, and Haq (2018)
	Enhanced sustainability value to customers (EC4)	Provision of greater value to customers either by reducing price or enhancing functions of products.	Gupta and Barua (2017)
	Investment in R&D for sustainable products (EC5)	Amount of financial resources invested as a proportion of total budget to complete research to support sustainable products production.	Horbach (2008); Halila and Rundquist (2011); Testa, Iraldo, and Frey (2011); Horbach, Rammer, and Rennings (2012); Zailani et al. (2012); Calik and Bardudeen (2016); Ansari and Kant (2017)
	Designing sustainable products to reduce material consumption and cost (EC6)	Organisational effort to design products to reduce material consumption and hence product cost in a sustainable production manner.	Moffat and Auer (2006); Gonzalez, Sarkis, and Adenso-Diaz (2008); Tseng and Chiu (2012); Calik and Bardudeen (2016); Govindan et al. (2016); Zhu et al. (2018)
Environmental (EN)	Inter- and Intra- organisation collaboration (EN1)	Collaboration between different organisational functions and amongst organisations to share resources and technologies to produce green and sustainable products.	Messeni Petruzzelli et al. (2011); Quist and Tukker (2013); Bocken et al. (2014); Cai and Zhou (2014); Tariq et al. (2017); Taylor and Vachon (2018); Mathivathanan, Kannan, and Haq (2018)
	Technical expertise availability and investment in R&D for green practices (EN2)	Availability of technical expertise and research facilities to manage and complete green and sustainable practices in organisations.	Kammerer (2009); Rennings and Rammer (2009); Lin and Ho (2011); Horbach, Rammer, and Rennings (2012); Shen et al. (2013); Triguero, Moreno-Mondéjar, and Davia (2013); Kannan, de Sousa Jabbour, and Jabbour (2014); Dangelico (2016); Tariq et al. (2017); Das (2018); Li and Mathiyazhagan (2018)
	Green logistics capabilities development (EN3)	Organisations capabilities to package, label and transport products in an environmentally friendly manner.	Rao and Holt (2005); Zhu, Sarkis, and Lai (2008); Liu, Dai, and Cheng (2011); Wang et al. (2012); Kannan, de Sousa Jabbour, and Jabbour (2014); Hashemi, Karimi, and Tavarna (2015); Jabbour et al. (2015); Luthra et al. (2017); Golini et al. (2017); Mathivathanan, Kannan, and Haq (2018)

(Continued)

Table 1. Continued.

Main criteria	Sub-criteria	Short descriptions	Supporting literature
	Green manufacturing and operational capabilities development (EN4)	Adoption of innovative manufacturing practices to minimise energy consumption and waste in production.	Zhu, Sarkis, and Lai (2008); Nelson and Winter (2009); Tsai et al. (2012); Triguero, Moreno-Mondéjar, and Davia (2013); Maruthi and Rashmi (2015); Somsuk and Laosirihongthong (2017); Ansari and Kant (2017)
	Environment management commitment and initiatives (EN5)	Implementation and adoption of various environmental policies and standards in organisations.	Zhu and Sarkis (2006); Simpson, Power, and Samson (2007); Lin and Juang (2008); Wagner (2008); Tsai et al. (2012); Inoue, Arimura, and Nakano (2013); Shen et al. (2013); Lee et al. (2014); Hashemi, Karimi, and Tavana (2015); Somsuk and Laosirihongthong (2017); Tariq et al. (2017); Das (2018)
	Designing products to reduce their impact on environment (EN6)	Organisation product design to reduce environmental impact including using environmental friendly materials for products for easier disposal at end of life.	Moffat and Auer (2006); Wagner (2008); Tseng (2011); Tseng and Chiu (2012); Govindan, Khodaverdi, and Jafarian (2013); Bai and Sarkis (2014); Kannan, de Sousa Jabbour, and Jabbour (2014); Hashemi, Karimi, and Tavana (2015); Ansari and Kant (2017)
	Conducting regular environmental audits (EN7)	Repeated auditing in organisations to ensure compliance with environmental standards.	Mahmood et al. (2013); Kannan, de Sousa Jabbour, and Jabbour (2014); Hassan et al. (2016); Somsuk and Laosirihongthong (2017); Mathivathanan, Kannan, and Haq (2018)
Social (SC)	Implementation of socio-eco policies in organisations for sustainability (SC1)	Implementation and enforcement of socio-environmental standards and policies by organisations.	Pickman (1998); Horbach (2008); Demirel and Kesidou (2011); Horbach, Rammer, and Rennings (2012); Yabar, Uwasu, and Hara (2013); Govindan et al. (2016); Tariq et al. (2017)
	Quick response to high customers and market demand for sustainable products (SC2)	Organisational responsiveness to customers and market demand and, awareness regarding benefits of using environmentally friendly and green products.	Kammerer (2009); Zhou, Brown, and Dev (2009); Artiach et al. (2010); Horbach, Rammer, and Rennings (2012); Chiou et al. (2011); Zhu, Sarkis, and Lai (2012); Mondéjar-Jiménez et al. (2015); Golini et al. (2017); Tariq et al. (2017)
	Enhancing social image of the organisation (SC3)	Efforts companies put in place for enhancing their image in the market by producing environmentally friendly products.	Noci and Verganti (1999); Rennings (2000); Kammerer (2009); De Marchi (2012); Tariq et al. (2017); Zhu et al. (2018)
	Responding to stakeholders pressure for green and sustainable products (SC4)	Response to pressure created from various stakeholders such as customers, employees, shareholders, suppliers and competitors to produce green and sustainable products.	Horbach (2008); Demirel and Kesidou (2011); Berrone et al. (2013); Yabar, Uwasu, and Hara (2013); Amore and Bennesen 2016; Doran and Ryan (2016); Tariq et al. (2017)
	Corporate social responsibility initiatives (SC5)	Organisational developments and implementation of general ethical policies towards social and green initiatives.	Wagner (2010); Chang (2011); Tariq et al. (2017); Ansari and Kant (2017)

(Continued)

Table 1. Continued.

Main criteria	Sub-criteria	Short descriptions	Supporting literature
	Cultural, social values and norms (SC6)	Values and beliefs of organisations or individuals, where the benefit of society is considered important over individual interest.	Rothenberg and Zyglidopoulos (2007); Montalvo (2008); Chiarvesio, Marchi, and Maria (2015); Huang and Li (2015); Jia et al. (2018)
	Occupational health, safety and rights of the employees (SC7)	Refers to health, safety and rights of the employees and organisations efforts to improve these conditions in a sustainable manner.	Bai and Sarkis (2010); Ageron, Gunasekaran, and Spalanzani (2012); Wang et al. (2012); Sarkis and Dhavale (2015); Calik and Bardudeen (2016); Badri Ahmadi, Petrudi, and Wang (2017); Luthra et al. (2017); Golini et al. (2017); Das (2018); Jia et al. (2018); Mathivathanan, Kannan, and Haq (2018); Zhu et al. (2018)

Trapp and Sarkis 2016; Badri Ahmadi, Kusi-Sarpong, and Rezaei 2017; Luthra et al. 2017; Golini et al. 2017; Das 2018; Taylor and Vachon 2018). There is limited focus on sustainable innovation (Hellström 2007; Ayuso et al. 2011; Ozaki 2011; Watson and Sauter 2011; Vasilenko and Arbačiauskas 2012; Iles and Martin 2013; Calik and Bardudeen 2016; Mousavi and Bossink 2017; Tariq et al. 2017).

These limited sustainable innovation studies either present sustainable innovation systematic literature reviews or conceptual frameworks. Only one study was identified that empirically develop scales to measure supply chain sustainable innovation (Calik and Bardudeen 2016). There is a lack of robust empirical studies on sustainable supply chain innovation criteria, especially in manufacturing settings. Studies related to prioritising these criteria for guiding general implementation, especially from emerging economy nations, is non-existent.

This study explores and evaluates a comprehensive and unified criteria framework for manufacturing supply chain sustainable innovation by prioritising criteria using the best–worst method in the Indian manufacturing organisation context.

2.4. Finalisation of the evaluation criteria

The literature review is initially conducted to identify and select potential criteria. Past green and sustainable innovation studies are reviewed with twenty-five criteria identified.

These criteria were then tabulated and put forward to the five industry managers for elimination consideration based on a simple ‘Yes’ (acceptance) and ‘No’ (rejection); or for the addition of missing criteria. Researchers agreed on a minimum of four ‘Yeses’ received by a criterion as an affirmative vote to maintain a criterion. No further additions were made. After the evaluation analysis, twenty criteria received four or more ‘Yes’ votes reaffirming their importance to be part of the sustainable innovation criteria framework. The managers were further requested to categorise these criteria under the economic, environmental and social based criteria. After three rounds of group/panel reviews and discussions (deliberations) with one of the researchers and all five industrial managers with the aid of previous criteria categorisations information, sub-criteria categorisation consensus was constructed with the final listing and categories summarised in Table 1.

