A Review of Decision-Support Tools and Performance Measurement for Sustainable Supply Chain Management

Abstract:

In recent years, interest on sustainable supply chain management has risen significantly in both the academic and business communities. This is confirmed by the growing number of conferences, journal publications, special issues and websites dedicated to the topic. Within this context, this paper reviews the existing literature related to decision-support tools and performance measurement for sustainable supply chain management. A narrative literature review is carried out to capture qualitative evidence, while a systematic literature review is performed using classic bibliometric techniques to analyse the relevant body of knowledge identified in 384 papers published from 2000 to 2013. The key conclusions include: the evidence of a research field that is growing, the call for establishing the scope of current research, i.e. the need for integrated performance frameworks with new generation decision support tools incorporating triple bottom line (TBL) approach for managing sustainable supply chains. There is a need to identify a wide range of specific industry-related TBL metrics and indexes, and assess their usefulness through empirical research and case-base analysis. We need mixed methods to thoroughly analyse and investigate sustainable aspects of the product life cycle across the supply chains, through empirical evidence, building and/or testing theory from and in practice.

Keywords: sustainability; supply chain; performance management; decision-support tool

1. Introduction

Over the last decade, there has been an increase in awareness amongst consumers and society of green or sustainable products (Hitchcock 2012). The resulting pressure from various stakeholders to commit to sustainable practices and performance management (Dey and Cheffi 2012), has rapidly increased the interest shown in sustainable supply chains and their management on the part of government regulators, NGOs, academics and industrial players. There has been particular focus on the areas of for green supply chain management and reverse logistics as a basis of sound practice.

The earliest work relating to the green supply chain management literature can be linked to Ayres and Kneese (1969). Since then the research was mainly focused on understanding the operational issues related to collecting, testing, sorting, and remanufacturing of returned products. In the 90's, research started focusing on investigating the quantitative models of reverse logistics related to distribution planning, inventory control, and production planning (Fleischmann *et al.* 1997). Later research was focused on environmentally conscious manufacturing and product recovery Gungor and Gupta (1999), recycling and remanufacturing were (Guide, Jayaraman and Srivastava 1999; Guide and Van Wassenhove 2002). Researchers mainly focused on the environmental aspects of supply chains, looking at intra-organisational aspects of manufacturing firms. Corbett and Kleindorfer (2003) argued that as sustainability for supply chain became important, a new wave of research emerged trying to capture the systemic nature of sustainability.

Kleindorfer, Singhal, and Van Wassenhove (2005) inaugurated a broader focus, incorporating various sustainability concepts including environmental management, closed-loop supply chains (CLSC) and the triple-bottom-line approach. Since then, operations management researchers started integrating sustainability issues within their traditional domain of expertise. As a result, some key contributions have emerged across a wide range of areas including strategy, finance, environmental operations and policy-making, product design, supplier relationship management and after sale customer service.

Linton *et al.* (2007) Argued that it is important to address the systemic issues of sustainability and environmental aspects of supply chains (Previous studies in this area have seen the incorporation of sustainability in legislation and the modification of the competitive environment in which businesses operate and perform (Webster and Mitra 2007; Kocabasoglu *et al.* 2007; Ackali *et al.* 2007; Mazhar *et al.* 2007). The work of Jovane *et al.* (2009) on Competitive Sustainable Manufacturing (CSM) initiated a discussion on sustainable practices as a possible source of competitive advantage in an industrial context at a strategic operations level.

Tonelli *et al.* (2013) argued that Sustainable Supply Chains (SSC) are a key component of sustainable development in promoting industrial sustainability. In order to maintain competitiveness, supply chain members should consider not only economic aspects but also environmental and social aspects (TBL) in fulfilling stakeholder requirements. As a consequence, companies practising SSC Management (SSCM) have (according to traditional notions of goal trade-offs) to satisfy multiple and conflicting objectives such as increasing returns while reducing costs, minimizing the environmental impact and increasing the social well-being. Previous operations research models have similarly focussed on the trade-offs between three goal dimensions of sustainability (i.e. economic, environment and social). However, Seuring (2013) argues that further research might usefully explore the consequences of win-win (rather than trade-off) and/or minimum achievement requirement on the three goal dimensions. In order to achieve these goals, decision-makers need innovative decision-support tools capable of dealing with global supply chain management as well as sustainability issues and opportunities (Dey and Cheffi 2012) that could overcome the disadvantages of traditional trade-off approaches. These tools have to support performance management in a multi-stakeholder environment assessing environmental impact and social benefits in a multi-party supply chain based on an inter-organizational approach (Taticchi *et al.* 2013; Ates *et al.* 2013). Decision-support tools are still insufficiently robust to deal with design, operational, economic, environmental, societal and technological aspects of systematic implementation of SSCM while contributing to competitive advantage (Bjorklund *et al.* 2012; Bhattacharya *et al.* 2013).

Hence the overall aim of this paper is to explore decision-support tools (DST) for performance management in the SSCM domain. Following Hassini *et al.* (2012, p.70), we define SSCM as: *"...the management of supply chain operations, resources, information, and funds in order to maximize the supply chain profitability while at the same time minimizing the environmental impact and maximizing the social well-being"*. The focus of this paper will be on the sourcing, manufacturing and distribution side rather than design side of the supply chain. Product-design aspects have already been discussed and presented in numerous papers (see Roy 2000; Ehrenfeld 2001; Mont 2001; Manzini and Vezzoli 2003; McAloone and Andreasen 2004; Aurich *et al.* 2006; Ramirez 2007; An *et al.* 2008; Sakao *et al.* 2009; Morelli 2009). An initial scan of the background literature suggests that decision-support tools and performance measurement (PM) in SSCM need to address three main aspects: (1) reduction of negative environmental and social impacts within policy-making context (2) inclusion of all stages across the value chain of each product (3) adoption of a multi-disciplinary perspective throughout the product life-cycle (Taticchi *et al.* 2013). As already articulated, for each of these three aspects, goals should encompass minimum performance (respecting environmental legislation), trade-offs (balancing TBL aspects), and win-win configurations (improving value recovery).

Unfortunately, given the major influence of sustainability on firms' supply-chains, competitiveness and strategy, SSCM and DST remain isolated from one another. Some attention has been given to measuring performance (Taticchi *et al.* 2013) and qualitative and quantitative modelling (Seuring 2013) within the context of SSCM, yet no holistic approaches integrating SSCM, DST, and PM have been found in the literature (Dey and Cheffi 2012; Bhattacharya *et al.* 2013) even if they share strongly related concepts in practice. Thus, the specific objective of this study is to investigate the nature of existing literature and its spread across publications to identify the potential development of DST in SSCM domain from a PM perspective. In this research, the authors reviewed the existing literature assessing developments in SSCM, PM, DST, aiming to derive implications and guidelines for a research agenda.

For this purpose, the authors performed both a narrative and a systematic literature review (Tranfield *et al.* 2003), in order to capture qualitative evidence from literature and rigorous facts. The next section presents the findings of the narrative literature review, while section 3 introduces the methodology adopted to review the literature. Section 4 incorporates presentation on systematic review with bibliographic analysis demonstrating the trends in the literature. This will be followed by section 5 with a discussion on the key findings from this research and the setting of an agenda for further work. Finally, conclusions are drawn in section 6.

2. Narrative Literature Review

The aim of this review is to analyse the existing body of literature on performance measurement (PM) and decision-support tools (DST) in the context of sustainable supply chain management (SSCM) so as to identify major works, and thereafter, to classify them in order to identify relevant areas for further insight based on systematic literature review as provided in the second part of this research. Initially, and for this purpose, an approach based on narrative literature review is suitable since it can contribute to structuring the research field and provide a reference for further research to be developed (Easterby-Smith *et al.* 2002). A strong understanding of evidence from the literature is in fact necessary towards theory development (Weick 1995). The narrative review, provides basic definitions and key concepts of both PM and DST, and describes the evolution of research in these fields and current challenges. Particular attention is given to the recent application of these theories in the context of SSCM.

2.1 Performance Measurement of Sustainable Supply Chains management

Performance measurement and management (PMM) has increased predominantly in the last three decades (Garengo *et al.* 2005; Taticchi *et al.* 2010; Nudurupati *et al.* 2011). Neely *et al.* (1995) describes performance measurement as the process of quantifying efficiency and effectiveness of action, which according to Sharma *et al.* (2005) is an important element in improving business performance. Bititci *et al.* (2012) describes performance management as the process of using measurement information for supporting managers in decision-making processes aiming to link strategy to operations. Nudurupati *et al.* (2011) reported that performance management is an organisation-wide shared vision that surrounds performance measurement activity. Today, PMM practices have become common in all sectors of industry to compete in complex and continuously changing environments (Bititci *et al.* 2012). As articulated by Nudurupati *et al.* (2011) and Taticchi *et al.* (2009) firms have to measure, monitor and manage performance in multiple dimensions using balanced and dynamic set of measures that facilitates support of decision-making processes. The word “balanced” implies the necessity of using different metrics, (i.e. financial vs non-financial; quantitative vs qualitative; internal vs external; etc.) that provide a holistic view of the organisation (Kaplan and Norton 1996; Burgess *et al.* 2007). The word “dynamic” implies the need of developing a system that constantly monitors the internal and external context and reviews objectives and priorities up to date (Garengo *et al.* 2005).

