Proceedings of the 2011 International Conference on Industrial Engineering and Operations Management
Kuala Lumpur, Malaysia, January 22 – 24, 2011

Exploring Lean and Green Supply Chain Performance Using Balanced Scorecard Perspective

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Abstract
Going lean/green is a trend more manufacturers are beginning to recognize as important in an era of economic austerity and environmental responsibility. Unlike lean supply chain, which focuses on ways to improve operations and cut wastes from the customer's perspective, green initiatives look at ways to eliminate waste from the environment's perspective. Looking at operations from a 'lean/green' perspective has benefits to not only the environment, but to manufacturers and customers as well. Based on the literature review we developed a conceptual model incorporating lean and green supply chain into a performance measurement system, using the balanced scorecard approach.

Keywords
Supply chain management; Lean supply chain; Green supply chain; Balanced Scorecard

1. Introduction
Today's information age brings with it an ever-expanding portfolio of technology solutions, sophisticated processes, and new organizational skills in order to deliver products and services to a global marketplace in less time, with higher quality, and at a lower cost than ever before. In such scenario, organizations must take proactive strategies to react to market globalization and competition growth. A key area for improvement in many companies is the requirement for environmental management to be taken using a systemic approach, i.e. analyzing how decisions will impact not only on environmental aspects but also on the overall business and operations strategy. Opportunities are then emerging for supply chain improvement when exploring lean and green supply chain paradigms. While the lean supply chain searches for reducing wastes increasing value-added, the green supply chain aims to minimize environmental impacts. Such paradigms change supply chain management (SCM) practices in order to obtain a more efficient and sustainable supply chain.
Literature emphasizes the importance of performance measurement systems at different levels of decision making [1], however performance measurement does not get enough consideration in supply chain management [2]. According to Cai *et al*. [3] "since many measurement systems lacked strategy alignment, a balanced approach and systemic thinking, they had difficulty in systematically identifying the most appropriate metrics." For these authors [3] to address this difficulty, the balanced scorecard (BSC) framework should be used to evaluate supply chain performance. The BSC can help top managers clarify and operationalize the vision and strategy of the organization, focusing management's attention on a few but critical value drivers, and gives an indication of how performance measurement is perceived by stakeholders on supply chain [4]. Sidiropoulos *et al*. [5] developed the Eco-Balanced Scorecard (Eco-BS) incorporating in the widely-adopted BSC developed by Kaplan and Norton [6-8] a fifth perspective consisting of environmental indicators. According to the authors, "a company that uses the Eco-BS can model its processes, assess their performance in relation to all five perspectives, contemplate on improvements, implement them on the model(s) and then assess their effects".
A very few studies relate lean/green measures to operational and strategy goals on the SCM. Based on the revision of literature, this paper seeks to gather a number of measures integrating lean/green considerations into strategic and operational decisions, using the BSC approach. It focuses on the adoption of a hybrid supply chain trying to understand what green and lean thinking have in common and how firms can benefit from a holistic approach on managing performance at the strategic level.
This paper consists in four parts: section 2 presents a review on literature related to the lean and green supply chain; in section 3 a briefly literature review on supply chain performance and the BSC perspective. In section 4 the model was designed, to explore the linkages between the benefits of supply chain performance and the BSC. Finally, we

close with conclusions and indicate some directions of future work.

2. Supply Chain Management

The success of a firm passes through the control of its supply chain. According to Roy and Dhalla [9] "Supply chain initiatives have become a critical part of firms operations". SCM intends to manage and improve the flow of materials, services and information, from the origin to the delivery points, in way to satisfy the requirements of the final customer to the lowest possible cost for all the intervenient [10]. The purpose passes for delivering the right materials, in the right places, in the right quantities, with the appropriate appearance [11]. To achieve this purpose, the supply chain is confronted with an increased number of modern management strategies that recognize new opportunities for supply chain improvement, mainly through lean and green approaches. These paradigms have been explored in an independent way, in isolated contexts and normally applied to production level. However, the understanding of how these two paradigms may be integrated within the supply chain context does not seem to have been deeply explored. These two paradigms aim the same goal, i.e. to satisfy the customer needs, at the lowest possible cost to all members in the supply chain.