3. Research methodology

The multiple case study research approach is applied in this study to gain insight into the subject matter. Many studies (e.g. Seuring 2008; Lee 2009) utilise case study research to investigate diverse subjects and uses bounded contextually rich data to investigate a specific phenomenon (Barratt, Choi, and Li 2011).

Manufacturing supply chain sustainable innovation is a multi-criteria concept. Evaluating this multiple criteria framework within a multiple case study situation can benefit through MCDM application as a methodological tool. The ‘best–worst’ method (BWM) (Rezaei 2015) is used in this case. This intuitive, yet robust, MCDM approach for evaluating various criteria provides some advantages to this subject area; where it has not been applied to this specific situation. The required information for BWM and the BWM method are overviewed initially.

3.1. The best–worst method

MCDM techniques are utilised for complex problems; problems typically with trade-offs. Decision-makers in these environments may face selection of the ‘best’ alternative from among many alternatives. Many MCDM techniques exist. MCDM

approaches have been especially prevalent for addressing complete sustainable supply chain management and sustainable supplier selection problems (e.g. see Brandenburg et al. (2014) and Govindan et al. (2015) for broad reviews). Fuzzy DEA (Azadi et al. 2015); grey system and rough sets (Bai and Sarkis 2010); AHP and IGRA (Badri Ahmadi, Petrudi, and Wang, 2017); AHP (Cucchiella et al. 2017) are some recent efforts of utilising MCDM techniques for sustainable supply chain evaluation.

These models tend to lack consistency among alternatives (Rezaei 2015). BWM overcomes these problems. BWM has some advantages including requiring fewer decision maker inputs for obtaining overall weights and rankings of the variables; and the aforementioned consistency. AHP, one of the most popular approaches for MCDM, was compared to BWM and Rezaei (2015) found BWM's results were more consistent when compared to AHP. BWM requires significantly smaller datasets and expert inputs since comparisons are completed between best alternative/criterion and given alternatives/criteria; along with comparisons between given alternatives/criteria and worst alternative/criterion. BWM saves expert time and eases for calculations enabling consistent results. This MCDM technique, like any other, has some limitations. It depends solely on the judgment of experts selected for the study; this reliance on a group of experts and may result in some bias. To overcome this limitation, we have tried to involve experts from different industries and different backgrounds. Another limitation is the number of experts used. There are still different opinions about the number of experts that are sufficient for MCDM analysis. However, there are many authors that have used 5 or fewer experts for MCDM including Kannan, Pokharel, and Kumar (2009), Dou, Zhu, and Sarkis (2014), Govindan, Diabat, and Shankar (2015); Gupta and Barua 2016, 2017, 2018a; Shaw et al. (2012), and Wu et al. (2012). Most recently, Rezaei et al. (2018) in their paper on evaluating the quality of baggage handling at airports, made it clear that only 4–10 experts are required for achieving reliable data for MCDM analysis. Another widely used MCDM evaluation technique is DEA, which is also very sensitive to its data set; results can change significantly if a decision-making unit (DMU) or criteria is dropped.

Due to its advantages, BWM has been utilised for an increasing number of MCDM-based studies; many of which relate to this study. Ranking of enablers of technological innovation in manufacturing enterprises (Gupta and Barua 2016); supplier segmentation (Rezaei, Wang, and Tavasszy 2015; Bai, Rezaei, and Sarkis 2017); green supplier selection (Rezaei et al. 2016; Gupta and Barua 2017); innovation and efficiency of university–industry projects (Salimi and Rezaei 2016); ranking energy efficiency alternatives and other sustainability technology (Gupta, Anand, and Gupta 2017; Ren, Liang, and Chan 2017); and evaluating airport services and operations (Gupta 2017; Rezaei, Hemmes, and Tavasszy 2017); to name a few related studies. None have explicitly integrated manufacturing supply chain innovation studies, as this study does.

General steps involved in this technique include (Rezaei 2015, 2016):

Step 1: Finalisation of decision criteria.

The finalised decision criteria are denoted as $\{c_1, c_2, \dots, c_n\}$ for n main criteria.

Step 2: Determination of best and worst criteria among main as well as sub-criteria.

Step 3: On a 9-point scale of 1 to 9, where 1 means equal preference and 9 means extreme preference, determine the preference of the best criterion over all other criteria. The best-to-others (BO) vector can be represented as:

$A_B = (a_{B1}, a_{B2}, \dots, a_{Bn})$, where a_{Bj} indicates the preference of the best criterion B over criteria j ; $a_{BB} = 1$.

Step 4: Determine the preference of all other criteria over the worst criterion using a 9-point scale of 1 to 9. The others-to-worst (OW) vector can be represented as:

$A_W = (a_{1W}, a_{2W}, \dots, a_{nW})^T$, where a_{jW} indicates the preference of the criteria j over the worst criterion W; $a_{WW} = 1$.

Step 5: Calculate the optimal weights $(w_1^*, w_2^*, \dots, w_n^*)$.

Determine weights of criteria such that the maximum absolute differences for all j are minimised over the following set $\{|w_B - a_{Bj}w_j|, |w_j - a_{jW}w_W|\}$.

A minimax model can be formulated as:

$\min \max_j \{|w_B - a_{Bj}w_j|, |w_j - a_{jW}w_W|\}$,

Subject to:

$$\sum_j w_j = 1$$

$$w_j \geq 0, \text{ for all } j \quad (1)$$

Model (1) can be solved by converting it into the following linear programming problem model:

Min ξ^L

Subject to:

$|w_B - a_{Bj}w_j| \leq \xi^L, \text{ for all } j$

$$|w_j - a_{jW}w_W| \leq \xi^L, \text{ for all } j$$

$$\sum_j w_j = 1$$

$$w_j \geq 0, \text{ for all } j \quad (2)$$

Solving the linear model (2) will result in optimal weights ($w_1^*, w_2^*, \dots, w_n^*$) and optimal value ξ^L . Consistency (ξ^L) of comparisons also needs to be determined. A value closer to 0 is more desired for consistency (Rezaei 2016).

4. Practical application and evaluation

This multi-case field study used five case manufacturing companies from Indian manufacturing sectors. Case company 1 is an automobile company and has been in operation for four decades. Case company 2 is an automobile company that has been in operation for over 20 years and has pan-India presence. Case company 3 is an electric component manufacturer. Case company 4 is a plastics manufacturer. Case company 5 is an electric and electronic component manufacturer.

All the companies in this sample were selected because they have organisational goals to reduce the environmental impact of their products using innovative technologies. Furthermore, all the companies were ensured to have a minimum of 10 years of operational experience. Senior and upper-level managers from each company participated in both sustainable innovation criteria refinement and response to the BWM questionnaire. The participants were given a short presentation regarding the objectives of the study. The various objectives and criteria for sustainable innovation finalised in the previous phase were presented to the respondents along with the details of each criterion. The respondents were then asked to rate first main criteria on the scale of 1–9 (scale mentioned in Appendix 1). The respondents were asked to first identify the best criterion and thereafter conduct a pairwise comparative rating of the best to other criteria. Similarly, they were asked to identify the worst criterion and rate other criteria with respect to the worst criterion. A similar approach was applied to all the sub-criteria. All the five respondents were asked to rate the criteria individually and later the average of weights obtained from the ratings of each respondent was taken to arrive at the final ranking of sub-criteria as well as main criteria.

The case company 1 respondent is a Senior Manager of R&D and New Product Development and is responsible for evaluating the technical feasibility of projects, identifying new product development opportunities, designing of new products and technical changes in product design. He is an engineering graduate and has been working for the company for about 11 years. The case company 2 respondent is a manager of Strategy, Marketing and Market Development, and is responsible for assessing the market situation and demands, customer needs and marketing the products and explaining the benefit of the products to customers. He holds a graduate degree in marketing and has been associated with the company for the over 7 years. The case company 3 respondent is a Senior Manager of Plant Operations and Production and is responsible for managing the operations related to the shop floor and also managing the resources required for production. He is also responsible for the greening initiatives of the company. He is an engineering graduate and has been associated with the company for about 10 years. The case company 4 respondent is a Senior Manager of Product Development and is responsible for incorporating new technologies into the product and processes. He is also responsible for the innovation-related activities of the company. He is a graduate in engineering and has been associated with the company for about 8–9 years. The case company 5 respondent is a Senior Manager Operations and Planning and is responsible for the production-related activities and also a member of the company's team for incorporating green practices into the system. He holds a graduate degree in Industrial Engineering and has been associated with the company for 12–13 years.

Representatives from each company were asked to select the best and worst criteria from among all the main criteria. This step occurred after initial factors refinement in previous stages. They were asked to provide their preference ratings of the best main criterion over the other main criteria; preference ratings of all the main criteria over the worst criterion were also determined. The best and worst criteria identified by experts/representatives of all case companies are shown in Table 2.