Although there is existing literature on designing and implementing PMM in supply chains, it needs a significant shift due to the changing nature of competitive environment, i.e. shift of competition from individual organisations to supply chains competing against each other (Bai *et al.* 2012; Taticchi *et al.* 2012; Cagnazzo *et al.* 2009). Consequently, there are several calls from researchers to develop performance measures for supply chains (Chan and Qi 2003; Gunasekaran *et al.* 2004). According to Shepherd and Gunter (2005) as reported in Taticchi *et al.* (2013), several metrics were developed and classified, as follows:

- Whether they are qualitative or quantitative;
- What they measure (i.e. cost vs non-cost; quality, delivery and flexibility, resource utilization, visibility, trust and innovativeness);
- Their operational, tactical or strategic focus;
- The process in the supply chain they relate to.

In spite of substantial research on supply chain metrics, research focussing on the development of integrated tools and frameworks for measuring the performance of supply chains was limited (Gunasekaran *et al.* 2001; Bagchi *et al.* 2005). The Supply Chain Council (SCC) has developed an integrated framework (SCOR model ver. 11) for describing the entire processes of the supply chain and extending the performance metrics for individual organisations and supply chain over the entire network (Gunasekaran and Kobu 2007). Although SCOR model is widely implemented across the industry, it receives limited attention from researchers and academia (Taticchi *et al.* 2013). Similarly there are other frameworks proposed by academics (Beamon 1999; Chan and Qi 2003; Chan *et al.* 2003; Gunasekaran *et al.* 2004; Berrah and Clivillé 2007) that has received little attention from industry creating a gap for researchers. Shepherd and Gunter (2005) has reported a number of limitations on the current available performance measurement frameworks for supply chains. They argued that the existing frameworks, lack connection with strategy, has no focus on balanced approaches (as articulated earlier), has insufficient focus on customers, lack holistic focus thus aiming at local optimizations, etc. Ahi and Searcy (2013) conducted an extended review and summarised the key characteristics of SCM as focusing on flow, co-ordination, stakeholders, relationships, value, efficiency, and performance aspects, useful to integrate current understanding about the complex nature of the SCM.

Recently, several researchers have argued that there are inconsistencies between the known principles of performance measures and supply chain dynamics (Lehtinen and Ahola 2010; Bititci *et al.* 2012). In parallel to the development of PM for SCM, there were also calls to develop performance measures for environmental and social aspects of SCM (McIntyre *et al.* 1998; Keating *et al.* 2008). Since then several studies have emerged in literature reporting on performance measurement and green supply-chains, with their focus on environmental aspects (Lee and Klassen 2008; Gavronski *et al.* 2011; Kim *et al.* 2011). Bjorklund *et al*. (2012) identified five dimensions of performance measurement for green SCM, namely stakeholder perspective, purpose of measuring, managerial levels of measuring, measuring across the supply chain and combination of measurements. Shi *et al.* (2012) identified causal links between institutional drivers, intra-organisational and inter-organisational environmental practices that would affect green SCM performance. There are also similar studies reported on corporate social responsibility (CSR) and SCM, with their focus however on social aspects (Dahlsrud 2008).

While the call for sustainability measurement is certainly not new (Milne 1996), many organisations are still reluctant to implement performance measures, unless legally obliged to do so. The implementation of sustainable measures appears however to have been boosted in recent times (Eccles and Krzus 2010). For instance, many organisations have started measuring the sustainability with three main goals: transparency and communication to stakeholders, improvement of operations and strategy alignment. As reported in Taticchi *et al.* (2013), a number of metrics and frameworks have been proposed by practitioner bodies such as the the Carbon Disclosure Project (CDP 2013), Global Reporting Initiative (GRI 2013) and the International Federation of Accountants (IFAC 2013). Academia has produced both revised versions of traditional frameworks such as the Responsive Business Scorecards (Van der Woerd and Van den Brink 2004) and more innovative models such as the Corporate Sustainability Model (Epstein 2008), the Sustainability Evaluation and Reporting System (Perrini and Tencati 2006), the Sustainability DartBoards (Bonacchi and Rinaldi 2007) and the Sustainability Assessment Model (Bebbington *et al.* 2007).

Despite this effort, most of the frameworks mentioned above are based on individual elements of the triple bottom line (TBL) concept identifying the need to approach sustainability with both generic and industry-specific measures of performance. This is echoed by Ahi and Searcy (2013) who conducted an extended review summarising the characteristics of business sustainability, focusing on economic, environmental, social, stakeholder, volunteer, resilient and long-term aspects. Walker and Jones (2012) identified external as well as internal barriers and enablers for SSCM and validated their findings in seven large companies in UK. Hassini *et al.* (2012) have reviewed the literature on sustainable supply chains during the period 2000-2010 to develop an original framework for sustainable supply chain management and performance measurement. The framework incorporates six elements, namely sourcing, transformation, delivery, value proposition, customers and product use along with reuse, recycle and return, which provides a link to closed-loop supply chains.

The above researchers highlight the need to develop performance measures for supply chain, the insufficient development of integrated tools and frameworks for measuring the performance of supply chain. They call for the development of performance measures for environmental and social aspects of SCM, particularly in the two areas relating to performance measurement for SSCM. Firstly, much of the literature is fragmented into silo fields concentrating on either economic, environmental or social performance of SCM with few studies recently emphasizing on addressing all three aspects. Secondly, according to Walker and Jones (2012) there is a wide gap between what practitioners say and do about SSCM in reality because they only provide lip service to SSCM. Although these needs are initially raised through conceptual work, there is still a need to establish empirical work in this field, particularly using quantitative models (Seuring, 2013), also demonstrating the utility of PM in SSCM.

2.2 Decision-Support Tools for Sustainable Supply Chains Management

Seuring (2013) suggests that the intersection of sustainability and supply-chain management needs to be further researched, especially on the quantitative side, so as better to support decision-making. Decision-making can be effectively supported by a computer or knowledge based information system supporting organizational automatic, manual or hybrid decision-making activities associated with management, operations, and planning levels of an organization (usually middle and higher management), usually called Decision Support Systems (DSS). According to Keen (1980), academics usually perceive DSS as a tool to support decision-making process while typical DSS users see DSS as a tool to facilitate organizational processes. Sprague (1980) defines DSS by its characteristics, i.e. targeting underspecified problems, combining use of models or analytical techniques, enabling features that for ease of use as well as providing flexibility and adaptability to change.

Decision support tools (DSTs), being part of a more extensive decision support system (DSS), can play a key role in improving the ability of decision-makers to assess and decide how good different configurations might be with respect to set criteria or goals. In other words, DSS-DST could be defined as an approach that would identify and assess multiple control variables (constructs or criteria) that would impact performance of supply chains in general and SSCM in particular. As reported in Taticchi *et al.* (2013), several studies focused on analytical models to implement sustainability: scheduling (Lejeune 2006) with energy aware considerations (Bruzzone *et al.* 2012), facility location (Srivastava 2008; Dou and Sarkis 2010), supplier selection, policy assessment, optimization (Cannon *et al.* 2005), analytical hierarchy process (Che 2010), fuzzy decision making (Tsai and Hung 2009), heuristics such as genetic algorithm (Wang and Hsu 2010), simulation (Van Der Vorst *et al.* 2009; Vlachos *et al.* 2007), "exergoeconomics" (Ji 2008), Life Cycle Costing (LCC) and Life Cycle Assessment (LCA) (Matos and Hall 2007; Frota Neto *et al.* 2010). There are also several studies using MCDM methodology that employ integrated analytical hierarchy process or analytical network process, most are focused on either performance measurement (Lee *et al.* 2008; Wu *et al.* 2009), supply chain management issues (Wang *et al.* 2004; Ravi *et al.* 2006; Chan *et al.* 2008) or both performance measurement and supply chain management (Bhagwat and Sharma 2007). However few studies offer decision support tools strongly related to performance measurement for SSCM.

SSCM related complex decisions, in practice, often involve groups of inter-related players, require the synthesis of lot of information that often have high risks. Examples might include deciding on where to locate a new manufacturing facility or how to select suppliers with multi-stakeholder needs. Such complex problems often involve decisions/techniques to break them down into manageable steps and overcome any inherent biases and errors through traditional active decision-support tools and techniques:

- Structured Decision Making (SDM) - involves defining a complex problem with stakeholder input and breaking that into decision objectives. It then involves picking and evaluating different alternatives. Finally trade-offs are made for picking the preferred alternative.
- Multi Criteria Decision Analysis (MCDA) – involves establishing multiple decision criteria. It then involves assessing the criteria against each of the alternatives. Finally a weighting is obtained, which is fed into the software that calculates an overall score for each alternative.

