Benchmarking: An International Journal

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Received 14 April 2015
Revised 23 November 2015
Accepted 2 December 2015

Connecting the pieces of the puzzle toward sustainable organizations

A framework integrating OM principles with GSCM

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Abstract

Purpose – The purpose of this paper is to propose a framework integrating the Hart and Milstein (2003) strategies for organizational sustainable development (SD) with the ideas of Kleindorfer *et al.* (2005) on sustainable operations management (SOM), which requires guidance of green supply chain management (GSCM).

Design/methodology/approach – The construction of the framework was based on previous studies that discussed synergies between operations management principles with environmental bias and studies on adoption of GSCM practices.

Findings – The proposed framework guides managers to reconcile operations management practices/principles that are already being implemented in organizations with an environmental perspective because these practices sustain organizations to simultaneously reach SOM and SD.

Originality/value – The paper presents a framework that provides guidance on how organizations can seek sustainability in their operations, considering that articles on the topic of sustainability have not been developed with this specific focus.

Keywords Sustainable development, Operations management, Sustainable operations, Green supply chain management

Paper type Conceptual paper

1. Introduction

Operations management has evolved in recent years due to changes in market requirements and competitiveness including an increase in environmental awareness, causing industries to rethink their productivity and quality strategies (Gunasekaran and Ngai, 2012). Natural environmental management requires strategic integration with business processes and other company functions in order to maintain consistency between operational strategic planning and environmental planning (Wagner, 2007).

Benchmarking: An International Journal
Vol. 23 No. 6, 2016
pp. 1605-1623

1463-5771
DOI 10.1108/BIJ-04-2015-0033

Therefore, the concept of sustainable operations management (SOM) has gained prominence in the last decade (Gunasekaran and Irani, 2014).

SOM can be defined as strategies, actions and techniques that support operational policies to achieve economic and environmental objectives simultaneously (Gunasekaran *et al.*, 2014).

Hart and Milstein (2003) proposed a framework whose purpose was to present how organizations could pursue the creation of sustainable value for shareholders and hence contribute to sustainable development (SD). Hart and Milstein's (2003) article has about 300 citations in Scopus (through October 2015), and articles that cited it have not yet explored the framework proposed by the authors through the lens of SOM (i.e. as principles of operations management can contribute to the implementation of the strategies suggested by Hart and Milstein, 2003 to reach SD). Therefore, the absence of that perspective tends to be a research opportunity in terms of integration proposals between the topics of sustainability and operations management. Such an argument was confirmed by Dubey *et al.* (2015), who claimed that there is an urgent need for an integrated framework for sustainable manufacturing; Westkämper (2008) outlined that systems, such as total quality management (TQM), total productive maintenance (TPM), and just in time (JIT), have significant impacts on sustainable manufacturing implementation. Additionally, Despeisse *et al.* (2012) claimed that the translation of sustainable manufacturing principles into an operational activity is a blind spot.

Considering the findings of Dubey *et al.* (2015), Despeisse *et al.* (2012) and Westkämper (2008), it is believed that Kleindorfer *et al.*'s (2005) proposal can be integrated into the framework of Hart and Milstein (2003) in order to propose a framework to present how organizations can contribute to SD through operations management principles. Kleindorfer *et al.* (2005) offered a framework which suggested strategies/actions to achieve sustainable operations. These authors have been cited more than 360 times in Scopus (through October 2015), and the ideas put forward by them in that framework have not yet been explored in scientific research.

Some articles were identified in discussing ways to SOM (Sangwan and Mittal, 2015; Subramanian and Gunasekaran, 2015; Dubey *et al.*, 2015; Srai *et al.*, 2013; Despeisse *et al.*, 2013; Mani *et al.*, 2014), but none considered the ideas disseminated by Hart and Milstein (2003) and Kleindorfer *et al.* (2005).

Therefore, the purpose of this paper is to propose a framework integrating Hart and Milstein's (2003) strategies to organizational SD with the ideas of Kleindorfer *et al.* (2005) on SOM, which requires guidance of green supply chain management (GSCM). The proposed framework will guide managers to combine operations management practices that are already being implemented in organizations with an environmental perspective for these practices to sustain organizations to simultaneously reach SOM and SD.

Thus, the framework introduced in this paper provides a starting point for discussing the synergies between principles of operations management and GSCM. It addresses the support of lean/JIT, TQM, theory of constraints (TOC), Six Sigma principles and GSCM practices for organizational adoption to achieve levels of excellence in sustainability.

The following section of this paper presents how the framework proposed was developed (Section 2); Section 3 discusses some recent research regarding SOM; Section 4 provides an overview of lean/JIT, TQM, TOC and Six Sigma principles and their potential contributions to environmental sustainability and GSCM.

In Section 5, the proposed conceptual framework is introduced. Finally, in Section 6, final remarks are presented concerning the applicability of the framework and suggestions for future studies.

2. Methodology

This paper aims to propose an integrative framework between SOM and SD with the support of GSCM. Articles that support this proposition are Hart and Milstein (2003) and Kleindorfer *et al.* (2005). These two articles were selected because they are relevant in their areas of expertise (sustainability and operations). The main foundations of these two articles are presented.

Hart and Milstein (2003) proposed a framework whose purpose was to present how organizations could pursue the creation of sustainable value for shareholders. Some strategies were suggested for organizations that could contribute to SD. The strategies suggested were pollution prevention, product stewardship, cleaner technologies, and vision of sustainability. The framework can be used by organizations as a diagnostic tool and for identifying opportunities to develop capabilities for achieving sustainable value and thus new markets. The framework was based on four quadrants: today and tomorrow internal and today and tomorrow external.

Kleindorfer *et al.* (2005) alluded to the proposal by Hayes and Wheelwright (1984) regarding the four stage model for evaluating the role and contribution of the production function in a company's competitive advantage. They proposed four strategies: internal present, external present, internal to the future, and external to the future. These strategies generally suggest actions that organizations can follow in order to improve environmental aspects of their operations. Those authors believed that supply chains could be involved for external strategies.