The ratings for the best main criterion over the other main criteria and the other main criteria over the worst criterion for the case company 1 respondent are shown in Table 3. Here for all the pairwise comparisons of different criteria, a scale for Best–Worst Method (See Appendix 1) used by Rezaei, Wang, and Tavasszy (2015) and Gupta (2017) was also adopted. In Table 3, for example, Environmental (EN) criterion (best criterion) is considered 'moderately more important' over Economic (EC) criterion, hence rated 3 by the respondent manager at the intersection of EN and EC. At the intersection of EN and EN, an automatic rating of 1, which means, 'equally important' is provided. Similarly, at the intersection of EN and Social (SC), EN is considered 'very strongly more important' over SC criterion, hence rated 7 by the respondent manager. The second part of the table provides a rating of other criteria with respect to worst criterion in a similar manner as above.

Table 2. Best and Worst criteria identified by managers of case companies.

Sustainable innovation criteria	Determined as Best by managers	Determined as Worst by managers
Economic (EC)	3, 4	
EC1		
EC2	1, 2, 3, 5	
EC3		
EC4		1, 2, 3, 4, 5
EC5	4	
EC6		
Environmental (EN)	1, 2, 5	
EN1		1
EN2	1, 2, 4, 5	
EN3		4
EN4	3	
EN5		
EN6		
EN7		2, 3, 7
Social (SC)		1, 2, 3, 4, 5
SC1		5
SC2	1, 2, 3, 4, 5	
SC3		
SC4		
SC5		3
SC6		1, 2, 6
SC7		

Table 3. Main criteria comparison for case company 1.

BO	Economic (EC)	Environmental (EN)	Social (SC)
Best criterion: Environmental (EN)	3	1	7
OW	Worst criterion: Social (SC)		
Economic (EC)		3	
Environmental (EN)		7	
Social (SC)		1	

Table 4. Pairwise comparison for Economic sub-criteria for case company 1.

BO	EC ₁	EC ₂	EC ₃	EC ₄	EC ₅	EC ₆
Best criterion: EC ₂	4	1	7	9	5	3
OW	Worst criterion: EC ₄					
EC ₁				3		
EC ₂				9		
EC ₃				2		
EC ₄				1		
EC ₅				2		
EC ₆				3		

The case company 1 respondent was asked to evaluate the sub-criteria under each main criterion in a similar manner using a 9-point scale of 1–9 as above. The comparison scores of sub-criteria under economic, environmental and social main criteria are shown in Tables 4–6 below:

After the pairwise comparison of each of the main criteria and sub-criteria by the respondent, the next step is determining the main criteria and sub-criteria weights. Using formulation (2), the main criteria and sub-criteria weights for case company 1 are summarised in Table 7.

Each case company respondent rated the main and sub-criteria. After obtaining the ratings from each company, criteria weights were simply averaged. The averaged weights are summarised in Table 8.

Table 5. Pairwise comparison for Environmental sub-criteria for case company 1.

BO	EN ₁	EN ₂	EN ₃	EN ₄	EN ₅	EN ₆	EN ₇
Best criterion: EN ₂	9	1	5	2	4	3	8
OW	Worst criterion: EN ₁						
EN ₁				1			
EN ₂				9			
EN ₃				3			
EN ₄				4			
EN ₅				2			
EN ₆				3			
EN ₇				2			

Table 6. Pairwise comparison for Social sub-criteria for case company 1.

BO	SC ₁	SC ₂	SC ₃	SC ₄	SC ₅	SC ₆	SC ₇
Best criterion: SC ₂	6	1	2	4	8	9	5
OW	Worst criterion: SC ₆						
SC ₁				2			
SC ₂				9			
SC ₃				4			
SC ₄				3			
SC ₅				2			
SC ₆				1			
SC ₇				2			

Table 7. Weights of main and sub-criteria for case company 1.

Main criteria	Local weights main criteria	Sub-criteria	Local weights sub-criteria	Global weights	Ranking
Economic (EC)	0.236	EC1	0.127	0.030	10
		EC2	0.480	0.113	3
		EC3	0.073	0.017	14
		EC4	0.050	0.012	15
		EC5	0.102	0.024	12
		EC6	0.169	0.040	7
Environmental (EN)	0.673	EN1	0.039	0.026	11
		EN2	0.387	0.261	1
		EN3	0.084	0.057	6
		EN4	0.191	0.128	2
		EN5	0.105	0.071	5
		EN6	0.140	0.094	4
		EN7	0.053	0.035	9
Social (SC)	0.091	SC1	0.075	0.007	18
		SC2	0.420	0.038	8
		SC3	0.203	0.018	13
		SC4	0.112	0.010	16
		SC5	0.056	0.005	19
		SC6	0.043	0.004	20
		SC7	0.090	0.008	17

5. Results analysis and discussion

The outcomes, summarised in Table 8, provide some initial strategic managerial guidance insights. The first major observation is that general environmental criteria (EN) category seems to be the highest ranked for developing sustainability innovation in manufacturing supply chains. This finding first tells us that these companies view sustainability from an environmental aspect, or at least driven by environmental policies and philosophies. Secondly, it is surprising that the environmental factors take precedence, even for sustainability innovation, given that the major drivers of most organisations

Table 8. Aggregate weights of main and sub-criteria for all case companies.

Main criteria	Local weights main criteria	Sub-criteria	Local weights sub-criteria	Global weights	Ranking
Economic (EC)	0.425	EC1	0.150	0.064	6
		EC2	0.407	0.173	1
		EC3	0.076	0.032	11
		EC4	0.049	0.021	14
		EC5	0.163	0.069	4
		EC6	0.154	0.066	5
Environmental (EN)	0.483	EN1	0.057	0.027	12
		EN2	0.348	0.168	2
		EN3	0.078	0.038	10
		EN4	0.241	0.116	3
		EN5	0.100	0.048	8
		EN6	0.123	0.060	7
		EN7	0.054	0.026	13
Social (SC)	0.092	SC1	0.078	0.007	18
		SC2	0.424	0.039	9
		SC3	0.176	0.016	15
		SC4	0.109	0.010	16
		SC5	0.065	0.006	19
		SC6	0.057	0.005	20
		SC7	0.093	0.009	17

remain economic; some of these results may have been influenced by respondents who were active in greening initiatives in their organisations.

The top 10 sustainable innovation sub-criteria by ranking are EC2 > EN2 > EN4 > EC5 > EC6 > EC1 > EN6 > EN5 > SC2 > EN3. 'Financial availability for innovation (EC2)' has the highest sustainable innovation criterion global weight of 0.173, whereas 'cultural, social values and norms (SC6)' has the lowest sustainable innovation criteria global weight of 0.005.

In addition, 'Technical expertise availability and investment in R&D for green practices (EN2)' and 'Green manufacturing and operational capabilities development (EN4)' are ranked second and third, respectively, in order of priority, whereas 'Investment in R&D for sustainable products (EC5)' and 'Designing sustainable products to reduce material consumption and cost (EC6)' happens to be the fourth and fifth, respectively, in order priority. This outcome may be argued that EC2 is the most promising, critical, important and influential sub-criterion for fostering successful sustainable supply chains when these organisations attempt to implement sustainable innovation initiatives. That is to say, the respondent managers may view 'financial availability for innovation', as an important initiative that may need to be present to support other initiatives.

For example, organisational technical expertise and investment in R & D for green practices (ranked second on the list), if available may only be useful, or will only be possible to develop when there are some resources, and in this case, resources for supporting innovative green practices and sustainable product development activities. Investments in research and development (R & D), again, reaffirming the critical need for financial availability prior to and in support of the development of other sustainable innovation sub-criteria. In a similar situation, the development of green manufacturing and operational capabilities (ranked third on the list) will require the prior existence and need of financial availability to help fund, for example, the purchases of parts and components for upgrading and replacing existing traditional manufacturing systems to build the needed capabilities. This result means these manufacturing organisations consider sustainable innovation from an economic sustainability perspective. This interpretation may mean that the initiatives and programmes implemented by these manufacturing organisations towards sustainability may have been focused on economic sustainability; hence the emphasis placed on financial/economic innovation criteria. Another interpretation is that sound financial standing and resources will effectively support the overall sustenance of the sustainable innovation programme.

The socio-cultural value and norms initiative (ranked twentieth on the list) may be viewed as less economically beneficial when innovating for sustainability, as a cost centre, and not offering any economic benefits to other programmes. The country and industry may be less reliant on social initiatives when attempting to address sustainability issues, hence may explain the reason for the lower ranking of 'Cultural, social values and norms' and overall, the sub-criteria under the social dimension. The implication of this result to the manufacturing industry is that EC2 among others would require the greatest and urgent managerial attention to aid in achieving a desirable sustainable outcome. This outcome does complement and is consistent with a number of previous studies. For example, financial constraints may hold back sustainable innovation as firms cannot

innovative if they're not financially sound, since most if not all, innovations start with research and development (R & D) activities which come with significant investment cost element (Hyytinen and Toivanen 2005; Canepa and Stoneman 2007; Savignac 2008). Another reason may be that the managers and companies are more concerned with greening initiatives and may define sustainability as an environmental issue. This interpretation is reinforced by some managers' involvement in 'greening' initiatives, implying an environmental focus to sustainability in these organisations.