From this preliminary analysis, it is clear that these studies do not simply relate to analytical models or tools to analyse and optimize one, or a few, sustainability dimensions to the aim is rather to extend them in line with a new holistic view, considering multiple stakeholders and goal relationships, and so related performance measures. This new view moves from linear to non-linear thinking, from a sectorial to a multi-sector and multi-dimensional approach, from short to long term, from local to global or 'glocal' analysis, from excluding externalities and exogenous variables from the model to internalizing them within it. In line with this view, a recent review of sustainability analysis methodologies for efficient decision support in green production operations (Liu *et al.* 2011), identified three main: (a) sustainability analysis has moved to whole life cycle assessment from single-stage assessment, (b) sustainability analysis has shifted away from single criterion to MCDA and (c) sustainability analysis has evolved from stand-alone approaches to integrated systematic methodologies.

It is generally agreed that sustainability analysis is most effective and efficient in its support for complex decision making in a sustainable supply chain when it is integrated. However most available studies analyze sustainability issues at isolated stages of the supply chains. Hadiguna (2012) introduced a new paradigm for sustainable assessment in supply chain operations based on functional capabilities: modelling, data management, and knowledge management to support all decision-making processes.

Adding to this approach, Liu *et al.* (2012) suggest an integrated sustainability analysis (ISA) framework, which integrates life cycle assessment into a multi-criteria decision-making process to support integration of environmental management and social responsibility with the economic aspects of supply chain management. Tan and Khoo (2005) demonstrated the usefulness of the LCA method in quantitatively measuring the environmental impacts of sustainable operations in supply chains.

Cruz (2008) developed a dynamic decision-making model for supply chain networks incorporating corporate social responsibility in attaining an equilibrium between environmental and economic impacts. Tsoulfas and Pappis (2008) proposed a MCDM model based on five sets of environmental performance indicators to support decision making in supply chains. Power (2002) presented another taxonomy for DSS in using the mode of assistance as the criterion:

- A communication-driven DSS supports more than one person working on a shared task.
- A data-driven DSS or data-oriented DSS emphasizes access to and manipulation of a time series of internal company data and, sometimes, external data.

- A document-driven DSS manages, retrieves, and manipulates unstructured information in a variety of electronic formats.
- A knowledge-driven DSS provides specialized problem-solving expertise stored as facts, rules, procedures, or in similar structures.
- A model-driven DSS emphasizes access to and manipulation of a statistical, financial, optimization, or simulation model. Model-driven DSS use data and parameters provided by users to assist decision makers in analyzing a situation even if they are not necessarily data-intensive.

Dey and Cheffi (2013) developed a framework for green supply chain performance measurement consisting of two higher order constructs based on environmental practices and sustainable performances across the supply chain using AHP. Bhattacharya *et al.* (2013) identified five constructs and developed a green supply chain performance measurement framework and tested with collaborative decision-making approach using fuzzy analytical network process based on green balance scorecard. The study identified and tested the green causal relationships between the constructs, i.e. organisational commitment, eco-design, green supply chain process, social performance and sustainable performance.

Bradenburg *et al.* (2013) argue that several studies are emerging on SSCM using case study or model-based approaches within food, apparel and automotive industries while other sectors being neglected. Hence it could be argued that more sophisticated modeling approaches such as dynamic programming, agent based modeling, system dynamics, evolutionary algorithms, could be developed to offer large-scale optimization, while considering different dimensions of SSCM.

The narrative literature review of the decision support systems for sustainable supply chain management highlights the need for further research on the interaction of sustainability and supply-chain management, the insufficient investigation on decision support tools related to performance measurement for SSC Management, and the prevailing tendency to analyze sustainability issues at isolated stages of the supply chain, rather than to use integrated approaches.

The narrative literature review summarized above highlights relevant areas with regard to both performance measurement and decision support tools in the context of SSCM. In order to investigate further, a systematic literature review was carried out to complement our initial findings and support in achieving the overall aim of this research. We believed that a systematic literature review with bibliometric analysis would prove useful in addressing the following objectives:

- To understand and assess the size of the research and trends in this field,
- To identify the leading journals and authors contributing to the field and in which areas,
- To explore the existing methods and approaches used in the field in an attempt to explore the need for more methods .

We developed dimensions that were used to investigate the above objectives and synthesized in Table 1 and described in the next section.

3. Review Methodology

The systematic literature review was performed by using classic bibliometric techniques such as the analysis of publications, citations and adopted research methods. These techniques were used several times for performing literature reviews in different management fields in the past (Pilkington and Leston-Heyes 1999; Neely 2005; Burgess *et al* 2006; Taticchi *et al* 2010; Hassini *et al.* 2012). While Taticchi *et al.* (2013)

interrogated PM and SSCM in the past, this research extends and revises their work by incorporating decision support tools with PM and SSCM.

In order to perform this study, authors have used "ISI Web of Science", a dataset which is one of the most consistent source for articles in business and management fields (Shepherd and Gunter, 2005). In September 2013, the dataset was interrogated twice (so as to build two separate databases) searching for papers' titles, abstracts and keywords:

- ["Sustainable" OR "Sustainability"] AND ["Supply Chain Performance"] AND ["Measurement" OR "Management" OR "Metrics" OR "Indicators"];
- ["Sustainable" OR "Sustainability"] AND ["Supply Chain"] AND ["Decision"] AND ["Making" OR "Support" OR "Tool" OR "System" OR "Application"];

The interrogation allowed the construction of a database[1] related to PM in SSCM with 274 papers, and another database related to DST in SSCM with 110 papers. Works included in the search/databases were not limited in time, but restricted to peer-reviewed publications in the areas of business, management, engineering, economic, environmental and social sciences. To perform the bibliometric analysis, the dataset was uploaded to the Sitkis software (Schildt *et al.* 2006). Two authors independently performed the reviewing process by verifying every record in the databases to ensure accuracy of the process, and errors identified were consequently amended. This accorded with current best practices for bibliometric analysis (Schildt 2002). In this process, fifty-one publications were found to be common to both datasets, thus highlighting a strong overlap among the two research areas.

Two classification frameworks were developed with the goal of clarifying the review methodology adopted. The first framework, summarised in Table 1, presents 12 dimensions that were used for analysing the articles related to two groupings: analysis of publication data and analysis of citation data. The dimensions identified were designed to provide a comprehensive characterisation of available literature. The second framework, summarised in Figure 1, identifies 16 criteria that were used for classifying research methods. The latter is a modification of the classification proposed by Wacker (1998), who identified two broad macro-categories of research methods (analytical and empirical) further divided into six categories (analytical: conceptual, mathematical and statistical; empirical: experimental design, statistical sampling and case studies). The classification developed by Wacker has already been used by Burgess *et al.* (2006) in a systematic review of SCM literature. Wacker's classification was modified by identifying additional sub-categories for the "mathematical" category from the findings of Seuring (2013) who reviewed modelling approaches for SSCs and from empirical evidence during the review process performed by the authors. The "conceptual" category and "empirical" macro-category were adopted from the works of: Coughlan and Coghlan (2002), Weick (1995) and Tranfield *et al.* (2003).

With the purpose of ensuring consistency in the classification process of research methods, an independent classification was undertaken by two of the authors. Then, all authors discussed discrepancies together when necessary.

Papers may of course be based on more than one research method. For example, it is common to find papers using literature review and theory building at the same time, or statistical sampling and case studies simultaneously. In the presentation of findings, results are presented both in terms of total numbers (here the total of research methods is higher than the total of papers examined) and percentages.

(Insert Table 1 here)

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[1] A full list of papers is available to public online at: http://sscm.esy.es/IJPR Dataset Web.htm

(Insert Figure 1 here)

4 Systematic Literature Review

4.1 Analysis of Publication Data

Figures 2 and 3 present the distribution of publications in both domains over time, highlighting a research field that is growing very fast in the last few years.

(Insert Figure 2 here) (Insert Figure 3 here)

Table 2 presents the list of the top ten journals where the research on PM-SSCM and DST-SSCM were published respectively. *Journal of Cleaner Production*, *International Journal of Production Economics*, *International Journal of Production Research* seems to be amongst the top three in both the databases.

(Insert here Table 2)

Table 3 presents the ranking of most prolific scholars in both the databases. Sarkis J., Klassen, R.D., Seuring S., and Vachon S. lead in the field of PM-SSCM with at least 6 publications. These authors have similar disciplinary backgrounds in operations and supply chain management. The list in the field of DST-SSCM is led by Govindan, K. (with 4 publications) who is followed by a number of other authors with three publications. The academic background of the leading author (Govindan) is management accounting. The backgrounds of the authors following him in the list include business, computer science and manufacturing. Here it is also interesting to note that the academic backgrounds of scholars working in DST-SSCM appears to embrace more fields than those of scholars researching in PM-SSCM, with system sciences, business and management being particularly prominent. Sarkis and Govindan are present in both lists (PM and DST).

(Insert Table 3 here)

Table 4 presents the geographic breakdown of scholars. North American and European academic institutions have made substantial contributions to the research field's development, in approximately equal measure, in both PM-SSCM and DST-SSCM. In addition, Table 4 highlights the emerging contribution of scholars from China and Taiwan, suggesting the relevance of this topic to Asian countries. Studies from Asian countries show a preference for practical and quantitative approaches.

(Insert Table 4 here)

4.2 Analysis of Citation Data

The frequency of citations was explored in a greater detail for individual publications. The 274 papers included in the PM-SSCM dataset provided 3,149 citations. The 110 papers included in the DST-SSCM dataset provided 686 citations. As is often observed in such analyses, the trend of citations over time is consistent with the trend of publications as demonstrated in Figures 4 and 5.