Figure 1 shows summarized main ideas using Kleindorfer *et al.* (2005) and Hart and Milstein's (2003) proposals. Figure 1 shows Kleindorfer *et al.*'s (2005) ideas in the squares and Hart and Milstein's (2003) strategies for organizational SD in the pentagons. It can identify alignment between the strategies of Hart and Milstein (2003) and the actions of Kleindorfer *et al.* (2005); however, it did not identify articles that integrated the two proposals and nor articles that proposed how organizations can pursue the SD by SOM in the literature. Therefore, this paper may be justified because

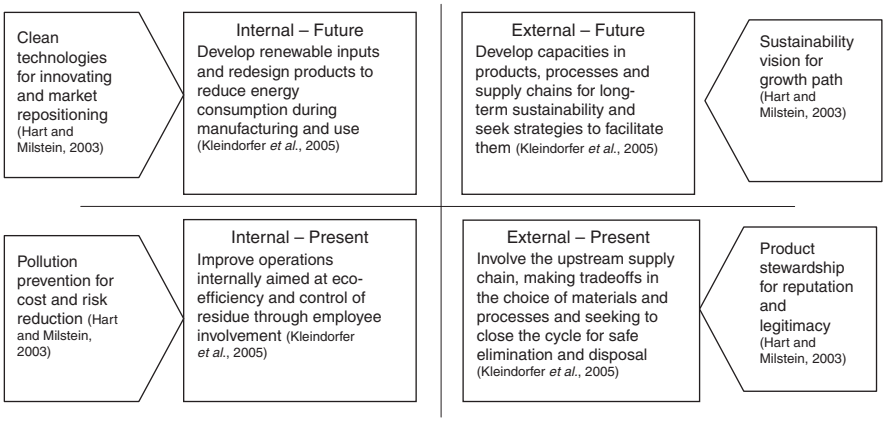


Figure 1. Summarized main ideas using Kleindorfer *et al.* (2005) and Hart and Milstein (2003)

it proposes a framework explaining how principles of operations management and GSCM practices can support the actions suggested by Kleindorfer *et al.* (2005) and hence enable the strategies suggested by Hart and Milstein (2003).

The main principles of operations management, that literature has been considered important to organizational environmental improvement, were selected according to MacCarthy *et al.* (2013) in order to support the actions suggested by Kleindorfer *et al.* (2005). Examples include lean/JIT, TQM, TOC and Six Sigma. Some of the relationships have been pondered such as synergies between lean and green (King and Lenox, 2001; Duarte and Cruz-Machado, 2013; Dües *et al.*, 2013); lean, green and supply chains (Azevedo *et al.*, 2012; Hajmohammad *et al.*, 2012); TQM, supply chain and green (Corbett and Klassen, 2006); TQM, lean and GSCM (Zhu and Sarkis, 2004); lean and sustainable operations (Piercy and Rich, 2015; Wong and Wong, 2014); and green, lean and Six Sigma (Garza-Reyes, 2015). However, there are no articles that simultaneously integrated lean, TQM, Six Sigma, TOC and GSCM.

3. SOM

SOM can be defined as strategies, actions and techniques that support operational policies to achieve economic and environmental objectives simultaneously (Gunasekaran *et al.*, 2014). The concept of SOM has gained prominence in the last decade (Gunasekaran and Irani, 2014).

Some articles that discuss SOM (Table I) were identified. Despeisse *et al.* (2013) and Mani *et al.* (2014) used the perspective of the input/transformation/output model to propose approaches or methodologies to measure or guide the search for sustainable manufacturing. Sangwan and Mittal (2015), Subramanian and Gunasekaran (2015) and Srai *et al.* (2013) considered product lifecycle stages or processes of a supply chain to suggest sustainable manufacturing practices. Dubey *et al.* (2015) considered a set of dimensions – which were institutional pressure, relationship with suppliers, remanufacturing system, and manufacturing strategy – to suggest a model for the adoption of sustainable manufacturing by organizations. These last authors were the one who held principles of operations management in sustainable manufacture's discussion.

Therefore, few articles analyzed the support of principles of operations management with GSCM in an integrated manner to seek a sustainable manufacturing or the organizational SD.

4. Greening operations management principles and green supply chain

Operations management influences environmental improvement through alterations in production processes and by taking into account the systemic logic of production systems (Corbett and Klassen, 2006). Operations management principles and philosophies such as JIT, TQM, TOC, Six Sigma and lean manufacturing can be adapted to support environmental management systems and improvements (MacCarthy *et al.*, 2013). Each of the major operations management principles and philosophies identified for this paper are now overviewed. Their general relationship to general corporate greening and environmental sustainability is also discussed.

4.1 Lean manufacturing, JIT and green issues

Historically, lean principles have been defined as the minimization of waste in processes and products during the manufacturing of a good or service. Its definition

Author(s)	Purpose of article	Framework proposed	Research methodology
Sangwan and Mittal (2015)	Identify frameworks from literature to discuss green manufacturing	Eight frameworks were selected, which were based on lifecycle products	Literature review
Subramanian and Gunasekaran (2015)	The study systematically reviewed articles to identify innovations in products, processes, and technology that lead to clean SCM	Some tables that systematized the extent of cleaner practices have been associated with supply chain management	Theoretical
Dubey *et al.* (2015)	Define a model for adoption through sustainable manufacturing enterprises	The model was based on some dimensions: institutional pressure, relationship with suppliers, remanufacturing system, and manufacturing strategy	Survey
Mani *et al.* (2014)	Propose a methodology to measure aspects of sustainability in manufacturing processes	Methodology included various information of a system input/ transformation/output	Theoretical
Despeisse *et al.* (2013)	Guidance for identifying inefficiencies and improvement opportunities for resource-efficient manufacturing	A workflow that considers aspects of building and facilities that can support manufacturing operations	Modeling and simulation
Srai *et al.* (2013)	Proposes a process maturity, model-based alternative to supply networks' carbon-measurement approaches, namely the systematic review of organizational routines and practices relevant to sustainable manufacturing	The framework proposed enables a systematic analysis and assessment of practices that support sustainable operations	Case studies

Table I.
Some recent studies about SOM

and operationalization has had a significant focus on inventory reduction and zero-inventory philosophies, parts of which include the JIT philosophy.

Some have argued that lean is green and aids in the greening of operations within an organization and across the supply chain (Dhingra *et al.*, 2014). The lean and green discussion can be traced back to at least the late 1980s and early 1990s when the issues of relating manufacturing strategy and environmental concerns in organizations were evolving (Sarkis, 1995). In 2003, a US Environmental Protection Agency (EPA) report examined the relationship between lean and the environment and identified opportunities for further enhancing organizations' environmental performance through their lean initiatives. Some key findings of the report included the following:

- Lean manufacturing and processes produce an operational and cultural environment that is conducive to waste minimization and pollution prevention. Lean typically results in less material use, less scrap, reduced water and energy use and decreased number and amount of chemicals used in operations.
- Lean manufacturing and processes can be leveraged to produce greater environmental improvement. Through its continual, improvement-based, waste elimination culture, lean methods do not explicitly incorporate environmental

performance considerations. The philosophy provides a platform for broadening companies' definition of "waste" to address environmental risk and product lifecycle considerations.

- Some regulatory issues can be encountered when applying lean manufacturing to environmentally sensitive processes. Lean manufacturing can be challenging to use in environmentally sensitive manufacturing processes such as painting and coating. Some lean practitioners believe this situation results in either constraining environmental performance improvements or increasing the risk of non-compliance.
- There is a strong and growing network of organizations promoting lean manufacturing. These organizations share a goal of promoting environmental improvement and pollution prevention.