2.1 Lean Supply Chain

Lean paradigm connected to SCM is a strategy based on cost and time reduction to improve the effectiveness. It is focused on optimizing the processes of all supply chain, searching for simplification, reducing waste and reducing activities that do not add value [11]. Lean thinking, extended to supply chain, comprises: i) identifying value; ii) determining the best sequence for value-creating steps, eliminating wastes; iii) performing activities without interruption when a customer requests them; and iv) improving processes continually [12]. Shah and Ward [13] developed a list of lean characteristics: i) supplier feedback; ii) JIT delivery by suppliers; iii) supplier development; iv) customer involvement; v) pull system; vi) continuous flow; vii) set up time reduction; viii) total preventive maintenance; ix) statistical process control and x) employee involvement. Adopters of lean strategy may implement practices such as mass production, just-in-time, and long-term supplier relationships to eliminate waste and achieve a lower cost [14].

2.2 Green Supply Chain

Another relevant issue in SCM is the green paradigm related to the environmental and ecological efficiency of the organizations [15]. Practices connected with the environmental questions are based on green purchasing to be integrated into life-cycle management supply chains flowing from supplier, through manufacturer, customer, and closing the loop with reverse logistics [15]. Mudgal *et al.* [16] refer that "greening the supply chains is considered as a process of integration the environmental values into supply chain". Greening the supply chains seek to balance marketing performance with environmental issues [16]. According Shang *et al.* [17] green supply chain management involves finance flow, logistics flow, information flow, integration, relationships, and environmental management, promoting efficiency and synergy between partners, facilitates environmental performance, minimal waste and cost savings. Therefore it is an important source of the organizations' competitive advantages.

2.3 Hybrid Supply Chain

Integrating lean and green paradigms may develop a hybrid supply chain. The compatibility between lean and green paradigms represents a new way of thinking in the context of SCM. Cost efficiency and environmental responsibility are not mutually exclusive, they are mutually enforcing. Lean manufacturing minimizes wasted material and energy usage, as well as storage space and transportation expenses [18], while green operations practices can be considered as those practices that contribute to the enhancement of environmental performance in companies' operations. The practices that support lean paradigm are related to the environmental performance practices [18]. Organizations implementing lean practices continually expected to improve environmental performance through good housekeeping practices, such as general waste reduction and minimizing hazardous wastes, reducing lead times, material and staff costs and yet simultaneously increasing production activity and enhancing quality [19].

EPA [20] adds environmental metrics to lean metrics and refers that "using environmental metrics in lean efforts will allow [companies] to document the environmental benefits that are part of lean implementation, as well as identify targets for future improvement efforts". Kainuma and Tawara [21] examined both paradigms extending the range of supply chain to include re-use and recycling throughout the life cycle of products and services. Franchini *et al.* [22] evaluate how to combine green and lean practices, investigating their links and analyze the impact on environmental and operational performance. Gordon [23] also provides a summary of practices after lean and green implementation. Another perspective is provided by Johansson and Winroth [24] who claim a lack of understanding of lean and green relationship concepts.

2.4 Supply Chain Performance

The application of paradigms practices on SCM influences the performance measurement systems and allows organizations to obtain a more holistic vision of effective and efficient businesses. However, very few studies exist relating performance metrics in current strategies of the SCM [25]. Pochampally *et al.* [26] refer that "developing the metrics for performance measurement of a supply chain is a difficult problem". The performance measures may influence the decisions to be made at the different organizational levels: i) Financial measures are appropriate for strategic decision and ii) Non-financial measures might be more proper for operational decisions. So it is important to develop a performance measurement system that incorporates issues in way to study the lean and green supply chain performance. Based on the literature, Table 1 summarizes a list of lean and green measures divided into two categories: financial indicators and non-financial or operational indicators.

Table 1: List of performance measures identified for supply chain paradigms

Financial performance measures	Ref.	Non-financial performance measures	Ref.
Revenue	[28]	Air emission	[15, 21]
Profit	[27, 28]	Energy use	[21]
Return on asset	[21, 28]	Water pollution/Waste water; Solid waste	[15, 21]
Return on investment	[27]	Hazardous/harmful/toxic materials	[21]
Total sales	[28]	Effectiveness; Flexibility; Green image	[26]
Labor cost per hour	[26]	On-time delivery	[15, 26, 27, 28]
Training cost	[15, 28]	Inventory levels; Scrap rate	[15, 27]
Operational cost	[15, 26, 28]	New products/processes	[26]
Transportation costs	[27, 28]	Product quality	[15, 27]
Environmental costs	[15]	Capacity utilization	[15, 28]
		Lead time	[26, 27, 28]
		Employee efficiency	[27]
		Employee morale & satisfaction; Market share	[27, 28]
		Customer satisfaction	[21, 28]

Successful supply chains will coordinate their processes, focus on delivering customer value and eliminate unnecessary costs in key functional. The four major goals of SCM are waste reduction, time compression, flexible response, and unit cost reduction [29]. A supply chain that achieves those goals will ultimately create financial benefits, tangible benefits for customers whilst companies will continually learn and innovate to ensure future profitability.