(Insert Figure 4 here) (Insert here Figure 5 here)

As demonstrated in Table 5, the most frequently cited journals in PM-SSCM research are: *International Journal of Operations & Production Management* (491 citations), *Journal of Cleaner Production* (381 citations), *International Journal of Production Economics* (300 citations) and the *International Journal of Production Research* (253 citations). The most frequently cited journals in DST-SSCM research are: *Journal of Cleaner Production* (175 citations), *International Journal of Production Research* (117 citations), *International Journal of Production Economics* (97 citations) and the *International Journal of Physical Distribution & Logistics* Management (37 citations). The most cited journals are in the field of operations and production management, demonstrating its strong link (typically in relation to tactical and operational decisions) with supply chain management in the sustainability and decision-making domains.

(Insert Table 5 here)

The most frequently cited authors in the field of PM-SSCM are presented in Table 6: Rao and Holt (168 citations), Linton *et al* (133 citations), Kleindorfer *et al* (128 citations), Guide *et al* (114 citations) and Vachon *et al* (111 citations). The authors identified here have a diverse disciplinary background: Rao – environmental science, Linton and Guide – supply chain management, Kleindorfer – technology and operations management, and Vachon – supply chain management.

(Insert Table 6 here)

The most frequently cited authors in the field of DST-SSCM are presented in Table 7: Lu *et al* (49 citations), Hutchins and Sutherland (43 citations), Bai & Sarkis (40 citations), Tsai and Hung (34 citations) as well as Ukidve and Bakshi (34 citations). These researchers have different disciplinary backgrounds: Lu - mathematics and science computing, Hutchins - political science and economics, Bai - industrial engineering, Tsai - mathematics and Ukidwe - environmental science. These findings, clearly demonstrates diversity in the disciplines.

(Insert Table 7 here)

4.3 Analysis of Keywords

Wasserman and Faust (1994) developed an analytical technique for studying the social network of keywords for the most frequently cited works in literature. The authors followed this technique and downloaded the keywords from the dataset with the help of the Sitkis software (research works with over 20 citations were included) and using the UCINET software (Borgatti *et al.* 2002) to carry out the social network analysis. Figure 6 presents the visual network obtained from PM-SSCM dataset highlighting the centrality of eight keywords: “sustainable development”, “sustainability”, “green”, “supply chain management”, “industry”, “impact”, “performance” and “competitive advantage”. The social network analysis was repeated for DST-SSCM dataset and the keywords for the most frequently cited works in literature are presented in Figure 7. The visual network obtained highlights the centrality of five keywords: “sustainability”, “performance”, “design”, “management” and “framework”. Interestingly the keyword “design” shows multiple connections (more than management), suggesting that the DST should mainly be addressed to the design phase of SSCs, at least at this transition stage towards sustainability (reinforcing the notion of orienting the development and application of DST towards the tactical decision-making process). The social network analysis shows clearly that the DST-SSCM domain is still under strong development, and so deserving greater attention from scholars with quantitative decision science background.

(Insert Figure 6 here) (Insert Figure 7 here)

4.4 Analysis of Research Methodologies

By using the framework presented in Figure 1, PM-SSCM papers identified were classified based on the research methodology employed (Table 8). The findings highlight a balance between analytical and empirical papers. In the context of analytical papers, conceptual works based on theory building were significantly the most numerous, followed by works based on statistical methods. In the context of empirical papers, survey and case study based works dominate the table. A similarly classification was undertaken for DST-SSCM papers (Table 9). Findings highlight a majority of analytical papers where works based on theory building were significantly the most prevalent, followed by works based on equilibrium models, MCDM and LCA. In the context of empirical papers, case-study based works dominate the table, followed by papers based on statistical sampling.

(Insert Table 8 here)

(Insert Table 9 here)

5 Discussion and Research Agenda

This paper employs a systematic and methodologically rigorous process to review the existing and potential linkages between and practices within DST and PM for SSC design and management, using content analysis to assess a large sample of related papers and identifying current gaps and future perspectives. Literature reported from PM-SSCM dataset remained as analytical with 194 papers and empirical with 192 papers. Similarly, the literature reported from DST-SSCM dataset remained as analytical with 109 papers and empirical with 55 papers. Although not as significant as PM-SSCM, DST-SSCM is a growing area of its application, concepts, principles, techniques, and tools in industrial sustainability. There are however only 51 papers that considered aspects of both PM and DST in the SSCM domain, indicating *the need for more research on exploring DSTs for measuring performance of SSCs*

The rate of growth in these areas of research over the last few years is quite relevant. The top three journals identified are the same that were identified for PM-SSCM research showing an interesting similarity between PM and DST in the SSCM domain. The lead authors of PM-SSCM papers tend to have a background in management accounting, and *we suggest that there is scope for supply chain management scholars to engage more in this aspect of research*. The academic background of scholars working in DST-SSCM appears to embrace a wider range of fields, with roots particularly in system science, business and operations management. From the analysis, although there is evidence of some diversity in disciplines, *there is a need for more focused research in the area of policy development.* We urge the journal editors to stimulate more interest in these areas and in cross-disciplinary research.

As was demonstrated during the narrative and structured literature review, DST-SSCM research has concentrated on the resolution of isolated issues within the supply chain (Cannon *et al.* 2005; Lejeune 2006; Lu *et al.* 2007; Srivastava 2008; Dou and Sarkis 2010; Bai and Sarkis 2010). Existing research predominantly focuses on either the environmental or the social aspects of supply chains along with economic aspects, with only a few studies incorporating all three dimensions. The TBL approach, however, represents an emerging strand within the burgeoning literature on PM–SSCM and DST-SSCM. Relevant metrics can be classified along three dimensions: economic, environmental and social.

- **Economic:** While there is abundant literature focusing on this perspective, DST in SSCM domain have to advance towards the inter-organizational aspects of SCM and extend this to the industry system level (Tonelli *et al.* 2013; Kannegiesser and Günther 2013). Economic contributions of vertical coordination in the SSCM context can be assessed quantitatively using a set of performance metrics. As argued by Brandenburg *et al.* (2013), quantitative models could be employed to elaborate on the interplay of regulatory decisions made by legal authorities and managerial decision making in firms, supply chains, or industries, with the results being incorporated and implemented in a new generation of DSTs. Some of the criteria or metrics used to assess these aspects are: microeconomic factors such as cost, profitability, or revenue (Lovric *et al.* 2013); macroeconomic metrics including gross domestic product or growth rate (Agrell *et al.* 2004) as well as labor productivity, market concentration, or import dependency (Yakovleva *et al.* 2011) or overall macro-economic development (Feng *et al.* 2007). At tactical and operational level, a great deal of attention has been paid to reverse logistics and related activities such as collecting, testing, sorting, and remanufacturing of returned products (according to the CLSC and end-of-life concepts). At a more strategic level, the economic aspects of industrial sustainability have been neglected (it has been mainly analysed in pure financial terms). Hence understanding and measuring the costs of implementing sustainability practices versus costs for mitigating activities and outcomes derived by non-sustainable practices in supply-chains should, we suggest, be high on the future research agenda. These tactical and strategic considerations require a multi-stakeholder based PM framework (Taticchi *et al.* 2013) alongside new generation DSTs.
- **Environmental:** There is significant potential in addressing environmental and risk management aspects through a new generation DST incorporating a good knowledge of environmental performance metrics. As reported in Brandenburg *et al.* (2013), some of the metrics needed for this aspect include: input oriented factors including renewable energy sources (Georgopoulou *et al.* 1998; Munda 2009), natural resources (Liu *et al.* 2011), water and energy consumption (Yakovleva *et al.* 2011), or water quality (Feng *et al.* 2007); output-oriented environmental factors focus on waste (Yakovleva *et al.* 2011) and pollution (Georgopoulou *et al.* 1998). As discussed earlier, there is a need to understand the relative costs of implementing sustainable practices versus mitigating their non-implementation, and also to augment the hitherto limited research on how environmental considerations might eventually affect economic aspects of the businesses and social well-being. As suggested by Taticchi *et al.* (2013) and Tonelli *et al.* (2013) there is a need for an innovative holistic sustainable business model to tackle the above issues. Specific industry-oriented environmental performance evaluation systems and DSTs (i.e. capable of supporting decision-making through the best available techniques for each industrial sector), should be studied and developed.
- **Social aspects:** accordingly to the SSCM definition provided in the narrative review, social aspects need to be incorporated in the decision-making process of the new generation DSTs in order to maximize the social well-being. The existing literature contains some measures for the evaluation of the social dimension which include (Brandenburg *et al.* 2013): internal factors such as wages, employees, or employment gender ratios (Yakovleva *et al.* 2011) and external factors such as individual customer needs and requirements (Lovric *et al.* 2013), social acceptance and contribution to employment (Georgopoulou *et al.* 1998), and population growth (Feng *et al.* 2007). However, contributions relating to the social dimension of SSCM have been limited, and mainly related to the competitive aspects (Jovane *et al.*, 2009) of a specific industrial area/cluster (thus involving employees and communities).