A managerial tradeoff or conflict between lean and green relates to the operational vs strategic focus of these principles (Mollenkopf *et al.*, 2010). Organizations tend to focus on shorter-term efficiencies and initiatives with respect to lean practices and philosophies while greening is viewed in a longer-term perspective. Thus, organizations seeking lean implementation tended to seek quicker payback and returns, especially when compared to green initiatives.

Practically, as exemplified by the EPA's characterizations, lean and green can work together by minimizing solid waste or people's time and effort. This lean aspect can work in consort with organizational greening. The other aspect of lean operations is the effort to have smaller lot sizes of material. This type of practice would require more frequent deliveries and setups of equipment and production systems. More frequent deliveries in a lean system typically means less efficient deliveries and waste of fuel due to smaller vehicles used for delivery, which are typically less efficient on a per-unit basis. With greater setups, more material and/or energy may be used that does not add value to the product or service. These are a couple ways that lean can be less green. Additional internal setups required to maintain lessened inventory may also cause waste due to setup runs that require initial stabilization and energy use.

Alternatively, smaller inventories mean smaller space requirements and less spoilage and obsolescence waste. Less space for smaller inventories and warehousing means less energy usage, equipment, storage material and overall waste. Evaluating these tradeoffs requires data gathering, planning and analysis. Integration of these lean outcomes within a total quality environmental management (TQEM) set of practices may help to improve the lean and green relationship.

4.2 TQM and green issues

TQM is an operational strategy used by organizations to help meet customer needs and to satisfy the customer. There are numerous definitions and perspectives on TQM. In the USA, the TQM movement has been a mainstay in organizations since the early 1980s. Broader Six Sigma programs contain many of the same principles of TQM.

The TQM corporate philosophy covers a broad perspective and can incorporate a variety of tools, methodologies and organizational practices. Three major elements and numerous sub-elements of TQM can exist (Chase *et al.*, 2001). There are philosophical elements (e.g. customer-driven quality, continuous improvement, management by fact), generic tools (e.g. process flow charts, run charts, cause/effect diagrams) and traditional quality-control tools (e.g. Six Sigma, process capability, sampling plans).

Each of these TQM philosophies and tools can be applied to corporate environmental management practices, expanding it to TQEM. TQEM can work closely with eco-design, lifecycle assessment (LCA), and ISO 14000 environmental management systems.

The Global Environmental Management Initiative is an industry-run and industry-supported professional organization that put together a TQEM Primer in 1993. Within the primer, it defined four basic elements of TQEM:

(1) Customer identification: in TQEM, environmental quality is determined by customer preferences. Buyers, the local community, environmental groups, and the general public are considered external customers, while a company's employees represent the internal customer group.

(2) Continuous improvement: a company's management and employees should work systematically toward the improvement of environmental performance. Company-wide employee involvement in TQEM is a key to success.

(3) Doing the job right the first time: TQEM supports the elimination of environmental risks. Employees should seek to identify and eliminate potential environmental problems.

(4) A systems approach: it is important to design all components of the TQEM system so that they function together and support each other in achieving desired goals.

TQEM puts emphasis on source reduction and pollution prevention principles. Under this principle, source reduction is the primary means for achieving pollution prevention. Source reduction is defined as reduction in the amount of any hazardous substance, pollutant or contaminant entering any waste stream or otherwise released into the environment prior to recycling, treatment or disposal. Source reduction also refers to the use of materials, processes, or practices that reduce or eliminate the quantity and toxicity of wastes at the point of generation. By preventing waste, the need for costly treatment and disposal is decreased; that is, "an ounce of prevention is worth a pound of cure." Source reduction can be achieved by improving operating practices, training, substituting materials, and changing processes and equipment.

Another important dimension of TQEM programs includes mistake proofing (and zero defects), which can be effectively applied to pollution prevention. The concept of zero defects is a core element of TPM and TQM concepts. This concept has also driven organizations to focus on zero emissions and zero pollution programs. Thus, it deserves some mention at this time since successful programs in pollution prevention typically use this concept.

4.3 TOC and green issues

TOC is a management philosophy that aims to assist the managers regarding "what" to do and "how" to do it to improve administration and production control (Barnard, 2010; Boyd and Gupta, 2004; Goldratt, 1990; Lea and Fredendall, 2002), or in other words, it has its underpinnings in organizational theories (Gupta and Boyd, 2008) because initially it has been shown to address problems of use of resources.

Bearing in mind improvement of administration and production control, TOC focusses on the importance of the restrictive factors in a whole process or system. It seeks to optimize use of these production system constraints. Complementing this definition, TOC can be further defined as follows:

> […] a pragmatic and holistic approach to continuous improvement, covering disparate functionalities under a common theoretical foundation, and consists of an integrated suite of tools focused on those things that limit greater performance relative to the goal […] (Watson *et al.*, 2007, p. 400).

From the standpoint of TOC, the system constraints are resources that do not have the full capacity to meet demand or, in other words, something that limits improved performance. In that sense, the TOC assumes that in any system, at least one constraint exists. Otherwise, the system's performance would be limitless (Cai *et al.*, 2009; Corbett, 2005). By focussing on the system constraints as limiting factors of performance, the TOC enables an intuitive sense for improving the outputs of the system and avoids unused capacity because it enhances the capacity of all resources without exceeding the capacity of system constraints (Sobreiro and Nagano, 2012; Cai *et al.*, 2009; Finch and Luebbe, 2000; Luebbe and Finch, 1992).

In addition to physical constraints, a set of principles – commonly referred to as thinking processes – gives attention to or deals with other significant problems or intangible, political constraints (Watson *et al.*, 2007). In the broadest terms, thinking processes are logic diagrams that support an individual or group of individuals in solving complex problems, considering a cause and effect relationship (Kim *et al.*, 2008; Corbett, 2005; Rahman, 2002).

TOC focusses on corporate environmental sustainability or seeking to address GSCM remain unaddressed. Taking this situation into account, considerable opportunities exist for investigation of the intersection of TOC and corporate environmental sustainability. TOC has been proven successful to solve production problems such as optimizing product mix (Sobreiro and Nagano, 2012). An intriguing avenue is to verify whether TOC can be of help in mitigating organizational environmental burdens.

An ultimate goal of GSCM is to enhance the environmental performance of the entire system beyond the borders of an organization. Using a TOC perspective, supply chain optimization of environmental performance through managing environmental bottlenecks (e.g. pollution emissions, natural resources limitations, environmental technology management) and the bottlenecks of related processes after identifying the green supply chain system bottlenecks.