3. Supply Chain and Balanced Scorecard Perspective

Fundamentally, the Balanced Scorecard (BSC) is about performance measures. The appeal of the BSC is its ability to include both traditional financial metrics and non-financial performance measures in its reporting capacity, thus the term "balanced". Kaplan and Norton [7] distinguish Financial, Internal process, Customer, and Learning and Growth perspectives on organizational processes essential to an overall strategy. In their book *The Balanced Scorecard*, the authors set forth a hypothesis about the chain of cause and effect that leads to strategic success. This cause-and-effect hypothesis could be fundamental to understand SCM metrics in a way that the balanced scorecard prescribes. The BSC suggests that the balance is obtained by adopting performance measures from four different perspectives. The determination of SCM metrics can be a challenge and is important to explore which should be used. Table 2 summarizes a list performance measures categorized by the four BSC perspectives. This can be used as a template to evaluate SCM performance.

The mindset of the BSC is based on the perception of the firm as a profitability machine, which needs to be optimized to reach maximum efficiency through measuring and controlling for mostly company-owned processes. The focus is the single company. Kaplan and Norton [7] argue that for firms environmental clean is a competitive advantage. Sidiropoulos *et al.* [5] refers that there are three possibilities to integrate environmental and social aspects in BSC: i) metrics can be integrated in the existing four standard perspectives, ii) an additional perspective can be added to take environmental and social aspects into account and iii) a specific environmental and social scorecard can be formulated. Some authors [5, 30] argue that there are specific measures for environmental perspective namely, energy use, water use, material use, hazardous materials use, emissions to water and to air, solid and hazardous wastes. Instead, Sidiropoulos *et al.* [5] use relative measures such as percentage of recyclable components, average half life of non-recyclable components, average time span of products and number of substitutes.

Table 2: List of performance measures for the BSC perspectives

Financial	**Ref.**	**Customer**	**Ref.**
Sales growth; Return on sales	[30]	Market share	[4, 5, 30]
Return on assets	[29, 30]	Customer satisfaction	[4, 5, 31]
Return on equity; Gearing	[30]	Perception of flexible response	[29]
Return on investment	[4,5]	No. customer contact point	[29]
Gross revenue	[4]	No. of customers retained	[4, 29]
Profit before tax	[4, 29]	No. new customers	[30]
Cost reduction	[4]	Customer value	[31]
Economic Value Added	[5]	Product return rate	[30]
Cash-to-cash cycle	[29]	Product/service quality	[31]
Customer growth & profitability	[29]	Defects	[30]
Operating earnings; Operating costs	[31]	Order response time	[29, 31]
Operating efficiency	[31]	Order cycle time	[30]
Internal process		**Learning and growth**	
Productivity	[30]	Employee satisfaction	[4, 5, 30]
Production and sales	[31]	Product finalization point	[29]
Quality of services	[4]	Product category commitment ratio	[29]
Labour turnover	[30]	New products	[30]
Av. unit production; Working capital/sales	[30]	New market entered	[30]
Capacity utilization	[30]	New customers	[31]
New services implemented per year	[4]	Development of new products / services	[31]
On time delivery	[4]	R&D spend/sale	[30]
Response time	[29, 31]	Training spend/sale	[30]
Waste reduction	[4]	Employee turnover per year	[4]
Cycle efficiency; Cost ownership	[29]	Number of suggestions implemented yearly	[4]
Target cost achieved	[29]	Money invested in employee training yearly	[4]
Quality	[5, 31]	Capital investment; Level of information	[31]
Cost; Lead-time	[5]	Invest./total assets	[30]
New products per year	[5]	Information diffusion	[5]

4. Linking the Balanced Scorecard to Supply Chain performance

There is little evidence that firms have incorporated the BSC approach into their SCM practices [29]. Sharma and Bhagwat [1] developed a BSC for the SCM evaluation using an analytical hierarchy process approach. Xiaoping and Chen [31] create a supply chain performance evaluation system based on the BSC and benchmarking approach. Sidiropoulos *et al.* [5] add a fifth environmental perspective to its BSC. Hsu and Liu [32] used a specific environmental BSC. In short, it seems that BSC is being compatible with lean paradigm. According to Stenzel [33] "companies already using the BSC prior to embarking on lean transformation should find the BSC a useful tool for promoting lean". Those who understand the interrelationship between the BSC and SCM will have a greater likelihood of leveraging their supply chains into a source of competitive advantage.