The foregoing represents an assessment of the detailed usage within the literature of the three sustainability dimensions, e.g. which metrics have been found suitable to represent sustainability factors in formal SSCM models and which perspectives are taken in holistic SSCM models (Brandenburg *et al.* 2013). It, strongly suggests a need to further integrate holistic TBL measures and the resulting performance impacts within

SSCM modeling. This would bridge the gap between the 'win-win' approaches to the three aspects of sustainability prevalent in SSCM research and the trade-off-based modeling approaches that dominate formal modeling research (Brandenburg *et al.* 2013; Seuring and Müller 2008; Seuring 2013). There is also a need to correct the sectorial imbalance that comes from papers on SSCM metrics tending to deal with manufacturing sectors such as automotive or electronics industries (Hassini *et al.* 2012). *We still need to identify a wider range of specific industry-related TBL metrics and indexes, and assess their usefulness through empirical research and case-base analysis.*

The PM & DST for SSCM data sets were separately analyzed because the two research fields emerged as largely isolated from one another. We suggest that there is a need for an integrated approach and a holistic framework. Our interpretation of quantitative DSS-DST research leads us to believe that these tools can benefit greatly from an appropriate link with SSCM-PM. This belief is also echoed by other researchers (Seuring and Müller 2008; Carter and Easton 2011; Carter and Rogers 2008; Gold *et al.* 2010a/b; Golicic and Smith 2013; Tang and Zhou 2012). On the other, hand most of the papers reported in the DST-SSCM dataset, include implementation of individual DST tools or techniques to resolve an issue within supply chain (such as supplier selection, scheduling, facility location, etc.) rather than consideration of sustainability aspects of the entire supply-chain. As articulated by Bai and Sarkis (2010), effective DST could allow rapid assessment of several SSC configurations (so supporting the design phase) around the world to facilitate decision-making at the firm and policy levels. Within the most frequently cited authors, a disciplinary diversity can be observed, ranging from mathematics and computing science to political, economic and environmental sciences. With the DST-SSCM domain still developing strongly, it represents a worthy object of attention for scholars with quantitative decision science and industrial engineering backgrounds. There is *more work required in the development of integrated performance frameworks with new generation of DSTs in managing SSCs*.

Much of the research reported in this paper focus on developing the frameworks for integrating sustainability to supply chain practices. Few researchers (Dey and Cheffi 2013; Bhattacharya *et al*. 2013) have worked in this field in the development of integrated framework (PM & DST) but however did not focus on implementation issues. For instance, Walker and Jones (2012) argue that most of the organisations provide lip service when it comes to sustainable aspects of their supply chain operations, suggesting a wide gap between theory and practice. This has implications on policy development and consumer awareness, as identified earlier. In respect of the limitations, based on the findings of this work, *there is a strong need for research that focus on identifying issues (such as barriers and drivers) in implementing integrated (PM & DST) framework in sustainable supply chains considering all three aspects of sustainability. More importantly, we need research to identify impact of such integrated frameworks.*

The visual network analysis in Figure 6 highlights the centrality of eight keywords: "sustainable development", "industry", "supply chain management", "impact", "green", "performance", "competitive advantage" and "sustainability". This suggests that measuring performance on the sustainable aspects of SCM could lead businesses to competitive advantage and thus impact industry as a whole. This proposition is supported by the work of Rao and Holt (2005), which received the highest number of citations as demonstrated in Table 6. Similarly, the visual network analysis in Figure 7 highlights the centrality of five keywords: "sustainability", "performance", "design", "management" and "framework". This supports our earlier claim regarding the desirability an integrated performance framework for managing sustainable aspects of SCs that have design implications.

The classification by research methodology shows a majority of analytical papers (theory building) followed by works based on equilibrium models, MCDM, fuzzy-logic and LCA. In the context of empirical papers, case-study based work dominates, followed by papers based on statistical sampling. Formal models such as fuzzy-logic and MCDM seem to be the natural connection between PM-SSCM and DST-SSCM, even if the popularity of statistical sampling has only started to grow in the last three years. In terms of modeling results, the findings do confirm the relevance of AHP/ANP, LCA, and MCDM for SSCM models (Dey and Cheffi 2013; Bhattacharya *et al.* 2013), but discrete event simulation (DES) and genetic algorithms (GA), system dynamics (SD) and agent-based modeling (ABM) could be further explored to offer large scale optimization and solve complex problems, while considering different dimensions of SSCM (Seuring 2013). So *a further research stream is to identify and feature descriptive or normative (deterministic vs. stochastic) approaches to be developed inside DST as well as extending proposed approaches (e.g. evaluating recent advances) in using Agent Based simulation for sustainability formal modeling*. For instance, we should identify and adapt the use of existing methods available in other disciplines such as conjoint analysis using the technique of discrete choice analysis (DCA) in an innovative way to this research field (Verma and Pullman, 1998). In summary, DCA is an econometric method used to quantify the relative weights of attributes and criteria assessed by the decision-maker in a choice experiment. *We have no doubt that similar models will prove beneficial to research in the areas of policy development and implementation and consumer research within the domain of SSCM that we identified earlier as a future research direction.*

As reported earlier, the majority of studies, whether analytical or empirical, involve developing a framework conceptually and then testing it in an organizational context through empirical study. In majority of these studies, the constructs, models or algorithms were theoretically developed with little input from practice. Thus, *we need mixed methods to thoroughly analyse and investigate sustainable aspects of the product life cycle across the SCs. This implies designing, implementing and testing the integrated frameworks through empirical evidence, building and/or testing theory from and in practice.*

6 Conclusion

This paper reports on an extensive literature review on DST and PM associated with SSCM. After an initial presentation of narrative literature review, it is evident that PM-SSCM and DST-SSCM are two isolated fields emerging in literature with only a handful of studies on the integrated approach. On one hand, it is clearly evident from this literature that sustainability include all three dimensions, namely economic, social and environmental dimensions. Hence there is a need for PM framework incorporating all three dimensions. On the other hand, literature provides evidence of using DSTs such as LCA, equilibrium, MCDM, AHP/ANP, etc. to enable decision making in SSCM. However most of these studies are limited to solve isolated or specific problems within the supply chains. Hence more studies need to be considered to use DSTs for inter-organisational aspects of SSCM and extend it to industry system level. It also identifies the gap for more DSTs based on system dynamics and agent based simulation-modeling methods for enabling decision making in complex situations.

While researchers have predominantly focused on developing integrated framework to tackle sustainability issues, there is dearth of literature relating to issues in the implementation of such frameworks: practical difficulties, ease and usefulness of implementing integrated frameworks, resistance from people or businesses in implementing such frameworks, etc. Some researchers (for example Walker and Jones, 2012) argue that many organisations provide only lip service while doing very little, highlighting a gap between literature and practice. Exploring and addressing this gap has major implications for policy research, for policy makers need to identify alternative ways of making businesses implement sustainable aspects, part of which can be raising consumer awareness. SCs could also take advantage in exploring consumer behaviour aspects that has implications on reverse SCs flows and policies as well as product (re)design aspects.

In summary the literature analysis and debate uncovers some interesting issues, including the need for:

- A holistic framework for integrating DST with PM and SCM considering TBL approach
- More research on sector specific measures and indicators for all sustainability dimensions of SCM
- More DSTs for incorporating inter-organizational aspects of SSCM and enabling decision making in solving complex problems
- Exploration of issues related to the implementation of the integrated approach for SSCM, e.g. difficulties, its usefulness and the implications for policy research
- More research focusing on implementing holistic frameworks and learning from industry/practice through inductive, exploratory and longitudinal studies
- More research on methods and approaches that could be adopted from other disciplines such as conjoint analysis and discrete choice experiments

The points listed above constitute a base for addressing future research on DST and PM for SSCM. However, there is a need to develop a detailed research agenda for each of these topics. As can be seen, the SSCM field has grown fast with increasing recognition from various stakeholders (including governments, citizens, consumers) and hence more sector specific measures and indicators as well as practical decision-making approaches need to be implemented to fully aid decision-making in more complex and dynamic situations within sustainable supply chains.

The work presented in this paper analysed the nature and spread of available publications, citation, keywords and research methods. Although we analysed the majority of the papers, of which the authors had prior knowledge, for the narrative literature review and citation tracking, our study has certain limitations. Firstly, the database (of 384 papers) was retrieved by using specific combinations of keywords might hence have omitted some relevant papers, which did not use those specific keywords. Secondly, we were not able to access all the papers listed in the database. This study could therefore be extended by conducting a content analysis of the papers listed in our database, which is now publicly available. We contend that these limitations do not compromise the value of our work to researchers.