TOC theory argues that the performance of the system is determined by the performance of the bottleneck, so we must first solve the problem of how to ensure the full use of bottleneck resources so that slack resources are not wasted. Environmental performance and bottlenecks can increase the instability and uncertainty of corporate environmental sustainability efforts. The Drum-Buffer-Rope theory buffer model in TOC can manage these unstable factors, specifically the factors related to the bottleneck resources and process.

For GSCM practices, setting up a buffer to protect the environmental bottleneck process and ensuring that the green practices plan can be completed effectively can be made TOC goals. This focus can improve organizational environmental performance through a focus on environmental bottlenecks.

Another avenue is to extend the TOC research results for a generic supply chain to GSCM. A number of examples exist:

- Using discrete-time linear analytical models (e.g. Hu *et al.*, 2002) formulated to minimize total operating costs subject to constraints that take into account internal and external factors, such as environmental operating strategies and governmental regulations, can be avenues for research.
- Identify within the green supply chain upstream and downstream enterprise collaboration to promote complete supply chain environmental performance and profit improvements (Simatupang *et al.*, 2004).
- Applying the thinking process of TOC to identify critical success factors in GSCM and understand causal relationships between these factors (Rahman, 2002).
- Applying the TOC thinking process to GSCM to achieve win-win (environmental and business) supply chain strategies (Mabin *et al.*, 2006). One point should be made before applying TOC in green supply chains.

These are some examples; many more exist that can apply various elements of TOC to corporate and supply chain environmental sustainability improvements. The field is wide open in this area to study TOC integration from analytical and empirical perspectives.

4.4 Six Sigma and green issues

Six Sigma has its underpinnings in TQM and has been used as a method to improve organizational products, services and processes (Dahlgaard and Dahlgaard-Park, 2006). A simple overview of Six Sigma can be summarized using two viewpoints. As a quantitative-based approach, it is a comprehensive statistical monitoring process that focusses on analytically reducing defects in organizations by increasing the level of capabilities. From a business practices perspective, Six Sigma is a set of fundamental principles to improve business profitability by reducing defects, wastes and costs that do not add customer value (Kwak and Anbari, 2006; Dahlgaard and Dahlgaard-Park, 2006).

Six Sigma has also been considered a repackage of old quality management principles, practices and techniques (Schroeder *et al.*, 2008). Independent of this observation, Six Sigma contributed to operations management by offering a framework or system of fundamental rules used to help managers to continuously improve the quality of their products, services and processes.

This process of continuous improvement is realized and generally known under the acronym define, measure, analysis, improve and control (DMAIC; Mast and Lokkerbol, 2012), as shown in Table II.

There is growing interest and evidence from practitioner and academic settings for extending and improving the concepts of Six Sigma to the supply chain. Greening aspects

Elements of DMAIC	Descriptions of its key processes
Define	Define the problems or processes and benefit analysis
Measure	Measure the problems or processes
Analyze	Analyze the cause of defect and main and starting point of variation
Improve	Improve the processes to exclude the variation
Control	Control the system with the objective of improving the processes

Sources: Adapted of Kwak and Anbari (2006) and Mast and Lokkerbol (2012)

Table II.
Elements of DMAIC and its descriptions

play a significant role in this expected extension. In certain situations (e.g. foreign suppliers), the quality of green processes in all parts of the supply chain may need to be known.

Expanding even further, Six Sigma projects can be targeted to improve the environmental protection performance of supply chain management. Six Sigma can help in the determination of metrics and support constructing measurement models for green supply chain performance. These metrics could be applied in a variety of settings to solve a broad array of issues, including environmental governance capabilities, green service, environmental quality and even supplier improvement on environmental dimensions.

The fact-based, data-driven, problem solving approaches from Six Sigma can help to discover "root causes" about environmental issues. Integrated performance management tools, such as the balanced scorecard and Six Sigma, have been recommended as complementary tools for corporate environmental management practices (Hsu and Liu, 2010; Länsiluoto and Järvenpää, 2008).

Environmental management systems (EMS), such as ISO 14001, can also play a role in how Six Sigma relates to organizational greening. For example, ISO 14001 requires the existence of proper environmental quality plans, programs, documentation, and procedures. Thus, ISO 14001 certification and environmental quality performance can integrate environmentally oriented Six Sigma projects.

4.5 GSCM

Operations management discussion should not be restricted to the context of the organization. It needs to involve a holistic supply chain perspective. The production of a given product requires management and coordination of material flows and information and relationships among the organization, suppliers and clients (Harland, 1996). When concern for the environmental impacts of products is included, a more systemic perspective is needed, reaching the context of GSCM (Corbett and Klassen, 2006).

GSCM has emerged as an effective management approach and a philosophy for leading and proactively developing greener manufacturing organizations (Zhu *et al.*, 2008). GSCM represents the integration of environmental thought into supply chain management, including product design, selection and obtaining materials, production processes, final product delivery to the consumer (transportation and packaging) and the product's end of lifecycle after its useful life (Golicic and Smith, 2013; Srivastava, 2007; Min and Kim, 2012; Zhu *et al.*, 2008), and reverse logistics of closing the loop (Sarkis *et al.*, 2011; Srivastava, 2007). Firms can be positioned in different stages of GSCM, and because of this, they may adopt different practices of GSCM (Carbone and Moatti, 2011).

Figure 2 shows the GSCM practices in the context of the immediate relations of a supply chain, and in Table III, brief definitions are presented for each GSCM practice.

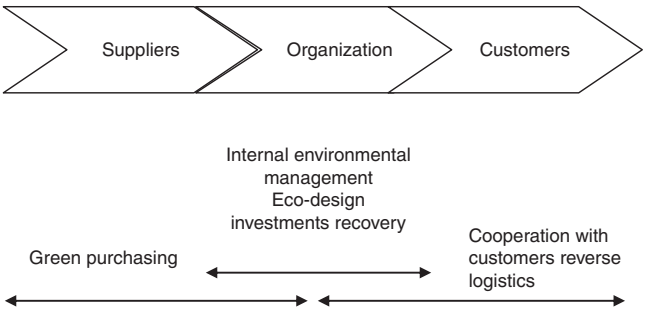


Figure 2.
Illustration of GSCM practices in the context of a supply chain

GSCM practice	Definition
Internal environmental management	Environmental management system and environmental auditing actions with support from upper and middle management as well as inter-functional integration on behalf of environmental improvements in the production process
Green purchasing	Environmental concern considerations in the selection, evaluation, and auditing process of suppliers, and the involvement of suppliers in meeting the organization's environmental objectives
Cooperation with customers	Customer collaboration in cleaner production, eco-design, and use of returnable packaging
Eco-design	Product design considering aspects such as easy to disassemble, easy to recycle, reduced consumption of resources, reduced or no use of hazardous/polluting substances
Investments recovery	Sale of used equipment and scrap
Reverse logistics	Reuse, recycling, remanufacturing, and correct disposal of products/components/packaging of after sale and after consumption