Among the top 10 ranked sustainable innovation sub-criteria are four out of the six economic dimensions including EC1, EC2, EC5 and EC6; five out of the seven environmental criteria including EN2, EN3, EN4, EN5 and EN6; and one criterion (SC2) of the social dimension. This empirical results evidently supports the fact that fostering successful organisational sustainable innovation implementation programmes arises from economic and environmental perspectives and initiatives. Thus, social sustainability issues are relatively less influential when it comes to sustainable innovation in manufacturing sectors. This observation can be made from the results in Table 8 which show that 'quick response to high customers and market demand for sustainable products (SC2)' is the only sub-criteria among the top 10, with 6 out of the 7 social dimension sub-criteria including SC1, SC3, SC4, SC5, and SC6, ranked the lowest (ranked 18, 15, 16, 19, 20 and 17, respectively) among the 20 sustainable innovation sub-criteria.

These results are reaffirmed by the outcome depicted in Table 7 for case company 1, which also ranked the same set of social sustainable innovation sub-criteria as the lowest among all sub-criteria. From a practical perspective; this may mean the economic and environmental dimension activities such as 'financial availability for innovation' exists and financial availability and stability has already been achieved. Social sustainability innovation practices and criteria may be interpreted as non-core activities of these organisations and managers. When innovating for sustainability they are either not incentivised or are less capable of focusing on these initiatives.

6. Research implications and managerial feedback

6.1. Academic, managerial and country implications

The results from this study do have several implications for research and practice.

Academically, this study advances the supply chain sustainability literature by further investigating innovation in manufacturing organisation sustainable supply chains. It extends previous studies that only focus on green innovation initiatives to broader sustainability dimensions. The study introduces sustainability innovation initiatives as an important aspect of sustainable supply chain management. The conceptualisation of the sustainable innovation framework strengthens the theoretical foundation for evaluating, controlling and monitoring sustainable supply chain innovation in manufacturing sectors. These constructs may prove valuable for broader theoretical investigations for more complete evaluation of innovation within the organisational sustainability literature.

From a practical perspective, managers and policy makers may encourage broader adoption of sustainable innovation initiatives by targeting sub-criteria that are highly ranked (e.g. top 10 ranked) as an initial step. These 'lower hanging fruit' initiatives may gain the organisational and political support for a sustainable supply chain innovation implementation programme. Another option, if organisations wish to build social sustainability, is focusing and investing in the lower ranked social dimension sub-criteria, which seem to be either more immature or less reinforced initiatives. The results may provide initial insights into a sequential implementation path.

The study's results do inform and provide options for industrial managers and decision-makers on which sub-criteria to focus during implementation. It may also indicate which initiatives they may delay, as a way to introduce systematically, the sustainable innovation activities. In this study, although the results are specific to a given industry in an emerging economy nation, the outcome may be applicable to other emerging economies and contexts, reaffirming its usefulness.

Implications for India and its manufacturing sector also exist. The India manufacturing sector may face more economic and environmental pressures when compared to social pressures. Thus, their foundational activities for sustainable supply chain innovation implementation programmes are still in the very early stages, overall for environmental sustainability. Additionally, organisations may not have the necessary resources to adopt and implement sustainable innovations simultaneously; and so may have to choose amongst a set of sustainable innovation activities. Maximising performance outcomes in a resource-constrained environment is the goal of most industries; this modelling effort and results can help set the foundation for prioritising. In many cases, greening, or environmental initiatives, may have 'win-win' opportunities that can provide simultaneous economic and environmental benefits; whereas social sustainability initiatives may not have as many visible 'win-win' opportunities. It may require creative insights from managers to see value in social innovations, and there is a need for more support or external pressures to mature. Shared value contexts for sustainability innovations in supply chains need to expand based on this preliminary study.

It is therefore important for manufacturing organisations to be given some useful guidance from theoretical knowledge and evaluation of sustainable innovation. This paper's approach can and does provide some initial guidance for managing the

implementation of sustainability innovation in manufacturing supply chains. Overall, it is clear that Indian manufacturing companies believe they should first develop/build a very good financial base as an initial step for successful sustainable supply chain innovation, eventually addressing environmental and socio-cultural issues.

6.2. Managerial feedback

In order to validate and further interpret the study results; feedback was sought from managers of three different companies from the ones involved in this study. Three managers provided feedback. The respondent managers were from three different backgrounds. The first respondent is an Environmental Manager for a leading automobile company; the second respondent is a Senior Manager-Finance in an automobile company and, the third respondent is a Manager for Production, Planning and Control in an electronics industry. The industrial managers were presented with Table 1, which contains the various main and sub-criteria, and also with Table 8, that had the final aggregated results which present the weights and corresponding rankings of the criteria.

The Environmental Manager confirmed the results and further stated that he strongly believes that environmental factors are the major drivers for sustainable innovation in the supply chain. In fact, the manager is of the opinion that developing green manufacturing capabilities is very important for attaining the overall goal of sustainable supply chain management. He also reaffirms 'availability of finance for innovation' in his response as an important criterion.

The Senior Manager-Finance perceived economic criterion as the best among all the other criteria and is of the opinion that investment in research will lead to more innovations and will help reduce material consumption and cost if products are designed considering sustainability aspects. Surprisingly, The Manager for Production, Planning and Control also considered environmental criterion as the most important criterion.

Although the respondent managers' feedback confirmed the results of the study, they were all of the opinion that environmental and economic criteria are of equal importance as exhibited in our results and in Table 8. It is worth noting that these responses may be due to social desirability. A more critical examination through having them perform a more analytical evaluation could get around this issue but was not completed at this time.

They did show concern with the low weights of the Social criterion in the study as they believe that although in comparison with Economic and Environmental criteria, the social criterion is generally viewed as less important. But their impression was this factor shouldn't have received such low weights (9.2%), in its overall contribution to sustainability. They were also of the opinion that separate in-depth studies of each sector may provide further insight. Overall, the respondent managers were satisfied with the results and confirmed were what they expected.

7. Conclusion and future research

The manufacturing sector faces serious sustainability issues throughout their supply chains, and in particular, in emerging economies, such as India. Sustainable innovation is one of the ways to help overcome these sustainability issues. This study has introduced a sustainable innovation criteria framework to deal with the sustainable innovation issues within the Indian manufacturing sector. The Best–Worst Method (BWM) is applied to aid in ranking the sustainable innovation criteria. The results from this exploratory evaluation showed that the industrial managers viewed 'financial availability for innovation' as the most important and critical sub-criteria to foster sustainable supply chain management and sustainable development followed by 'technical expertise availability and investment in R&D for green practices' and 'green manufacturing and operational capabilities development'. It was also evident that 'Cultural, social values and norms' was the lowest ranked criterion.

Although this study does have a number of contributions, there exist some limitations and concerns. These limitations do provide useful and additional opportunities for future and further studies into the subject. Given that only a few managers from the Indian manufacturing sector provided inputs, generalisations cannot be made. The study is a snapshot in time, and much broader empirical and longitudinal investigation to determine if the sustainable innovation criteria importance may change over time is required. However, given the homogeneity of the respondent managers, we can be certain about particular activities and concerns in relation to sustainable innovation of Indian's manufacturing companies and its manufacturing sector. We suggest future researchers utilise other MCDM techniques together with our sustainable manufacturing supply chain innovation framework, to investigate the criteria weights, and compare the results of the two models. As this study involved three different types of manufacturing organisations including automobile, plastic and electrical and electronics, therefore generalising results for one particular sector may be difficult. Future studies can involve a bigger data set from any two types of industries and performing a comparative analysis of results of these two industries.

Clearly, sustainable innovation of manufacturing supply chains in emerging economies is a subject that merits and requires further research. We believe this paper sets an initial stage for further and future research investigation and practical application of sustainable innovation of manufacturing supply chains.

Disclosure statement

No potential conflict of interest was reported by the authors.