7 References

1. Ackali, E., Karakayali, I. and Emir-Farinas, H., 2007. An analysis of decentralized collection and processing of end-of-life products. *Journal of Operations Management*, 25 (6), 1161–1183.
2. Agrell, P. J., Stam, A., and Fischer, G. W., 2004. Interactive multi-objective agro-ecological land use planning: The Bungoma region in Kenya. *European Journal of Operational Research*, 158, 194-217.
3. Ahi, P. and Searcy, C., 2013. A Comparative Literature Analysis of Definitions of Green and Sustainable Supply Chain Management. *Journal of Cleaner Production*, 52, 329-341.
4. Akkerman, R., Farahani, P. and Grunow, M., 2010. Quality safety and sustainability in food distribution: a review of quantitative operations management approaches and challenges. *Or Spectrum*, 32 (4), 863-904.
5. An, H. J., Yang, H. S., Liu, Z. D., and Zhang, Z. Z., 2008. Effects of heating modes and sources on nanostructure of gelatinized starch molecules using atomic force microscopy. *LWT-Food Science Technology,* 41 (8), 1466–1471.
6. Ates, A., Garengo, P., Cocca, P., Bititci, U. 2013. The development of SME managerial practice for effective performance management, Journal of Small Business and Enterprise Development, 20 (1), pp. 28-54
7. Aurich, J.C., Fuchs, C., Wagenknecht, C., 2006. Life cycle oriented design of technical Product-Service Systems. *Journal of Cleaner Production*, 14 (17), 1480–1494.
8. Ayres, R.U. and Kneese, A.V., 1969. Production, consumption, and externalities. *The American Economic Review*, 59 (3), 282–297.
9. Bagchi, P. K., Ha, B. C., Skjoett-Larsen, T. and Soerensen, L. B., 2005. Supply chain integration: a European survey. *The International Journal of Logistics Management*, 16 (2), 275 – 294.
10. Bai, C., & Sarkis, J., 2010. Integrating sustainability into supplier selection with grey system and rough set methodologies. *International Journal of Production Economics*, 124(1), 252–264.
11. Bai, C., Sarkis, J., Wei, X. and Koh, L., 2012. Evaluating ecological sustainable performance measures for supply chain management. *Supply Chain Management: An International Journal*, 17 (1), 78-92.
12. Beamon, B.M., 1999. Designing the green supply chain. *Logistics Information Management*, 12 (4), 332-342.
13. Bebbington, J., Brown, J. and Frame, B., 2007. Accounting Technologies and Sustainability Assessment Models. *Ecological Economics*, 61 (2-3), 224-236.
14. Berrah, L. and Clivillé, V., 2007. Towards an aggregation performance measurement system model in a supply chain context. *Computers in Industry*, 58 (7), 709-719.
15. Bhagwat, R., Sharma, M.K., 2007. Performance measurement of supply chain management: a balanced scorecard approach. *Computers & Industrial Engineering*, 53 (1), 43-62.
16. Bhattacharya A, Mohapatra P., Kumar V., Dey P.K, Brady M, Tiwari M. K. and Nudurupati S., 2013. Green supply chain performance measurement using fuzzy ANP-based balanced scorecard: a collaborative decision-making approach. *Production Planning & Control*: SI - The Management of Operations, DOI:10.1080/09537287.2013.798088.
17. Bititci U., Garengo P., Dörfler V. Nudurupati S., 2012. Performance Measurement: Challenges for Tomorrow. *International Journal of Management Reviews*, 14 (3), 305.
18. Bjorklund, M., Martinsen, U. and Abrahamsson, M., 2012. Performance measurements in the greening of supply chains. *Supply Chain Management: An International Journal*, 17 (1), 29–39.
19. Bonacchi, M. and Rinaldi, L., 2007. DartBoards and Clovers as New Tools in Sustainability Planning and Control. *Business Strategy and the Environment*, 16 (7), 461-473.
20. Borgatti, S.P., Everett, M.G. and Freeman, L.C., 2002. *Ucinet for Windows: Software for Social Network Analysis*. MA: Analytic Technologies, Harvard.

21. Brandenburg, M., Govindan, K., Sarkis, J., Seuring, S., 2013. Quantitative models for sustainable supply chain management: developments and directions. *European Journal of Operational Research*, doi:http://dx.doi.org/10.1016/j.ejor.2013.09.032.
22. Bruzzone, A.A.G., Anghinolfi, D., Paolucci, M. and Tonelli, F., 2012. Energy-aware scheduling for improving manufacturing process sustainability: A mathematical model for flexible flow shops. *CIRP Annals - Manufacturing Technology*, 61 (1), 459-462.
23. Burgess, K., Singh, P.J., Koroglu, R., 2006. Supply chain management: a structured literature review and implications for future research. *International Journal of Operations & Production Management*, 26 (7), 703-729.
24. Burgess, T., Ong, T.S. and Shaw, N., 2007. Traditional or Contemporary? The Prevalence of Performance Measurement System Types. *International Journal of Productivity and Performance Management*, 56 (7), 583-602.
25. Cagnazzo, L., Taticchi, P., Brun, A., 2009. The Role of Performance Measurement Systems to Support Quality Improvement Initiatives at Supply Chain Level. *The International Journal of Productivity and Performance Management*, 59 (2), 163-185.
26. Cannon, M., Kouvaritakis, B. and Huang, G., 2005. Modelling and optimisation for sustainable development policy assessment. *European Journal of Operational Research*, 164 (2), 475–490.
27. Carbon Disclosure Project (CDP), 2013. Collaboration delivers targets and mutually beneficial energy savings. available at: https://www.cdproject.net/en-US/WhatWeDo/Pages/Case-Study-Dell.aspx (accessed 4 March 2013).
28. Carter, C.R. and Easton, P.L., 2011. Sustainable supply chain management: evolution and future directions. *International Journal of Physical Distribution & Logistics Management*, 41 (1), 46-62.
29. Carter, C.R. and Rogers, D.S., 2008. A framework of sustainable supply chain management: moving toward new theory. *International Journal of Physical Distribution & Logistics Management*, 38 (5), 360-387.
30. Chaabane, A., Ramudhin, A. and Paquet, M., 2012. Design of sustainable supply chains under the emission trading scheme. *International Journal of Production Economics*, 135 (1), 37-49.
31. Chan, F. T. S.,Kumar,N., Tiwari,M.K., Lau, H. C. W. and Choy,K. L., 2008. Global supplier selection: A fuzzy-AHP approach. *International Journal of Production Research*, 46, 3825–3857.
32. Chan, F.T.S. and Qi, H.J., 2003. An innovative performance measurement method for supply chain management. *Supply Chain Management: An International Journal*, 8 (3), 209-223.
33. Chan, F.T.S., Qi, H.J., Chan, H.K., Lau, H.C.W. and Ip, R.W.L., 2003. A conceptual model of performance measurement for supply chains. *Management Decision*, 41 (7), 635-642.
34. Che, Z.H., 2010. Using fuzzy analytic hierarchy process and particle swarm optimisation for balanced and defective supply chain problems considering WEEE/RoHS directives. *International Journal of Production Research*, 48 (11), 3355–3381.
35. Corbett, C.J. and Kleindorfer, P.R., 2003. Environmental management and operations management: introduction to the third special issue. *Production and Operations Management*, 12 (3), 287–289.
36. Coughlan, P. and Coghlan D., 2002. Action research for operations management. *International Journal of Operations & Production Management*, 22 (2), 220 – 240.
37. Cruz, J.M., 2008. Dynamics of supply chain networks with corporate social responsibility through integrated environmental decision-making. *European Journal of Operational Research*, 184 (3), 1005–1031.
38. Cucek, L., Klemes, Jiri, J. and Kravanja, Z., 2012. A review of footprint analysis tools for monitoring impacts on sustainability. *Journal of Cleaner Production*, 34, 9-20.
39. Dahlsrud, A., 2008. How Corporate Social Responsibility Is Defined: An Analysis of 37 Definitions. *Corporate Social Responsibility and Environmental Management* 15 (1), 1-13.