Sources: Based on Zhu *et al.* (2005, 2008)

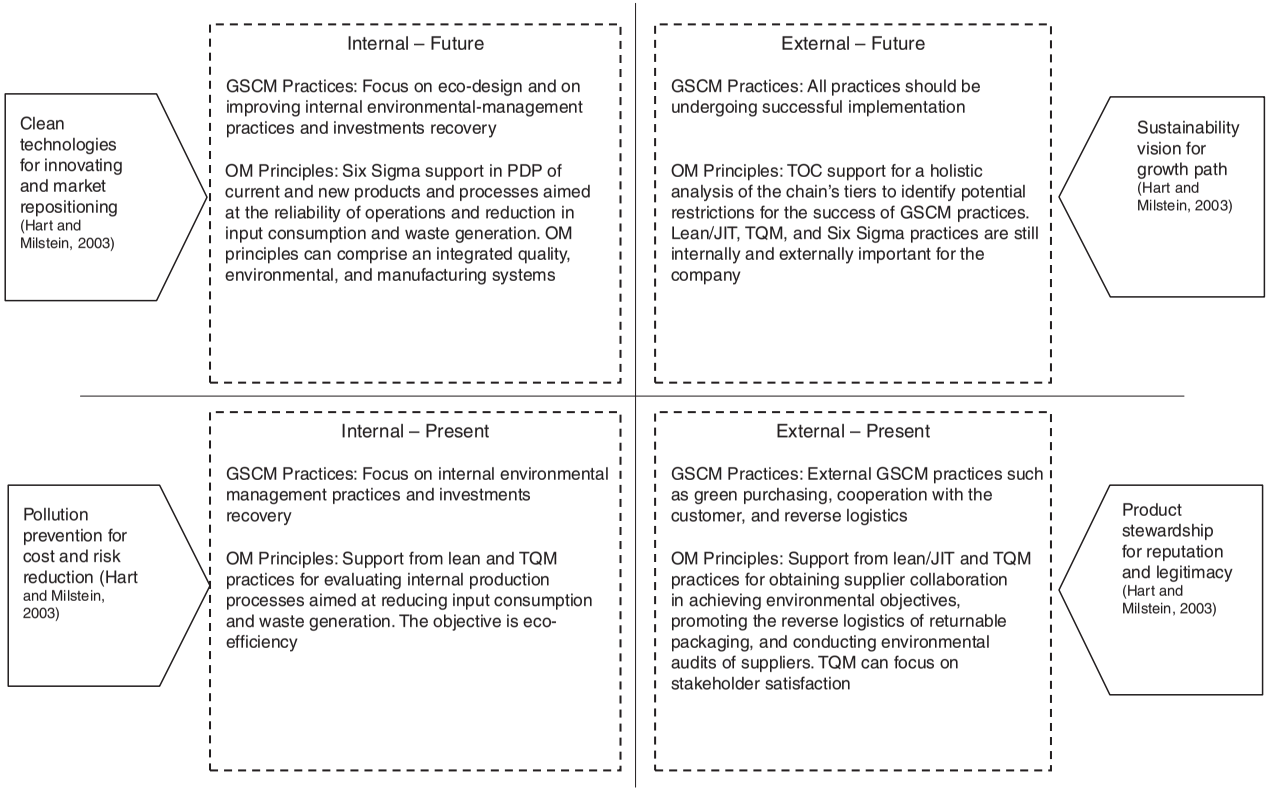
Table III.
Brief definitions of GSCM practices

5. Proposal of an integrated approach: OM principles and GSCM

Taking into account the previous section, which introduced some conceptual pillars of integration between principles of operations management and green issues and GSCM, Figure 3 presents a theoretical proposal on how to integrate these principles within a SD context. This framework is based on an adaptation for seeking more SOM by Kleindorfer *et al.* (2005) and on the ideas of Hart and Milstein (2003). The left side of this grid is focussed on issues related to internal practices and concerns of organizations. The right hand side of the grid is on external concerns. The present issues, short-term operational concerns, are at the bottom of the grid, while future, more strategic concerns are at the top portion of the grid.

In the first quadrant (internal – present), the focus is on the organization's internal operations. In order to make the operations more sustainable in this stage, the GSCM practices that could have the biggest contribution would be internal environmental management and recovery of investments. These practices tend to be the most usual for companies in the initial stages of GSCM (Jabbour and Jabbour, 2012). Lean and TQM are the operations management principles that may be effectively employed at this stage. According to Dües *et al.* (2013), lean is like a catalyzer for facilitating the implementation of green. In this sense, lean principles that tend to support the practice of internal environmental management are the involvement of employees in the search for environmental improvements and the reduction of hierarchical levels, encouraging employees to assume responsibilities in the company's environmental management system. According to Wong and Wong (2014), human aspects of lean may address sustainable operations. With the practice of recovery of investments, lean can support these GSCM activities from the perspective of reducing waste. TQM can support the internal environmental management practice from the perspective of consumer satisfaction, internal or external, of the company in relation to promoting environmental programs of continuous improvement and the search for a philosophy of pollution prevention (Borri and Boccaletti, 1995). Therefore, in this stage, the target is internal eco-efficiency supported by lean and TQM in a GSCM context. As a consequence, pollution prevention for the cost and risk reduction strategies from Hart and Milstein (2003) may be achieved.

Figure 3.
Proposed framework



In the second quadrant (external – present), the first actions of supply chain involvement occur on behalf of environmentally conscious production. A more systemic perspective should be adopted. GSCM practices that can be effectively adopted are green purchasing, cooperation with customers and reverse logistics. Internal practices (internal environmental management and investments recovery) continue to be applied as the scope becomes broader. However, according to the literature, companies tend to be in the initial stages of external practices. Green purchasing and cooperation with customers are the least adopted organizational GSCM practices in general (Zhu *et al.*, 2012; Jabbour *et al.*, 2013).

Lean with JIT actions and TQM are the operations management principles that can be effectively employed within this quadrant. In relation to the practice of green purchasing, lean principles can support actions by suppliers in meeting the organization's environmental objectives because of the lean principle of relationships with suppliers (Dües *et al.*, 2013). TQM, in turn, can also support the practice of green purchasing with the principle of supplier partnership formation (Borri and Boccaletti, 1995) for reducing or eliminating the use of hazardous chemical substances in those inputs supplied. In addition, TQM can support the execution of internal environmental audit procedures in supplier installations (Borri and Boccaletti, 1995). It may support some audits of suppliers' sites in order to check workplace conditions to avoid social problems. It can keep up companies' reputation and legitimacy.