Based on the literature review, we argue that balanced scorecard is a promising starting-point to incorporate lean and green supply chain into a performance measurement system. The conceptual linkage between the supply chain performance and the BSC is shown in Figure 1.

5. Conclusions

This paper develop a conceptual model where apply the lean and green measures adopting the balanced scorecard perspective in order to reach the benefits on supply chain performance. Some limitations should be noted since the linkages between the supply chain performance and the BSC resulting from the literature review and no validation was proposed. However, it is evident from the research, literature and management perspective that SCM would benefit from a BSC approach to align with business objectives. We conclude that if firms take action by linking performance measurement system to their lean/green practices, then they will be better positioned to succeed in their supply chain initiatives. Future research beyond this study is to identifying specific approaches that support particular lean and green supply chain strategies. The proposed model may be checked through different contexts in SCM. It would also be beneficial to know if some lean/green attributes are more important than others with respect to organizational performance.

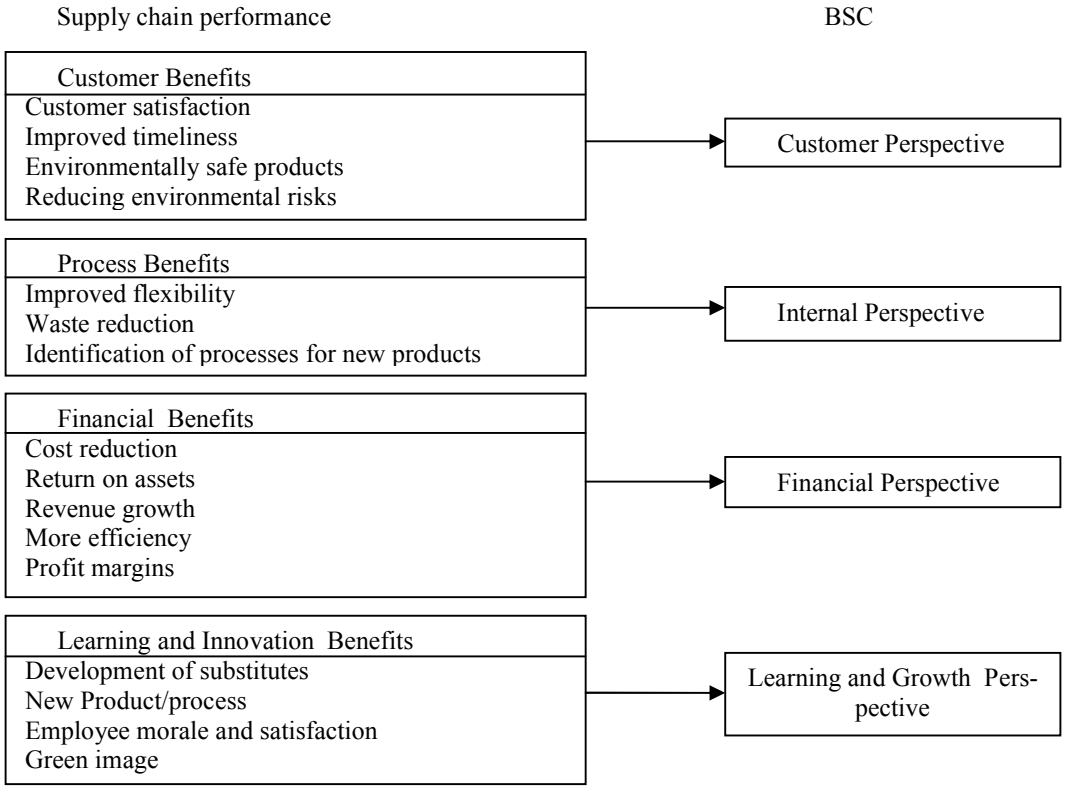

Figure 1: Linking supply chain performance and the BSC

Acknowledgements

Authors would like to acknowledge Fundação para a Ciência e Tecnologia for its support (project MIT-Pt/EDAM-IASC/0033/2008). Susana Duarte was supported by a PhD fellowship from Fundação para a Ciência e Tecnologia (SFRH/BD/60969/2009).

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