40. Dey, P. K. and Cheffi, W., 2012. Green Supply Chain Performance Measurement using the Analytic Hierarchy Process: A Comparative Analysis of Manufacturing Organisations. *Production Planning & Control*: The Management of Operations, 24 (8-9), 702-720, doi: 10.1080/09537287.2013.798088.
41. Dey, P.K. and Cheffi W., 2013. Managing supply chain integration: contemporary approaches and scope for further research. *Production Planning & Control*: The Management of Operations, 24 (8-9).
42. Dou, Y. and Sarkis, J., 2010. A joint location and outsourcing sustainability analysis for a strategic offshoring decision. *International Journal of Production Research*, 48 (2), 567–592.
43. Easterby-Smith, M., Thorpe, R. and Lowe, A., 2002. *Management Research: an Introduction*. London: Sage Publications.
44. Eccles, R.G. and Krzus, M.P., 2010. *One Report: Integrated Reporting for a Sustainable Strategy*. John Wiley & Sons, Inc., Hoboken, New Jersey.
45. Epstein, M.J., 2008. *Making Sustainability Work*, Greenleaf Publishing Limited. Sheffield, UK.
46. Ehrenfeld, J.R., 2001. *Sustainability by Design: A Subversive Strategy for Transforming Our Consumer Culture*, Yale University Press, New Haven.
47. Feng, S., Li, L. X., Duan, Z. G., and Zhang, J. L., 2007. Assessing the impacts of South-to-North water transfer project with decision support systems. *Decision Support Systems*, 42, 1989-2003.
48. Fleischmann, M., Bloemhof-Ruwaard, J.M., Dekker, R., Van Der Laan, E., Van Nunen, J.A.E.E., Van Wassenhove, L.N., 1997. Quantitative models for reverse logistics: a review. *European Journal of Operational Research*, 103 (1), 1–17.
49. Frota Neto, J.Q., Walther, G., Bloemhof, J., Van Nunen, J. and Spengler, T., 2010. From closed-loop to sustainable supply chains: the WEEE case. *International Journal of Production Research*, 48 (15), 4463–4481.
50. Garengo, P., Biazzo, S. and Bititci, U.S., 2005. Performance measurement systems in SMEs: a review for a research agenda. *International Journal of Management Reviews*, 7 (1), 25–47.
51. Gavronski, I., Klassen, R.D., Vachon, S. and do Nascimento, L.F.M., 2011. A resource-based view of green supply management. *Transportation Research Part E: Logistics and Transportation Review*, 47 (6), 872-885
52. Georgopoulou, E., Sarafidis, Y., and Diakoulaki, D., 1998. Design and implementation of a group DSS for sustaining renewable exploitation. *European Journal of Operational Research*, 109, 483-500.
53. Global Reporting Initiative (GRI), 2013. Reporting Framework Overview. available at: www.globalreporting.org/reporting/reporting-framework-overview/Pages/default.aspx (accessed 23 February 2013).
54. Gold, S., Seuring, S., and Beske, P., 2010a. The constructs of sustainable supply chain management – a content analysis based on published case studies. *Progress in Industrial Ecology – An International Journal*, 7 (2), 114-137.
55. Gold, S., Seuring, S., and Beske, P., 2010b. Sustainable supply chain management and interorganizational resources: a literature review. *Corporate Social Responsibility and Environmental Management*, 17, 230-245.
56. Golicic, S. L., and Smith, C. D., 2013. A meta-analysis of environmentally sustainable supply chain management practices and firm performance. *Journal of Supply Chain Management*, 49 (2), 78-95.
57. Guide Jr., V.D.R., Jayaraman, V. and Srivastava, R., 1999. Production planning and control for remanufacturing: A state-of-the-art-survey. *Robotics and Computer-Integrated Manufacturing*, 15 (3), 221-230.
58. Guide Jr., V.D.R., Jayaraman, V., Srivastava, R. and Benton, W.C., 2000. Supply Chain Management for recoverable manufacturing systems. *Interfaces*, 30 (3), 125-142.
59. Guide, V. D. R., Jr. and Van Wassenhove, L. N., 2002. The reverse supply chain. *Harvard Business Review*, 80 (2), 25-26.
60. Gunasekaran, A., Patel, C. and Tirtiroglu, E., 2001. Performance measures and metrics in a supply chain environment. *International Journal of Operations & Production Management*, 21 (1-2), 71.

61. Gunasekaran, A. and Kobu, B., 2007. Performance measures and metrics in logistics and supply chain management: a review of recent literature (1995-2004) for research and applications. *International Journal of Production Research*, 45 (12), 2819-40.
62. Gunasekaran, A., Parel, C. and Mc Gaughey, R.E., 2004. A framework for supply chain performance measurement. *International Journal of Production Economics*, 87 (3), 333-347.
63. Gungor, A. and Gupta, S., 1999. Issues in environmentally conscious manufacturing and product recovery: a survey. *Computers and Industrial Engineering*, 36 (4), 811-853.
64. Hadiguna, R.A., 2012. Decision support framework for risk assessment of sustainable supply chain. *International Journal of Logistics Economics and Globalisation*, 4 (1–2), 35-54.
65. Hassini, E., Surti, C. and Searcy, C., 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.
66. Hitchcock, T., 2012. Low carbon and green supply chains: the legal drivers and commercial pressures. *Supply Chain Management: An International Journal*, 17 (1), 98 – 101.
67. International Federation of Accountants (IFAC), 2013. IFAC Sustainability Framework 2.0. available at: http://www.ifac.org/publications-resources/ifac-sustainability-framework-20 (Accessed: 23 February 2013).
68. Ji, G., 2008. Performance evaluation of complaint management and virtual enterprise in closed-loop supply chains by using exergoeconomics and extenics: *International Journal of Services and Operations Management*, 4 (3), 368–397.
69. Jovane, F., Westkamper, E., Williams, D., 2009. *The ManuFuture Road: Towards Competitive and Sustainable High-Adding-Value Manufacturing*. Springer, Berlin.
70. Kannegiesser, M., and Günther, H.O., 2013. Sustainable development of global supply chains—part 1: sustainability optimization framework. *Flexible Services and Manufacturing Journal*, doi: 10.1007/s10696-013-9176-5.
71. Kaplan, R. and Norton, D., 1996. Using the Balanced Scorecard as a strategic management system. *Harvard Business Review*, January - February, 75–85.
72. Keating, B., Quazi, A., Kriz, A. and Coltman, T., 2008. In pursuit of a sustainable supply chain: insights from Westpac Banking Corporation. *Supply Chain Management: An International Journal*, 13 (3), 175-179.
73. Keen, P., 1980. *Decision support systems: a research perspective*. Cambridge, Mass.: Center for Information Systems Research, Afred P. Sloan School of Management.
74. Kim, H., Kim, S. and Dale, B.E., 2009. Biofuels, land use change and greenhouse gas emissions: some unexplored variables. *Environmental Science & Technology*, 43 (3), 961-967.
75. Kim, J., Realff., M.J. and Lee, J.H., 2011. Optimal design and global sensitivity analysis of biomass supply chain networks for biofuels under uncertainty. *Computers & Chemical Engineering*, 35 (9), 1738-1751.
76. Kleindorfer, P.R., Singhal, K. and Van Wassenhove, L.N., 2005. Sustainable operations management. *Production and Operations Management*, 14 (4), 482–492.
77. Kocabasoglu, C., Prahinski, C. and Klassen, R., 2007. Linking forward and reverse supply chain investments: the role of business uncertainty. *Journal of Operations Management*, 25 (6), 1141–1160.
78. Lee, C-K., Tan, B. and Chiu, J-Z., 2008. The impact of organisational culture and learning on innovation performance. *International Journal of Innovation and Learning*, 5 (4), 413-428.
79. Lee S.Y., Klassen R.D., 2008. Drivers and enablers that foster environmental management capabilities in small- and medium-sized suppliers in supply chains. *Production and Operations Management*, 17 (6), 573–586.
80. Lehtinen, J. and Ahola, T., 2010. Is performance measurement suitable for an extended enterprise?. *International Journal of Operations and Production Management*, 30 (2), 181–204.
81. Lejeune, M.A., 2006. A variable neighborhood decomposition search method for supply chain management planning problems. *European Journal of Operational Research*, 175 (2), 959–976.

82. Linton, J.D., Klassen, R. and Jayaraman, V., 2007. Sustainable supply chains: an introduction. *Journal of Operations Management*, 25 (6), 1075–1082.
83. Liu, S., Leat, M.,Smith, M.H., 2011. State-of-the-art sustainability analysis methodologies for efficient decision support in green production operations. *International Journal of Sustainable Engineering*, 4 (3), 236-250.
84. Liu, S., Wang, Z. and Liu, L., 2012. An integrated sustainability analysis approach to support holistic decision making in sustainable supply chain management. *Frontiers in Artificial Intelligence and Applications*, 238, 391-402.
85. Lovric, M., Li, T. and Vervest, P., 2013. Sustainable revenue management: A smart card enabled agent-based modeling approach. *Decision Support Systems*, 54 (4), 1587-1601.
86. Lu, L.Y.Y., Wu, C.H., Kuo, T.C., 2007. Environmental principles applicable to green supplier evaluation by using multi-objective decision analysis. *International Journal of Production Research*, 45 (18-19), 4317-4331.
87. Manzini, E.and Vezzoli, C., 2003. A strategic design approach to develop sustainable product service systems: examples taken from the 'environmentally friendly innovation' Italian prize. *Journal of Cleaner Production*, 11 (8), 851–857.
88. Matos, S. and Hall, J., 2007. Integrating sustainable development in the supply chain: the case of life cycle assessment in oil & gas and agricultural biotechnology. *Journal of Operations Management*, 25 (6), 1083–1102.
89. Mazhar, M.I., Kara, S. and Kaebernick, H., 2007. Remaining life estimation of used components in consumer products: life cycle data analysis by Weibull and artificial neural networks. *Journal of Operations Management*, 25 (6), 1184–1193.
90. McAloone, T. C. and Andreasen, M. M., 2004. *Design for utility, sustainability and societal virtues: Developing Product Service Systems*. International Design Conference - Design 2004, Dubrovnik.
91. McIntyre, K., Smith, H.A., Henham, A. and Pretlove, J., 1998. Environmental performance indicators for integrated supply chains: the case of Xerox Ltd'. *Supply Chain Management: An International Journal*, 3 (3), 149-156.
92. Milne, M. J., 1996. On sustainability; the environment and management accounting. *Management Accounting Research*, 7 (1), 135-161.
93. Mollenkopf, D., Stolze, H., Tate, W. and Ueltschy, M., 2010. Gree, lean, and global supply chains. *International Journal of Physical Distribution & Logistics Management*, 40 (1-2), 14-41.
94. Mont, O., 2001. *Introducing and developing a Product-Service System (PSS) concept in Sweden*. IIIEE Reports 2001:6, Lund University, Sweden.
95. Morelli, N., 2009. Service as value co-production: reframing the service design process. *Journal of Manufacturing Technology Management*, 20 (5), 568-590.
96. Munda, G., 2009. A conflict analysis approach for illuminating distributional issues in sustainability policy. *European Journal of Operational Research*, 194 (1), 307–322.
97. Neely, A., 2005. The evolution of performance measurement research: development in the last decade and a research agenda for the next. *International Journal of Operations & Production Management*, 25 (2), 1264-1277.
98. Neely, A., Gregory, M., Platts, K., 1995. Performance measurement system design: A literature review and research agenda. *International Journal of Operations & Production Management*, 15 (4), 80-116.
99. Nudurupati, S. S., Bititci U.S., Kumar V. and Chan F.T.S., 2011. State of the art literature review on performance measurement. *Computers & Industrial Engineering*, 60 (2), 279-290.
100. Perrini, F. and Tencati, A., 2006. Sustainability and stakeholder management: the need for new corporate performance evaluation and reporting systems. *Business Strategy and the Environment*, 15 (5), 296-308.
101. Pilkington, A. and Liston-Heyes, C., 1999. Is production and operations management a discipline? A citation/co-citation study. *International Journal of Operations & Production Management*, 19 (1), 7-20.