JIT can support the practice of reverse logistics, especially in the return of packaging from the supplier or customer. According to Jabbour *et al.* (2013), the practice of cooperation with customers is very important for supporting the reverse logistics practice. JIT also tends to support cooperation with customers. It is important to point out that TQM, which focusses on customer satisfaction, plays an important role in this quadrant, since environmental considerations to be mapped and incorporated in production belong to the stakeholders and not just the customers. In this stage, the companies are thinking beyond the organization and are initiating effective GSCM actions. As a consequence, the product stewardship strategy from Hart and Milstein (2003) may be adopted.

In the third quadrant (internal – future), eco-design, an internal GSCM practice, takes on special prominence. Once some external practices have been successful, such as supplier involvement in reducing or eliminating hazardous chemical substances, it is possible to start improving or creating products and processes aimed at being easy to disassemble, easy to recycle, having reduced consumption of resources, or having reduced or no use of hazardous/polluting substances. In this sense, the principles of Six Sigma take on great importance.

Six Sigma is a project management method that aims to improve processes and products, continuously seeking to reduce defects and variability while focussing on customer requirements (Kwak and Anbari, 2006). Therefore, Six Sigma, based on project management, planning and control of processes and DMAIC, can intervene in the traditional product development process (PDP). So, DMAIC will provide a sequence to help identify, define, prioritize, conduct, manage, achieve, sustain and improve green lean initiatives (Garza-Reyes, 2015). The intention is to seek solutions for new products based on the use of renewable or recyclable materials or materials that are easy to disassemble and that reduce input consumption. It also aims to analyze and propose more efficient production processes from an energy conservation perspective and to reduce the generation of waste.

It is also possible to integrate quality-, environmental- and manufacturing management systems within this quadrant. It thus permits joint actions (decisions and resources)

for using lean and TQM principles for environmental improvements in the process and in the product. In this quadrant, an organization may use learning with the adoption of external GSCM practices, even if still incipient, for improving and advancing in internal GSCM practices. As a result, clean technologies for innovating and market repositioning strategy from Hart and Milstein (2003) may be a reality.

In the fourth and last quadrant (external – future), the company is expected to have evolved in its understanding of GSCM practices as an effective management tool and a philosophy (Zhu *et al.*, 2008). In this quadrant, given that an organization has learned and evolved through the previous three quadrants, an organization will focus on eliminating possible physical or managerial restrictions between the tiers in the supply chain that may be hampering full adoption of all GSCM practices pertinent to it. Thus, the organization at this stage will have internal environmental management practices and investments recovery well consolidated. With the practice of green purchasing, the company is expected to have suppliers selected and evaluated based on environmental criteria. These suppliers will be involved in the development process of environmentally proper products and processes because of the advances in third quadrant's eco-design practices. The practice of reverse logistics should contribute to the remanufacturing and redesign processes because of advances in third quadrant's eco-design practices. In addition, cooperation with customers is expected to advance to where it also cooperates with the eco-design. In this sense, principles of TOC, such as the thinking process, which aims at understanding cause and effect relations (Rahman, 2002), can contribute toward the organization's construction of a holistic view on how to seek ongoing environmental improvements in the context of the supply chain. The other principles of operations management continue to collaborate and to contribute toward the more intense adoption of GSCM's internal and external practices. As a result, the sustainability vision for the growth path strategy from Hart and Milstein (2003) may be a reality.

Thus, in the most advanced quadrant of the proposed framework (external – future), organizations can properly align planning and the allocation of resources for integrated decision-making between operational strategic planning and environmental planning. This alignment of planning and resources can be feasible if the organization begins to propose integrated actions between functional areas of the company such as production, purchasing, logistics, product development, marketing, human resources and the environment. In other words, top management can propose cross-functional projects with objectives and goals linked to operational and environmental results in order to enable real synergy between the principles of operations management and GSCM.

This framework of quadrants can be used to guide organizations in a self-appraisal process and the eventual generation of action plans related to the search for more sustainable operations while also contributing to SD. A company's evolution through the quadrants tends to be gradual, but, at the same time, it requires the simultaneous adoption of GSCM practices because the stages tend to complement each other because of the learning curve in using the principles of operations management with an environmental bias.

6. Concluding remarks

This paper aimed to propose a framework between SOM and SD. The construction of the framework was based on previous studies that discussed synergies between operations management principles with environmental bias and studies on adoption of GSCM practices. There are four quadrants in the proposed framework: internal present, external present, internal future and external future. For each quadrant, this paper

proposed the adoption of operations management principles and GSCM practices that could support the actions suggested by Kleindorfer *et al.* (2005), thus supporting each strategy indicated by Hart and Milstein (2003) to organizations that contribute to SD.

The main contributions of the paper were as follows: propose an integration between the topics sustainability and operations management (Dubey *et al.*, 2015); provide ways to simultaneously integrate lean, TQM, Six Sigma, TOC and GSCM on sustainable manufacturing implementation (Westkämper, 2008); and guide how organizations can pursue SD through SOM (Despeisse *et al.*, 2012).

The conceptual proposal of this paper sought to guide managers to implement SD based on GSCM practices and operations management principles for achieving an improved environmental, and potentially economic, performance.

Also, the framework proposed can assist in teaching the management of more environmentally sustainable operations and GSCM. Most OM texts and courses have environmental issues inserted into the future of operations topical discussions (Gunasekaran and Ngai, 2012). Also, few OM courses consider this integration. The framework can also be useful for organizational consultants who work in sustainability as well as in operations management.

Some future research propositions are proposed:

P1. The proposed framework needs to be practically validated in a real-world situation. Whether it is through case studies, surveys, or even action research, verifying whether the framework is useful for diagnosing a company's needs is important.

P2. Given the evolutionary nature of the framework, investigating the longitudinal effects of GSCM practices and their support from OM principles needs to be carefully examined. This investigation can occur in different geographical, economic and political contexts, as in cases of developing and developed countries.

P3. Whether there are cultural and institutional differences that may cause this framework to be adjusted needs to be considered.

P4. Studying the application of this framework through the prism of the individual level behavioral aspects is important. For example, people involved in the process of enabling the synergy between principles of OM and GSCM, vs those who only focus on one or the other, but not both principles, and the effectiveness of implementation and outcomes need to be investigated.

P5. Analyzing some organizational capabilities and resources which will be necessary for organizations to move forward among quadrants of framework.

P6. Identifying and analyzing barriers for organizations to move over the quadrants of framework.

References

Azevedo, S.G., Carvalho, H., Duarte, S. and Cruz-Machado, V. (2012), "Influence of green and lean upstream supply chain management practices on business sustainability", *IEEE Transactions on Engineering Management*, Vol. 59 No. 4, pp. 753-765, doi: 10.1109/TEM.2012.2189108.

Barnard, A. (2010), "Continuous improvement and auditing", in Cox, J.F. III and Schleier, J.G. Jr, *Theory of Constraints Handbook*, McGraw-Hill, New York, NY, pp. 403-454.