References

- Ageron, B., A. Gunasekaran, and A. Spalanzani. 2012. "Sustainable Supply Management: An Empirical Study." *International Journal of Production Economics* 140 (1): 168–182.
- Aguado, S., R. Alvarez, and R. Domingo. 2013. "Model of Efficient and Sustainable Improvements in a Lean Production System Through Processes of Environmental Innovation." *Journal of Cleaner Production* 47: 141–148.
- Ahi, P., and C. Searcy. 2013. "A Comparative Literature Analysis of Definitions for Green and Sustainable Supply Chain Management." *Journal of Cleaner Production* 52: 329–341.
- Amindoust, A., S. Ahmed, A. Saghafinia, and A. Bahreinnejad. 2012. "Sustainable Supplier Selection: A Ranking Model Based on Fuzzy Inference System." *Applied Soft Computing* 12 (6): 1668–1677.
- Amore, M. D., and M. Bennesen. 2016. "Corporate Governance and Green Innovation." *Journal of Environmental Economics and Management* 75: 54–72.
- Ansari, Z. N., and R. Kant. 2017. "A State-of-Art Literature Review Reflecting 15 Years of Focus on Sustainable Supply Chain Management." *Journal of Cleaner Production* 142: 2524–2543.
- Artiach, T., D. Lee, D. Nelson, and J. Walker. 2010. "The Determinants of Corporate Sustainability Performance." *Accounting & Finance* 50 (1): 31–51.
- Ayuso, S., M. Ángel Rodríguez, R. García-Castro, and M. Ángel Ariño. 2011. "Does Stakeholder Engagement Promote Sustainable Innovation Orientation?" *Industrial Management & Data Systems* 111 (9): 1399–1417.
- Azadi, M., M. Jafarian, R. F. Saen, and S. M. Mirhedayatian. 2015. "A New Fuzzy DEA Model for Evaluation of Efficiency and Effectiveness of Suppliers in Sustainable Supply Chain Management Context." *Computers & Operations Research* 54: 274–285.
- Badri Ahmadi, H., S. Kusi-Sarpong, and J. Rezaei. 2017. "Assessing the Social Sustainability of Supply Chains Using Best Worst Method." *Resources, Conservation and Recycling* 126: 99–106.
- Badri Ahmadi, H., S. H. H. Petrudi, and X. Wang. 2017. "Integrating Sustainability Into Supplier Selection with Analytical Hierarchy Process and Improved Grey Relational Analysis: A Case of Telecom Industry." *The International Journal of Advanced Manufacturing Technology* 90 (9-12): 2413–2427.
- Bai, C., S. Kusi-Sarpong, and J. Sarkis. 2017. "An Implementation Path for Green Information Technology Systems in the Ghanaian Mining Industry." *Journal of Cleaner Production* 164: 1105–1123.
- Bai, C., J. Rezaei, and J. Sarkis. 2017. "Multicriteria Green Supplier Segmentation." *IEEE Transactions on Engineering Management*, doi:10.1109/TEM.2017.2723639.
- Bai, C., and J. Sarkis. 2010. "Integrating Sustainability into Supplier Selection with Grey System and Rough Set Methodologies." *International Journal of Production Economics* 124 (1): 252–264.
- Bai, C., and J. Sarkis. 2014. "Determining and Applying Sustainable Supplier Key Performance Indicators." *Supply Chain Management: An International Journal* 19 (3): 275–291.
- Barratt, M., T. Y. Choi, and M. Li. 2011. "Qualitative Case Studies in Operations Management: Trends, Research Outcomes, and Future Research Implications." *Journal of Operations Management* 29 (4): 329–342.
- Beise, M., and K. Rennings. 2005. "Lead Markets and Regulation: A Framework for Analyzing the International Diffusion of Environmental Innovations." *Ecological Economics* 52 (1): 5–17.
- Berrone, P., A. Fosfuri, L. Gelabert, and L. R. Gomez-Mejia. 2013. "Necessity as the Mother of 'Green' Inventions: Institutional Pressures and Environmental Innovations." *Strategic Management Journal* 34 (8): 891–909.
- Bocken, N. M. P., M. Farracho, R. Bosworth, and R. Kemp. 2014. "The Front-End of Eco-Innovation for Eco-Innovative Small and Medium Sized Companies." *Journal of Engineering and Technology Management* 31: 43–57.
- Boons, F., C. Montalvo, J. Quist, and M. Wagner. 2013. "Sustainable Innovation, Business Models and Economic Performance: An Overview." *Journal of Cleaner Production* 45: 1–8.
- Brandenburg, M., K. Govindan, J. Sarkis, and S. Seuring. 2014. "Quantitative Models for Sustainable Supply Chain Management: Developments and Directions." *European Journal of Operational Research* 233 (2): 299–312.
- Cai, W. G., and X. L. Zhou. 2014. "On the Drivers of Eco-Innovation: Empirical Evidence from China." *Journal of Cleaner Production* 79: 239–248.
- Calik, E., and F. Bardudeen. 2016. "A Measurement Scale to Evaluate Sustainable Innovation Performance in Manufacturing Organizations." *Procedia CIRP* 40: 449–454.
- Canepa, A., and P. Stoneman. 2007. "Financial Constraints to Innovation in the UK: Evidence from CIS2 and CIS3." *Oxford Economic Papers* 60 (4): 711–730.
- Carter, C. R., and D. S. Rogers. 2008. "A Framework of Sustainable Supply Chain Management: Moving Toward New Theory." *International Journal of Physical Distribution & Logistics Management* 38 (5): 360–387.
- Chang, C. H. 2011. "The Influence of Corporate Environmental Ethics on Competitive Advantage: The Mediation Role of Green Innovation." *Journal of Business Ethics* 104 (3): 361–370.

- Chardine-Baumann, E., and V. Botta-Genoulaz. 2014. "A Framework for Sustainable Performance Assessment of Supply Chain Management Practices." *Computers & Industrial Engineering* 76: 138–147.
- Chen, Y. S. 2008. "The Driver of Green Innovation and Green Image—Green Core Competence." *Journal of Business Ethics* 81 (3): 531–543.
- Chiavresio, M., V. D. Marchi, and E. D. Maria. 2015. "Environmental Innovations and Internationalization: Theory and Practices." *Business Strategy and the Environment* 24 (8): 790–801.
- Chiou, T. Y., H. K. Chan, F. Lettice, and S. H. Chung. 2011. "The Influence of Greening the Suppliers and Green Innovation on Environmental Performance and Competitive Advantage in Taiwan." *Transportation Research Part E: Logistics and Transportation Review* 47 (6): 822–836.
- Costantini, V., F. Crespi, G. Marin, and E. Paglialonga. 2017. "Eco-Innovation, Sustainable Supply Chains and Environmental Performance in European Industries." *Journal of Cleaner Production* 155: 141–154.
- Cucchiella, F., I. D'Adamo, M. Gastaldi, S. L. Koh, and P. Rosa. 2017. "A Comparison of Environmental and Energetic Performance of European Countries: A Sustainability Index." *Renewable and Sustainable Energy Reviews* 78: 401–413.
- Dangelico, R. M. 2016. "Green Product Innovation: Where We Are and Where We Are Going." *Business Strategy and the Environment* 25 (8): 560–576.
- Das, Debadyuti. 2018. "Sustainable Supply Chain Management in Indian Organisations: An Empirical Investigation." *International Journal of Production Research*, doi:10.1080/00207543.2017.1421326.
- De Marchi, V. 2012. "Environmental Innovation and R&D Cooperation: Empirical Evidence from Spanish Manufacturing Firms." *Research Policy* 41 (3): 614–623.
- de Medeiros, J. F., J. L. D. Ribeiro, and M. N. Cortimiglia. 2014. "Success Factors For Environmentally Sustainable Product Innovation: A Systematic Literature Review." *Journal of Cleaner Production* 65: 76–86.
- de Medeiros, J. F., J. L. D. Ribeiro, and M. N. Cortimiglia. 2016. "Influence of Perceived Value on Purchasing Decisions of Green Products in Brazil." *Journal of Cleaner Production* 110: 158–169.
- Demirel, P., and E. Kesidou. 2011. "Stimulating Different Types of Eco-Innovation in the UK: Government Policies and Firm Motivations." *Ecological Economics* 70 (8): 1546–1557.
- de Vargas Mores, G., C. P. S. Finocchio, R. Barichello, and E. A. Pedrozo. 2018. "Sustainability and Innovation in the Brazilian Supply Chain of Green Plastic." *Journal of Cleaner Production* 177: 12–18.
- Doran, J., and G. Ryan. 2016. "The Importance of the Diverse Drivers and Types of Environmental Innovation for Firm Performance." *Business Strategy and the Environment* 25 (2): 102–119.
- Dou, Y., Q. Zhu, and J. Sarkis. 2014. "Evaluating Green Supplier Development Programs with a Grey-Analytical Network Process-Based Methodology." *European Journal of Operational Research* 233 (2): 420–431.
- Dubey, R., A. Gunasekaran, T. Papadopoulos, S. J. Childe, K. T. Shihin, and S. F. Wamba. 2017. "Sustainable Supply Chain Management: Framework and Further Research Directions." *Journal of Cleaner Production* 142: 1119–1130.
- Esfahbodi, A., Y. Zhang, and G. Watson. 2016. "Sustainable Supply Chain Management in Emerging Economies: Trade-Offs Between Environmental and Cost Performance." *International Journal of Production Economics* 181: 350–366.
- Fabbe-Costes, N., C. Roussat, M. Taylor, and A. Taylor. 2014. "Sustainable Supply Chains: A Framework for Environmental Scanning Practices." *International Journal of Operations & Production Management* 34 (5): 664–694.
- Fahimnia, B., J. Sarkis, and H. Davarzani. 2015. "Green Supply Chain Management: A Review and Bibliometric Analysis." *International Journal of Production Economics* 162: 101–114.
- Franke, C., B. Basdere, M. Ciupek, and S. Seliger. 2006. "Remanufacturing of Mobile Phones – Capacity, Program and Facility Adaptation Planning." *Omega* 34 (6): 562–570.
- Gao, D., Z. Xu, Y. Z. Ruan, and H. Lu. 2017. "From a Systematic Literature Review to Integrated Definition for Sustainable Supply Chain Innovation (SSCI)." *Journal of Cleaner Production* 142: 1518–1538.
- Genovese, A., A. A. Acquaye, A. Figueroa, and S. L. Koh. 2017. "Sustainable Supply Chain Management and the Transition Towards a Circular Economy: Evidence and Some Applications." *Omega* 66: 344–357.
- Golini, R., A. Moretto, F. Caniato, M. Caridi, and M. Kalchschmidt. 2017. "Developing Sustainability in the Italian Meat Supply Chain: An Empirical Investigation." *International Journal of Production Research* 55 (4): 1183–1209.
- Gonzalez, P., J. Sarkis, and B. Adenso-Diaz. 2008. "Environmental Management System Certification and its Influence on Corporate Practices: Evidence from the Automotive Industry." *International Journal of Operations & Production Management* 28 (11): 1021–1041.
- Gopal, P. R. C., and J. Thakkar. 2016. "Sustainable Supply Chain Practices: An Empirical Investigation on Indian Automobile Industry." *Production Planning Control* 27 (1): 49–64.
- Gouda, S. K., and H. Saranga. 2018. "Sustainable Supply Chains for Supply Chain Sustainability: Impact of Sustainability Efforts on Supply Chain Risk." *International Journal of Production Research*, doi:10.1080/00207543.2018.1456695.
- Govindan, K., A. Diabat, and K. M. Shankar. 2015. "Analyzing the Drivers of Green Manufacturing with Fuzzy Approach." *Journal of Cleaner Production* 96: 182–193.
- Govindan, K., R. Khodaverdi, and A. Jafarian. 2013. "A Fuzzy Multi Criteria Approach for Measuring Sustainability Performance of a Supplier Based on Triple Bottom Line Approach." *Journal of Cleaner Production* 47: 345–354.
- Govindan, K., K. Muduli, K. Devika, and A. Barve. 2016. "Investigation of the Influential Strength of Factors on Adoption of Green Supply Chain Management Practices: An Indian Mining Scenario." *Resources, Conservation and Recycling* 107: 185–194.