102. Power, D. J., 2002. *Decision support systems: concepts and resources for managers*. Westport, Conn., Quorum Books.
103. Ramirez, M., 2007. *Sustainability Integration in Industrial Design Education: a world wide survey*. Connected 2007, International Conference on Design Education, University of New South Wales.
104. Rao, P. and Holt, D., 2005. Do green supply chains lead to competitiveness and economic performance? *International Journal of Operations & Production Management*, 25 (9), 898-916.
105. Ravi, R., McStravick, P., Bingham, B., Rowan, L. and Loynd, L., 2006. Worldwide and US business process outsourcing 2006-2010 forecast: market opportunities by horizontal business process. Available at: www.idc.com
106. Roy, R., 2000. Sustainable product-service systems. *Futures*, 32 (3–4), 289–299.
107. Sakao, T., Sandström, G. Ö., Matzen, D., 2009. Framing research for service orientation of manufacturers through PSS approaches. *Journal of Manufacturing Technology Management,* 20 (5), 754 – 778.
108. Schildt, H.A., 2002. *SITKIS: Software for Bibliometric Data Management and Analysis*, Helsinki Institute of Strategy and International Business, available at http://users.tkk.fi/~hschildt/sitkis/.
109. Schildt, H.A., Zahra, S.A. and Sillanpää, A., 2006. Scholarly Communities in Entrepreneurship Research: A Co-Citation Analysis, *Entrepreneurship Theory and Practice*, 30 (3), 399-416.
110. Seuring, S., 2013. A review of modeling approaches for sustainable supply chain management. *Decision Support Systems*, 54 (4), 1513-1520.
111. Seuring, S. and Muller, M., 2008. From a literature review to a conceptual framework for sustainable supply chain management. *Journal of Cleaner Production*, 16 (15), 1699–1710.
112. Sharma, M.K., Bhagwat, R. and Dangayach, G.S., 2005. Practice of performance measurement: experience from Indian SMEs. *International Journal of Globalisation and Small Business*, 1 (2), 183-213.
113. Shepherd, C. and Gunter, H., 2005. Measuring supply chain performance: current research and future directions, *International Journal of Productivity and Performance Management*, 55 (3-4), 242-258.
114. Shi, Q., Zuo, J. and Zillante, G., 2012. Exploring the management of sustainable construction at the programme level – a Chinese case study. *Construction Management and Economics*, 30 (6), 425–440
115. Sprague, R., 1980. A framework for the development of decision support systems. *Journal MIS Quarterly*, 4 (4), 1-26.
116. Srivastava, S.K., 2008. Network design for reverse logistics. *Omega*, 36 (4), 535–548.
117. Tan, R.B.H., Khoo, H.H., 2005. An LCA study of primary aluminium supply chain. *Journal of Cleaner Production*, 13, 607–618.
118. Tang, C. S., and Zhou, S., 2012. Research advances in environmentally and socially sustainable operations. *European Journal of Operational Research*, 223, 585-594.
119. Taticchi, P., Cagnazzo, L. and Tonelli, F., 2010. Performance measurement and management: a literature review and a research agenda. *Measuring Business Excellence*, 14 (1), 4-18.
120. Taticchi, P., Cagnazzo, L., Barber, K. and Beach, R., 2012. A Management Framework for Organisational Networks: a Case Study. *Journal of Manufacturing Technology Management*, 23 (5), 593-614.
121. Taticchi, P., Tonelli, F. and Cagnazzo, L., 2009. A Decomposition and Hierarchical Approach for Business Performance Measurement and Management. *Measuring Business Excellence*, 13 (4), 47-57.
122. Taticchi, P., Tonelli, F. and Pasqualino, R., 2013. Performance measurement of sustainable supply chains. A literature review and a research agenda. *International Journal of Productivity and Performance Management*, 62 (8), 782-804.
123. Tonelli, F., Evans, S. and Taticchi, P., 2013. Industrial sustainability: challenges, perspectives, actions. *International Journal of Business Innovation Research*, 7 (2), 143-163.

124. Tranfield, D., Denyer, D. and Smart, P., 2003. Towards a Methodology for Developing Evidence-Informed Management Knowledge by Means of Systematic Review. *British Journal of Management*, 14, 207–222.
125. Tsai, W.H. and Hung, S.J., 2009. A fuzzy goal programming approach for green supply chain optimisation under activity-based costing and performance evaluation with a value-chain structure. *International Journal of Production Research*, 47 (18), 4991–5017.
126. Tsoulfas, G.T., and Pappis. C. P, 2008. A model for supply chains environmental performance analysis and decision making. *Journal of Cleaner Production*, 16 (15), 1647–1657.
127. Ukidwe, N.U. and Bakshi, B.R., 2004. Thermodynamic accounting of ecosystem contribution to economic sectors with application to 1992 US economy. *Environmental Science & Technology*, 38 (18), 4810-4827.
128. Vachon, S. and Klassen, R.D., 2006. Extending green practices across the supply chain – The impact of upstream and downstream integration. *International Journal of Operations & Production Management*, 26 (7), 795-821.
129. Vachon, S. and Klassen, R.D., 2008. Environmental management and manufacturing performance: The role of collaboration in the supply chain. *International Journal of Production Economics*, 111 (2), 299-315.
130. Van Der Vorst, J.G.A.J., Tromp, S.O. and Van Der Zee, D.J., 2009. Simulation modelling for food supply chain redesign; integrated decision making on product quality, sustainability and logistics. *International Journal of Production Research*, 47 (23), 6611-6631.
131. Van der Woerd, F. and Van den Brink, T., 2004. Feasibility of a Responsive Business Scorecard - a Pilot Study. *Journal of Business Ethics*, 55 (2), 173-186.
132. Verma, R. and Pullman, M. E., 1998. An Analysis of the Supplier Selection Process. Omega *International Journal of Management Science*, 26 (6), 739-750
133. Vlachos, D., Georgiadis, P. and Iakovou, E., 2007. A system dynamics model for dynamic capacity planning of remanufacturing in closed-loop supply chains. *Computers and Operations Research*, 34 (2), 367–394.
134. Wacker, J.G., 1998. A definition of theory: research guidelines for different theory-building research methods in operations management. *Journal of Operations Management*, 16, 361-85.
135. Walker, H. and Jones, N., 2012. Sustainable supply chain management across the UK private sector, *Supply Chain Management: An International Journal*, 17 (1), 15 – 28.
136. Wang, F.K., Du, T.C. and Li, E.Y., 2004. Applying six-sigma to supplier development. *Total Quality Management & Business Excellence*, 15 (9-10), 1217-29.
137. Wang, H.F. and Hsu, H.W., 2010. A closed-loop logistic model with a spanning-tree based genetic algorithm. *Computers and Operations Research*, 37 (2), 376-389.
138. Wasserman, S. and Faust, K., 1994. *Social Network Analysis*, Cambridge University Press, Cambridge.
139. Webster, S. and Mitra, S., 2007. Competitive strategy and the impact of take-back laws. *Journal of Operations Management*, 25 (6), 1123– 1140.
140. Weick, K.E., 1995. What Theory Is Not, Theorizing Is. *Administrative Science Quarterly*, 40 (3), 385-390.
141. Wu, H. Y., Tzeng, G. H., & Chen, Y. H., 2009. A fuzzy MCDM approach for evaluating banking performance based on balanced scorecard. *Expert Systems with Applications*, 36, 10135–10147.
142. Yakovleva, N., Sarkis, J., and Sloan, T., 2011. Sustainable benchmarking of supply chains: the case of the food industry. *International Journal of Production Research*, doi: 10.1080/00207543.2011.571926.
143. Zhu, Q,H., Sarkis, J. and Geng, Y., 2005. Green supply chain management in China: Pressures, practices and performance. *International Journal of Operations & Production Management*, 25 (5-6), 449-468.

144. Zhu, Q,H., Sarkis, J. and Lai, K., 2007. Green supply chain management pressures, practices and performance within the Chinese automobile industry. *Journal of Cleaner Production*, 15 (11-12), 1041-1052.