Borri, F. and Boccaletti, G. (1995), "From total quality management to total quality environmental management", *The TQM Magazine*, Vol. 7 No. 5, pp. 38-42, doi: 10.1108/09544789510098614.

Boyd, L. and Gupta, M. (2004), "Constraints management: what is the theory?", *International Journal of Operations & Production Management*, Vol. 24 No. 4, pp. 350-371, doi: 10.1108/01443570810903122.

Cai, J., Liu, X., Xiao, Z. and Liu, J. (2009), "Improving supply chain performance management: a systematic approach to analyzing iterative KPI accomplishment", *Decision Support Systems*, Vol. 46 No. 2, pp. 512-521.

Carbone, V. and Moatti, V. (2011), "Towards greener supply chains: an institutional perspective", *International Journal of Logistics Research and Applications*, Vol. 14 No. 3, pp. 179-197.

Chase, R.B., Aquilano, N.J. and Jacobs, F.R. (2001), *Operations Management for Competitive Advantage*, 9th ed., McGraw-Hill Irwin, Boston, MA.

Corbett, C.J. and Klassen, R.D. (2006), "Extending the horizons: environmental excellence as key to improving operations", *Manufacturing & Service Operations Management*, Vol. 8 No. 1, pp. 5-22.

Corbett, T. (2005), *Bússola Financeira: O processo decisório da Teoria das Restrições*, Nobel, São Paulo.

Dahlgaard, J.J. and Dahlgaard-Park, S.M. (2006), "Lean production, Six Sigma quality, TQM and company culture", *The TQM Magazine*, Vol. 18 No. 3, pp. 263-281.

Despeisse, M., Oates, M.R. and Ball, P.D. (2013), "Sustainable manufacturing tactics and cross-functional factory modelling", *Journal of Cleaner Production*, Vol. 42, March, pp. 31-41.

Despeisse, M., Mbaye, F., Ball, P.D. and Levers, A. (2012), "The emergence of sustainable manufacturing practices", *Production Planning & Control*, Vol. 23 No. 5, pp. 354-376.

Dhingra, R., Kress, R. and Upreti, G. (2014), "Does lean mean green?", *Journal of Cleaner Production*, Vol. 85, December, pp. 1-7.

Duarte, S. and Cruz-Machado, V. (2013), "Lean and green: a business model framework", *Proceedings of the Sixth International Conference on Management Science and Engineering Management, Springer, London, January*, pp. 751-759.

Dubey, R., Gunasekaran, A. and Chakrabarty, A. (2015), "World-class sustainable manufacturing: framework and a performance measurement system", *International Journal of Production Research*, Vol. 53 No. 17, pp. 5207-5223.

Dües, C.M., Tan, K.H. and Lim, M. (2013), "Green as the new lean: how to use lean practices as a catalyst to greening your supply chain", *Journal of Cleaner Production*, Vol. 40, February, pp. 93-100.

Finch, B.J. and Luebbe, R.L. (2000), "Response to 'theory of constraints and linear programming: a re-examination", *International Journal of Production Research*, Vol. 38 No. 6, pp. 1465-1466, doi: 10.1080/002075400188960.

Garza-Reyes, J.A. (2015), "Green lean and the need for Six Sigma", *International Journal of Lean Six Sigma*, Vol. 6 No. 3, pp. 226-248.

Goldratt, E.M. (1990), *Theory of Constraints*, Croton-on-Hudson, North River, NY.

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*, Vol. 9 No. 2, pp. 78-95, doi: 10.1111/jscm.12006.

Gunasekaran, A. and Irani, Z. (2014), "Sustainable operations management: design, modelling and analysis", *Journal of the Operational Research Society*, Vol. 65 No. 6, pp. 801-805.

Gunasekaran, A. and Ngai, E.W. (2012), "The future of operations management: an outlook and analysis", *International Journal of Production Economics*, Vol. 135 No. 2, pp. 687-701.

Gunasekaran, A., Irani, Z. and Papadopoulos, T. (2014), "Modelling and analysis of sustainable operations management: certain investigations for research and applications", *Journal of the Operational Research Society*, Vol. 65 No. 6, pp. 806-823.

Gupta, M.C. and Boyd, L.H. (2008), "Theory of constraints: a theory for operations management", *International Journal of Operations & Production Management*, Vol. 28 No. 10, pp. 991-1012.

Hajmohammad, S., Vachon, S., Klassen, R.D. and Gavronski, I. (2012), "Lean management and supply management: their role in green practices and performance", *Journal of Cleaner Production*, Vol. 39, January, pp. 312-320.

Harland, C.M. (1996), "Supply chain management: relationships, chains and networks", *British Journal of Management*, Vol. 7 No. S1, pp. 63-80, doi: 10.1111/j.1467-8551.1996.tb00148.x.

Hart, S.L. and Milstein, M.B. (2003), "Creating sustainable value", *The Academy of Management Executive*, Vol. 17 No. 2, pp. 56-67.

Hayes, R.H. and Wheelwright, S.C. (1984), *Restoring Our Competitive Edge: Competing through Manufacturing*, Wiley, New York, NY.

Hsu, Y.L. and Liu, C.C. (2010), "Environmental performance evaluation and strategy management using balanced scorecard", *Environmental Monitoring and Assessment*, Vol. 170 Nos 1-4, pp. 599-607.

Hu, T.-L., Sheu, J.-B. and Huang, K.-H (2002), "A reverse logistics cost minimization model for the treatment of hazardous wastes", *Transportation Research Part E: Logistics and Transportation Review*, Vol. 38 No. 6, pp. 457-473.

Jabbour, A.B. and Jabbour, C.J. (2012), "Evolução da Gestão Ambiental e a Adoção de Práticas de Green Supply Chain Management no Setor Eletroeletrônico Brasileiro", in ANPAD (Ed.), *EnANPAD*, Rio de Janeiro, pp. 1-15.

Jabbour, A.B., Azevedo, F.S., Arantes, A.F. and Jabbour, C.J. (2013), "Green supply chain management in local and multinational high-tech companies located in Brazil", *The International Journal of Advanced Manufacturing Technology*, Vol. 68 Nos 1-4, pp. 807-815, doi: 10.1007/s00170-013-4945-6.

Kim, S., Mabin, V.J. and Davies, J. (2008), "The theory of constraints thinking processes: retrospect and prospect", *International Journal of Operations & Production Management*, Vol. 28 No. 2, pp. 155-184.

King, A.A. and Lenox, M.J. (2001), "Lean and green? An empirical examination of the relationship between lean production and environmental performance", *Production and Operations Management*, Vol. 10 No. 3, pp. 244-256, doi: 10.1111/j.1937-5956.2001.tb00373.x.