- Govindan, K., S. Rajendran, J. Sarkis, and P. Murugesan. 2015. "Multi Criteria Decision Making Approaches for Green Supplier Evaluation and Selection: A Literature Review." *Journal of Cleaner Production* 98: 66–83.
- Gupta, H. 2017. "Evaluating Service Quality of Airline Industry Using Hybrid Best Worst Method and VIKOR." *Journal of Air Transport Management* 68: 35–47.
- Gupta, P., S. Anand, and H. Gupta. 2017. "Developing a Roadmap to Overcome Barriers to Energy Efficiency in Buildings Using Best Worst Method." *Sustainable Cities and Society* 31: 244–259.
- Gupta, H., and M. K. Barua. 2016. "Identifying Enablers of Technological Innovation for Indian MSMEs Using Best–Worst Multi Criteria Decision Making Method." *Technological Forecasting and Social Change* 107: 69–79.
- Gupta, H., and M. K. Barua. 2017. "Supplier Selection among SMEs on the Basis of Their Green Innovation Ability Using BWM and Fuzzy TOPSIS." *Journal of Cleaner Production* 152: 242–258.
- Gupta, H., and M. K. Barua. 2018a. "A Framework to Overcome Barriers to Green Innovation in SMEs Using BWM and Fuzzy TOPSIS." *Science of The Total Environment* 633: 122–139.
- Gupta, H., and M. K. Barua. 2018b. "A Grey DEMATEL-Based Approach for Modeling Enablers of Green Innovation in Manufacturing Organizations." *Environmental Science and Pollution Research*, 1–23.
- Hafkesbrink, J., and M. Halstrick-Schwenk. 2005. "A Sustainable Innovation Scorecard for the Electronics Industry Innovation System." *Indicator Systems for Sustainable Innovation*, 143–177.
- Halila, F., and J. Rundquist. 2011. "The Development and Market Success of Eco-Innovations: A Comparative Study of Eco-Innovations and "Other" Innovations in Sweden." *European Journal of Innovation Management* 14 (3): 278–302.
- Hall, J. 2001. "Environmental Supply-Chain Innovation." *Greener Management International*, 105–119.
- Hall, J. 2002. "Sustainable Development Innovation; A Research Agenda for the Next 10 Years." *Journal of Cleaner Production* 10: 195–196.
- Hashemi, S. H., A. Karimi, and M. Tavana. 2015. "An Integrated Green Supplier Selection Approach with Analytic Network Process and Improved Grey Relational Analysis." *International Journal of Production Economics* 159: 178–191.
- Hassan, M. G., R. Abidin, N. Nordin, and R. Z. Yusoff. 2016. "GSCM Practices and Sustainable Performance: A Preliminary Insight." *Journal of Advanced Management Science* 4 (5): 430–434.
- Hassini, E., C. Surti, and C. Searcy. 2012. "A Literature Review and a Case Study of Sustainable Supply Chains with a Focus on Metrics." *International Journal of Production Economics* 140 (1): 69–82.
- Hellström, T. 2007. "Dimensions of Environmentally Sustainable Innovation: The Structure of Eco-Innovation Concepts." *Sustainable Development* 15 (3): 148–159.
- Horbach, J. 2005. "Methodological Aspects of an Indicator System for Sustainable Innovation." In *Indicator Systems for Sustainable Innovation*, 1–19. Physica-Verlag HD.
- Horbach, J. 2008. "Determinants of Environmental Innovation – New Evidence from German Panel Data Sources." *Research Policy* 37 (1): 163–173.
- Horbach, J., C. Rammer, and K. Rennings. 2012. "Determinants of Eco-Innovations by Type of Environmental Impact – The Role of Regulatory Push/Pull, Technology Push and Market Pull." *Ecological Economics* 78: 112–122.
- Huang, J. W., and Y. H. Li. 2015. "Green Innovation and Performance: The View of Organizational Capability and Social Reciprocity." *Journal of Business Ethics* 145 (2): 309–324.
- Hyytinen, A., and O. Toivanen. 2005. "Do Financial Constraints Hold Back Innovation and Growth?: Evidence on the Role of Public Policy." *Research Policy* 34 (9): 1385–1403.
- Iles, A., and A. N. Martin. 2013. "Expanding Bioplastics Production: Sustainable Business Innovation in the Chemical Industry." *Journal of Cleaner Production* 45: 38–49.
- Inoue, E., T. H. Arimura, and M. Nakano. 2013. "A New Insight into Environmental Innovation: Does the Maturity of Environmental Management Systems Matter?" *Ecological Economics* 94: 156–163.
- Isaksson, R., P. Johansson, and K. Fischer. 2010. "Detecting Supply Chain Innovation Potential for Sustainable Development." *Journal of Business Ethics* 97 (3): 425–442.
- Jabbour, C. J. C., D. Jugend, A. B. L. de Sousa Jabbour, A. Gunasekaran, and H. Latan. 2015. "Green Product Development and Performance of Brazilian Firms: Measuring the Role of Human and Technical Aspects." *Journal of Cleaner Production* 87: 442–451.
- Jenkins, H., and N. Yakovleva. 2006. "Corporate Social Responsibility in the Mining Industry: Exploring Trends in Social and Environmental Disclosure." *Journal of Cleaner Production* 14 (3): 271–284.
- Jia, F., L. Zuluaga-Cardona, A. Bailey, and X. Rueda. 2018. "Sustainable Supply Chain Management in Developing Countries: An Analysis of the Literature." *Journal of Cleaner Production* 189: 263–278.
- Kammerer, D. 2009. "The Effects of Customer Benefit and Regulation on Environmental Product Innovation: Empirical Evidence from Appliance Manufacturers in Germany." *Ecological Economics* 68 (8): 2285–2295.
- Kannan, D., A. B. L. de Sousa Jabbour, and C. J. C. Jabbour. 2014. "Selecting Green Suppliers Based on GSCM Practices: Using Fuzzy TOPSIS Applied to a Brazilian Electronics Company." *European Journal of Operational Research* 233 (2): 432–447.
- Kannan, G., S. Pokharel, and P. S. Kumar. 2009. "A Hybrid Approach Using ISM and Fuzzy TOPSIS for the Selection of Reverse Logistics Provider." *Resources, Conservation and Recycling* 54 (1): 28–36.