Kleindorfer, P.R., Singhal, K. and Van Wassenhove, L.N. (2005), "Sustainable operations management", *Production and Operations Management*, Vol. 14 No. 4, pp. 482-492, doi: 10.1111/j.1937-5956.2005.tb00235.x.

Kwak, Y.H. and Anbari, F.T. (2006), "Benefits, obstacles, and future of Six Sigma approach", *Technovation*, Vol. 26 Nos 5-6, pp. 708-715.

Länsiluoto, A. and Järvenpää, M. (2008), "Environmental and performance management forces: integrating 'greenness' into balanced scorecard", *Qualitative Research in Accounting & Management*, Vol. 5 No. 3, pp. 184-206.

Lea, B.-R. and Fredendall, L. (2002), "The impact of management accounting, product structure, product mix algorithm, and planning horizon on manufacturing perfomance", *International Journal Production Economics*, Vol. 79 No. 3, pp. 279-299.

Luebbe, R. and Finch, B. (1992), "Theory of constraints and linear programming: a comparison", *International Journal of Production Research*, Vol. 30 No. 6, pp. 1471-1478, doi: 10.1080/00207549208942967.

MacCarthy, B.L., Lewis, M., Voss, C. and Narasimhan, R. (2013), "The same old methodologies? Perspectives on OM research in the post-lean age", *International Journal of Operations & Production Management*, Vol. 33 No. 7, pp. 934-956.

Mabin, V.J., Davies, J. and Cox, J.F. (2006), "Using the theory of constraints thinking processes to complement system dynamics' causal loop diagrams in developing fundamental solutions", *International Transactions in Operational Research*, Vol. 13 No. 1, pp. 33-57.

Mani, M., Madan, J., Lee, J.H., Lyons, K.W. and Gupta, S.K. (2014), "Sustainability characterisation for manufacturing processes", *International Journal of Production Research*, Vol. 52 No. 20, pp. 5895-5912.

Mast, J. and Lokkerbol, J. (2012), "An analysis of the Six Sigma DMAIC method from the perspective of problem solving", *International Journal of Production Economics*, Vol. 139 No. 2, pp. 604-614.

Min, H. and Kim, I. (2012, March), "Green supply chain research: past, present, and future", *Logistics Research*, Vol. 4 Nos 1-2, pp. 39-47, doi: 10.1007/s12159-012-0071-3.

Mollenkopf, D., Stolze, H., Tate, W.L. and Ueltschy, M. (2010), "Green, lean, and global supply chains", *International Journal of Physical Distribution & Logistics Management*, Vol. 40 Nos 1/2, pp. 14-41.

Piercy, N. and Rich, N. (2015), "The relationship between lean operations and sustainable operations", *International Journal of Operations & Production Management*, Vol. 35 No. 2, pp. 282-315.

Rahman, S.U. (2002), "The theory of constraints' thinking process approach to developing strategies in supply chains", *International Journal of Physical Distribution & Logistics Management*, Vol. 32 No. 10, pp. 809-828.

Sangwan, K.S. and Mittal, V.K. (2015), "A bibliometric analysis of green manufacturing and similar frameworks", *Management of Environmental Quality: An International Journal*, Vol. 26 No. 4, pp. 566-587.

Sarkis, J. (1995), "Manufacturing strategy and environmental consciousness", *Technovation*, Vol. 15 No. 2, pp. 79-97.

Sarkis, J., Zhu, Q. and Lai, K.-h. (2011), "An organizational theoretic review of green supply chain management literature", *International Journal of Production Economics*, Vol. 130 No. 1, pp. 1-15.

Schroeder, R.G., Linderman, K., Liedtke, C. and Choo, A.S. (2008), "Six Sigma: definition and underlying theory", *Six Sigma: Definition and Underlying Theory*, Vol. 26 No. 4, pp. 536-554.

Simatupang, T.M., Wright, A.C. and Sridharan, R. (2004), "Applying the theory of constraints to supply chain collaboration", *Supply Chain Management: An International Journal*, Vol. 9 No. 1, pp. 57-70.

Sobreiro, V.A. and Nagano, M.S. (2012), "A review and evaluation on constructive heuristics to optimise product mix based on the theory of constraints", *International Journal of Production Research*, Vol. 50 No. 20, pp. 5936-5948, doi: 10.1080/00207543.2011.638940.

Srai, J.S., Alinaghian, L.S. and Kirkwood, D.A. (2013), "Understanding sustainable supply network capabilities of multinationals: a capability maturity model approach", *Proceedings of the Institution of Mechanical Engineers, Part B: Journal of Engineering Manufacture*, Vol. 227 No. 4, pp. 595-615.

Srivastava, S.K. (2007), "Green supply-chain management: a state-of-the-art literature review", *International Journal of Management Reviews*, Vol. 9 No. 1, pp. 53-80, doi: 10.1111/j.1468-2370.2007.00202.x.

Subramanian, N. and Gunasekaran, A. (2015), "Cleaner supply-chain management practices for twenty-first-century organizational competitiveness: practice-performance framework and research propositions", *International Journal of Production Economics*, Vol. 164, June, pp. 216-233.

Wagner, M. (2007), "Integration of environmental management with other managerial functions of the firm: empirical effects on drivers of economic performance", *Long Range Planning*, Vol. 40 No. 6, pp. 611-628.

Watson, K., Blackstone, J. and Gardiner, S. (2007), "The evolution of a management philosophy: the theory of constraints", *Journal of Operations Management*, Vol. 25 No. 2, pp. 387-402.

Westkämper, E. (2008), "Manufuture and sustainable manufacturing", *Manufacturing Systems and Technologies for the New Frontier*, Springer, London, pp. 11-14.

Wong, W.P. and Wong, K.Y. (2014), "Synergizing an ecosphere of lean for sustainable operations", *Journal of Cleaner Production*, Vol. 85, December, pp. 51-66.

Zhu, Q. and Sarkis, J. (2004), "Relationships between operational practices and performance among early adopters of green supply chain management practices in Chinese manufacturing enterprises", *Journal of Operations Management*, Vol. 22 No. 3, pp. 265-289.

Zhu, Q., Sarki, J. and Lai, K.-H. (2008), "Confirmation of a measurement model for green supply chain management practices implementation", *International Journal of Production Economics*, Vol. 111 No. 2, pp. 261-273.

Zhu, Q., Sarkis, J. and Geng, Y. (2005), "Green supply chain management in China: pressures, practices and performance", *International Journal of Operations & Production Management*, Vol. 25 No. 5, pp. 449-468.

Zhu, Q., Sarkis, J. and Lai, K.-H. (2012), "Examining the effects of green supply chain management practices and their mediations on performance improvements", *International Journal of Production Research*, Vol. 50 No. 5, pp. 1377-1394, doi: 10.1080/00207543.2011.571937.

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