- Kapetanopoulou, P., and G. Tagaras. 2011. "Drivers and Obstacles of Product Recovery Activities in the Greek Industry." *International Journal of Operations & Production Management* 31 (2): 148–166.
- Kemp, R., A. Arundel, and K. Smith. 2001. "Survey Indicators for Environmental Innovation." Paper Presented to the Conference Towards Environmental Innovation Systems in Garmisch-Partenkirchen.
- Klewitz, J., and E. G. Hansen. 2014. "Sustainability-Oriented Innovation of SMEs: A Systematic Review." *Journal of Cleaner Production* 65: 57–75.
- Kusi-Sarpong, S., C. Bai, J. Sarkis, and X. Wang. 2015. "Green Supply Chain Practices Evaluation in the Mining Industry Using a Joint Rough Sets and Fuzzy TOPSIS Methodology." *Resources Policy* 46: 86–100.
- Kusi-Sarpong, S., J. Sarkis, and X. Wang. 2016a. "Assessing Green Supply Chain Practices in the Ghanaian Mining Industry: A Framework and Evaluation." *International Journal of Production Economics* 181: 325–341.
- Kusi-Sarpong, S., J. Sarkis, and X. Wang. 2016b. "Green Supply Chain Practices and Performance in Ghana's Mining Industry: A Comparative Evaluation Based on DEMATEL and AHP." *International Journal of Business Performance and Supply Chain Modelling* 8 (4): 320–347.
- Lee, S. Y. 2008. "Drivers for the Participation of Small and Medium-Sized Suppliers in Green Supply Chain Initiatives." *Supply Chain Management: An International Journal* 13 (3): 185–198.
- Lee, K. H. 2009. "Why and How to Adopt Green Management into Business Organizations? The Case Study of Korean SMEs in Manufacturing Industry." *Management Decision* 47 (7): 1101–1121.
- Lee, V. H., K. B. Ooi, A. Y. L. Chong, and C. Seow. 2014. "Creating Technological Innovation via Green Supply Chain Management: An Empirical Analysis." *Expert Systems with Applications* 41 (16): 6983–6994.
- Li, Y., and K. Mathiyazhagan. 2018. "Application of DEMATEL Approach to Identify the Influential Indicators Towards Sustainable Supply Chain Adoption in the Auto Components Manufacturing Sector." *Journal of Cleaner Production* 172: 2931–2941.
- Lim, M. K., M. L. Tseng, K. H. Tan, and T. D. Bui. 2017. "Knowledge Management in Sustainable Supply Chain Management: Improving Performance Through an Interpretive Structural Modelling Approach." *Journal of Cleaner Production* 162: 806–816.
- Lin, C. Y., and Y. H. Ho. 2011. "Determinants of Green Practice Adoption for Logistics Companies in China." *Journal of Business Ethics* 98 (1): 67–83.
- Lin, S. S., and Y. S. Juang. 2008. "Selecting Green Suppliers with Analytic Hierarchy Process for Biotechnology Industry." *Operations and Supply Chain Management* 1 (2): 115–129.
- Liu, X., H. Dai, and P. Cheng. 2011. "Drivers of Integrated Environmental Innovation and Impact on Company Competitiveness: Evidence from 18 Chinese Firms." *International Journal of Technology and Globalisation* 5 (3-4): 255–280.
- Luthra, S., K. Govindan, D. Kannan, S. K. Mangla, and C. P. Garg. 2017. "An Integrated Framework for Sustainable Supplier Selection and Evaluation in Supply Chains." *Journal of Cleaner Production* 140: 1686–1698.
- Mahmood, W., W. Hasrulnizzam, M. N. Ab Rahman, B. Md Deros, K. Jusoff, A. Saptari, and Z. Ebrahim. 2013. "Manufacturing Performance in Green Supply Chain Management." *World Applied Sciences Journal* 21 (Special Issue of Engineering and Technology): 76–84.
- Maruthi, G. D., and R. Rashmi. 2015. "Green Manufacturing: It's Tools and Techniques that Can Be Implemented in Manufacturing Sectors." *Materials Today: Proceedings* 2 (4-5): 3350–3355.
- Mathivathanan, D., D. Kannan, and A. N. Haq. 2018. "Sustainable Supply Chain Management Practices in Indian Automotive Industry: A Multi-Stakeholder View." *Resources, Conservation and Recycling* 128: 284–305.
- Mathiyazhagan, K., and A. N. Haq. 2013. "Analysis of the Influential Pressures for Green Supply Chain Management Adoption – An Indian Perspective Using Interpretive Structural Modeling." *The International Journal of Advanced Manufacturing Technology* 68 (1-4): 817–833.
- Mehta, Y., and A. J. Rajan. 2017. "Manufacturing Sectors in India: Outlook and Challenges." *Procedia Engineering* 174: 90–104.
- Messeni Petruzzelli, A., R. Maria Dangelico, D. Rotolo, and V. Albino. 2011. "Organizational Factors and Technological Features in the Development of Green Innovations: Evidence from Patent Analysis." *Innovation* 13 (3): 291–310.
- Moffat, A., and A. Auer. 2006. "Corporate Environmental Innovation (CEI): A Government Initiative to Support Corporate Sustainability Leadership." *Journal of Cleaner Production* 14 (6): 589–600.
- Mondéjar-Jiménez, J., M. Segarra-Oña, Á. Peiró-Signes, A. M. Payá-Martínez, and F. J. Sáez-Martínez. 2015. "Segmentation of the Spanish Automotive Industry with Respect to the Environmental Orientation of Firms: Towards an Ad-Hoc Vertical Policy to Promote Eco-Innovation." *Journal of Cleaner Production* 86: 238–244.
- Montalvo, C. 2008. "General Wisdom Concerning the Factors Affecting the Adoption of Cleaner Technologies: A Survey 1990–2007." *Journal of Cleaner Production* 16 (1): S7–S13.
- Mousavi, S., and B. Bossink. 2017. "Firms' Capabilities for Sustainable Innovation: The Case of Biofuel for Aviation." *Journal of Cleaner Production* 167: 1263–1275.
- Nelson, R. R., and S. G. Winter. 2009. *An Evolutionary Theory of Economic Change*. Cambridge, MA: Harvard University Press.
- Noci, G., and R. Verganti. 1999. "Managing 'Green' Product Innovation in Small Firms." *R&D Management* 29 (1): 3–15.
- Ozaki, R. 2011. "Adopting Sustainable Innovation: What Makes Consumers Sign Up to Green Electricity?" *Business Strategy and the Environment* 20 (1): 1–17.
- Paulraj, A., I. J. Chen, and C. Blome. 2017. "Motives and Performance Outcomes of Sustainable Supply Chain Management Practices: A Multi-Theoretical Perspective." *Journal of Business Ethics* 145 (2): 239–258.

- Pickman, H. A. 1998. "The Effect of Environmental Regulation on Environmental Innovation." *Business Strategy and the Environment* 7 (4): 223–233.
- Quist, J., and A. Tukker. 2013. "Knowledge Collaboration and Learning for Sustainable Innovation and Consumption: Introduction to the ERSCP Portion of This Special Volume." *Journal of Cleaner Production* 48: 167–175.
- Rao, P., and D. Holt. 2005. "Do Green Supply Chains Lead to Competitiveness and Economic Performance?" *International Journal of Operations & Production Management* 25 (9): 898–916.
- Ren, J., H. Liang, and F. T. Chan. 2017. "Urban Sewage Sludge, Sustainability, and Transition for Eco-City: Multicriteria Sustainability Assessment of Technologies Based On Best-Worst Method." *Technological Forecasting and Social Change* 116: 29–39.
- Renning, K. 2000. "Redefining Innovation – Eco-Innovation Research and the Contribution from Ecological Economics." *Ecological Economics* 32 (2): 319–332.
- Renning, K., and C. Rammer. 2009. "Increasing Energy and Resource Efficiency Through Innovation – An Explorative Analysis Using Innovation Survey Data." ZEW - Centre for European Economic Research Discussion No. 09-056. Available at SSRN: <https://ssrn.com/abstract=1495761>.
- Rezaei, J. 2015. "Best-worst Multi-Criteria Decision-Making Method." *Omega* 53: 49–57.
- Rezaei, J. 2016. "Best-worst Multi-Criteria Decision-Making Method: Some Properties and a Linear Model." *Omega* 64: 126–130.
- Rezaei, J., A. Hemmes, and L. Tavasszy. 2017. "Multi-Criteria Decision-Making for Complex Bundling Configurations in Surface Transportation of Air Freight." *Journal of Air Transport Management* 61: 95–105.
- Rezaei, J., O. Kothadiya, L. Tavasszy, and M. Kroesen. 2018. "Quality Assessment of Airline Baggage Handling Systems Using SERVQUAL and BWM." *Tourism Management* 66: 85–93.
- Rezaei, J., T. Nispeling, J. Sarkis, and L. Tavasszy. 2016. "A Supplier Selection Life Cycle Approach Integrating Traditional and Environmental Criteria Using the Best Worst Method." *Journal of Cleaner Production* 135: 577–588.
- Rezaei, J., J. Wang, and L. Tavasszy. 2015. "Linking Supplier Development to Supplier Segmentation Using Best Worst Method." *Expert Systems with Applications* 42 (23): 9152–9164.
- Rothenberg, S., and S. C. Zyglidopoulos. 2007. "Determinants of Environmental Innovation Adoption in the Printing Industry: The Importance of Task Environment." *Business Strategy and the Environment* 16 (1): 39–49.
- Salimi, N., and J. Rezaei. 2016. "Measuring Efficiency of University-Industry Ph. D. Projects Using Best Worst Method." *Scientometrics* 109 (3): 1911–1938.
- Sarkis, J., and D. G. Dhavale. 2015. "Supplier Selection for Sustainable Operations: A Triple-Bottom-Line Approach Using a Bayesian Framework." *International Journal of Production Economics* 166: 177–191.
- Sauer, P. C., and S. Seuring. 2017. "Sustainable Supply Chain Management for Minerals." *Journal of Cleaner Production* 151: 235–249.
- Savignac, F. 2008. "Impact of Financial Constraints on Innovation: What Can Be Learned from a Direct Measure?" *Economics of Innovation and New Technology* 17 (6): 553–569.
- Schaltegger, S., and M. Wagner. 2011. "Sustainable Entrepreneurship and Sustainability Innovation: Categories and Interactions." *Business Strategy and the Environment* 20 (4): 222–237.
- Seuring, S. A. 2008. "Assessing the Rigor of Case Study Research in Supply Chain Management." *Supply Chain Management: An International Journal* 13 (2): 128–137.
- Seuring, S., and M. Müller. 2008. "Core Issues in Sustainable Supply Chain Management – A Delphi Study." *Business Strategy and the Environment* 17 (8): 455–466.
- Shaw, K., R. Shankar, S. S. Yadav, and L. S. Thakur. 2012. "Supplier Selection Using Fuzzy AHP and Fuzzy Multi-Objective Linear Programming for Developing Low Carbon Supply Chain." *Expert Systems with Applications* 39 (9): 8182–8192.
- Shen, L., L. Olfat, K. Govindan, R. Khodaverdi, and A. Diabat. 2013. "A Fuzzy Multi Criteria Approach for Evaluating Green Supplier's Performance in Green Supply Chain with Linguistic Preferences." *Resources, Conservation and Recycling* 74: 170–179.
- Simpson, D., D. Power, and D. Samson. 2007. "Greening the Automotive Supply Chain: A Relationship Perspective." *International Journal of Operations & Production Management* 27 (1): 28–48.
- Somsuk, N., and T. Laosirihongthong. 2017. "Prioritization of Applicable Drivers for Green Supply Chain Management Implementation Toward Sustainability in Thailand." *International Journal of Sustainable Development & World Ecology* 24 (2): 175–191.
- Su, C. M., D. J. Horng, M. L. Tseng, A. S. Chiu, K. J. Wu, and H. P. Chen. 2016. "Improving Sustainable Supply Chain Management Using a Novel Hierarchical Grey-DEMATEL Approach." *Journal of Cleaner Production* 134: 469–481.
- Tariq, A., Y. F. Badir, W. Tariq, and U. S. Bhutta. 2017. "Drivers and Consequences of Green Product and Process Innovation: A Systematic Review, Conceptual Framework, and Future Outlook." *Technology in Society* 51: 8–23.
- Taylor, K. M., and S. Vachon. 2018. "Empirical Research on Sustainable Supply Chains: IJPR's Contribution and Research Avenues." *International Journal of Production Research* 56 (1-2): 950–959.
- Testa, F., F. Iraldo, and M. Frey. 2011. "The Effect of Environmental Regulation on Firms' Competitive Performance: The Case of the Building & Construction Sector in Some EU Regions." *Journal of Environmental Management* 92 (9): 2136–2144.
- Trapp, A. C., and J. Sarkis. 2016. "Identifying Robust Portfolios of Suppliers: A Sustainability Selection and Development Perspective." *Journal of Cleaner Production* 112: 2088–2100.
- Triguero, A., L. Moreno-Mondéjar, and M. A. Davia. 2013. "Drivers of Different Types of Eco-Innovation in European SMEs." *Ecological Economics* 92: 25–33.

- Tsai, M. T., L. M. Chuang, S. T. Chao, and H. P. Chang. 2012. "The Effects Assessment of Firm Environmental Strategy and Customer Environmental Conscious on Green Product Development." *Environmental Monitoring and Assessment* 184 (7): 4435–4447.
- Tseng, M. L. 2011. "Green Supply Chain Management with Linguistic Preferences and Incomplete Information." *Applied Soft Computing* 11 (8): 4894–4903.
- Tseng, M. L., and A. S. Chiu. 2012. "Grey-Entropy Analytical Network Process for Green Innovation Practices." *Procedia-Social and Behavioral Sciences* 57: 10–21.
- Tseng, M., M. Lim, and W. P. Wong. 2015. "Sustainable Supply Chain Management: A Closed-Loop Network Hierarchical Approach." *Industrial Management & Data Systems* 115 (3): 436–461.
- Van Berkel, R. 2007. "Eco-Efficiency in the Australian Minerals Processing Sector." *Journal of Cleaner Production* 15 (8): 772–781.
- Vasilenko, L., and V. Arbačiauskas. 2012. "Obstacles and Drivers for Sustainable Innovation Development and Implementation in Small and Medium Sized Enterprises." *Environmental Research, Engineering and Management* 60 (2): 58–66.
- Vergheze, K., and H. Lewis. 2007. "Environmental Innovation in Industrial Packaging: A Supply Chain Approach." *International Journal of Production Research* 45 (18–19): 4381–4401.
- Wagner, M. 2008. "Empirical Influence of Environmental Management on Innovation: Evidence from Europe." *Ecological Economics* 66 (2): 392–402.
- Wagner, M. 2010. "Corporate Social Performance and Innovation with High Social Benefits: A Quantitative Analysis." *Journal of Business Ethics* 94 (4): 581–594.
- Wang, X., H. K. Chan, R. W. Yee, and I. Diaz-Rainey. 2012. "A Two-Stage Fuzzy-AHP Model for Risk Assessment of Implementing Green Initiatives in the Fashion Supply Chain." *International Journal of Production Economics* 135 (2): 595–606.
- Warren, J. P., E. A. Rhodes, and R. B. Carter. 2001. "A Total Product System Concept – A Case Study of the Smart(tm) Automobile." *Greener Management International* 35: 89–104.
- Watson, J., and R. Sauter. 2011. "Sustainable Innovation Through Leapfrogging: A Review of the Evidence." *International Journal of Technology and Globalisation* 5 (3-4): 170–189.
- Wooi, G. C., and S. Zailani. 2010. "Green Supply Chain Initiatives: Investigation on the Barriers in the Context of SMEs in Malaysia." *International Business Management* 4 (1): 20–27.
- Wu, W., G. Kou, Y. Peng, and D. Ergu. 2012. "Improved AHP-Group Decision Making for Investment Strategy Selection." *Technological and Economic Development of Economy* 18 (2): 299–316.
- Yabar, H., M. Uwasu, and K. Hara. 2013. "Tracking Environmental Innovations and Policy Regulations in Japan: Case Studies on Dioxin Emissions and Electric Home Appliances Recycling." *Journal of Cleaner Production* 44: 152–158.
- Zailani, S., K. Govindan, M. Iranmanesh, M. R. Shaharudin, and Y. S. Chong. 2015. "Green Innovation Adoption in Automotive Supply Chain: The Malaysian Case." *Journal of Cleaner Production* 108: 1115–1122.
- Zailani, S., K. Jeyaraman, G. Vengadasan, and R. Premkumar. 2012. "Sustainable Supply Chain Management SSCM) in Malaysia: A Survey." *International Journal of Production Economics* 140 (1): 330–340.
- Zhou, K. Z., J. R. Brown, and C. S. Dev. 2009. "Market Orientation, Competitive Advantage, and Performance: A Demand-Based Perspective." *Journal of Business Research* 62 (11): 1063–1070.
- Zhu, Z., F. Chu, A. Dolgui, C. Chu, W. Zhou, and S. Piramuthu. 2018. "Recent Advances and Opportunities in Sustainable Food Supply Chain: A Model-Oriented Review." *International Journal of Production Research*, doi:10.1080/00207543.2018.1425014.
- Zhu, Q., and J. Sarkis. 2004. "Relationships Between Operational Practices and Performance among Early Adopters of Green Supply Chain Management Practices in Chinese Manufacturing Enterprises." *Journal of Operations Management* 22 (3): 265–289.
- Zhu, Q., and J. Sarkis. 2006. "An Inter-Sectoral Comparison of Green Supply Chain Management in China: Drivers and Practices." *Journal of Cleaner Production* 14 (5): 472–486.
- Zhu, Q., J. Sarkis, and K. H. Lai. 2008. "Green Supply Chain Management Implications for "Closing the Loop"." *Transportation Research Part E: Logistics and Transportation Review* 44 (1): 1–18.
- Zhu, Q., J. Sarkis, and K. H. Lai. 2012. "Examining the Effects of Green Supply Chain Management Practices and their Mediations On Performance Improvements." *International Journal of Production Research* 50 (5): 1377–1394.

Appendix 1

Scale for best worst method								
Equally important	Equal to moderately more important	Moderately more important	Moderately to strongly more important	Strongly more important	Strongly to very strongly more important	Very strongly more important	Very strongly to extremely more important	Extremely more important
1	2	3	4	5	6	7	8	9