A proposal of LARG Supply Chain Management Practices and a Performance Measurement System

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***Abstract*—Supply chains (SC) in an attempt to be more competitive, are adopting new management paradigm. Among these paradigms there are four that deserve particular mention because of their importance to better SC performance: lean, agile, resilient and green. The main objective of this paper is to propose a conceptual model for a lean, agile, resilience and green SC, with the purpose of improving their operational, economic and environmental performance. In this attempt a set of SC management practices, which were named LARG practices, and several performance measures are suggested. This model is based in the literature review about the four SC management paradigms and also SC performance measurement. Among the suggested LARG practices the ones influencing more the SC performance are the just in time and also the supplier relationships. Also the SC performance measures with more LARG practices influencing them are the inventory levels and the time, that is, the SC's operational performance is the most affected.**

***Index Terms*—Lean, Agile, Resilient, Green, Performance measurement, Supply chain.**

I. Introduction

A supply chain (SC) can be described as a network linking various entities, from the customer to the supplier, through manufacturing and services, so that the flow of materials, money and information can be effectively managed to meet the business requirements [1]. In present-day there is the assumption that SC's should compete instead of companies [2], being the SC's success mainly determined by the marketplace. Therefore, Supply Chain Management (SCM) is considered a strategic factor for the better attainment of organizational goals such as enhanced competitiveness, improved customer service and increased profitability [3]. However, to ensure a better SCM it is important to develop a performance measurement system that properly reflects the real SC's performance.

Given a SC perspective, the performance measurement is also strategic and essential because most companies realize that SCM needs not only to be assessed for its performance but also SCM processes must be well-defined and controlled [4].

The lean, agile, resilient and green SCM paradigms had been adopted to improve the SC performance. The literature shows that almost researches have been focused on the study of individual SCM paradigms [5, 6]; or on the integration of only a couple of paradigms in SCM, e.g., lean vs. agile [7], lean vs. green [8], resilience vs. agile [9] or resilience vs. green [10]. However, the simultaneous integration of lean, agile, resilient, and green paradigms in SCM may help SC's to become more efficient, streamlined and sustainable.

Consequently, this paper main objective is to propose a conceptual model suggesting several SCM practices to become the SC more lean, agile, resilient and green, named as "LARG practices", and to analyze these practices influence on manufacturing SC's performance. A deductive research approach was used to develop the conceptual model from the literature review. This paper also suggests a performance measurement system which allows managers and decision makers to evaluate and control the results attained with the implementation of LARG practices. The paper is organized as follows. Following the introduction, a literature review on the four paradigms lean, agile, resilient and green from a SCM perspective is presented. After this, some insights on SC performance measurement are presented. Subsequently, a conceptual model is proposed as a means of suggesting a set of LARG practices and several performance measures. Finally, some considerations are drawn.

II. New Supply Chain Management Paradigms - Lean, Agile, Resilient And Green

A. The Lean Paradigm

The lean management paradigm, developed by Taiichi Ohno [11] of the Toyota Motor Corporation in Japan, forms the basis for the Toyota Production System (TPS) with two main pillars: 'autonomation' and 'just-in-time' (JIT) production. The lean paradigm has essentially focused on waste reduction as a means to increase actual value-added to fulfil customer needs and maintain profitability [12].

Reichhart and Holweg [13] had extended the concept of lean production to the downstream or distribution level: "We define lean distribution as minimizing waste in the downstream SC, while making the right product available to the end customer at the right time and location". To Parveen and Rao [14] the lean SC focus is on eliminating waste or non value steps along the chain to achieve internal manufacturing efficiencies and set-up time reduction, enabling the economic production of small quantities and enhancing cost reduction,

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profitability and manufacturing flexibility.

Anand and Kodali [15] stressed that a lean SC involves integrating all the upstream and downstream activities into a coherent whole. However, extending lean beyond the factory and component supply system into distribution operations results in a potential conflict: the need for production smoothing and kanban systems (which can't cope with high levels of variability) and the need to link the production pull signal to variable demand in the marketplace [13]. To provide added value to the customer, the lean approach seeks ways to reduce demand variation by simplifying, optimising and streamlining, and create capability by utilising assets more effectively than in traditional systems [16; 14].

Some authors have highlighted other key principles or lean practices, such as: respect for people [17], quality management [18], pull production [18] and mistake-proofing [19]. At the operational level, the lean paradigm is implemented by using a number of techniques such as kanban, 5S, visual control, takt-time, Poke-yoke and SMED [20]. In addition to these techniques manufacturing practices, such as JIT, TPM (Total Productive Maintenance) and TQM (Total Quality Management) are used to eliminate various types of waste [21]. A set of lean SCM practices have been suggested, such as: i) just in time [5, 22]; ii) supplier relationships [5; 23]; iii) cycle/setup time reduction [22]; iv) total quality management (TQM) [22].

B. The Agile Paradigm

The SC objective is to delivering the right product, in the right quantity, in the right condition, to the right place, at the right time, for the right cost. Since customer requirements are continuously changing, SC's must be adaptable to future changes to respond appropriately to market requirements and changes.

The agile paradigm intends to create the ability to respond rapidly and cost effectively to unpredictable changes in markets and increasing levels of environmental turbulence, both in terms of volume and variety [24, 25]. Baramichai, Zimmers and Marangos [26] consider that: "an agile SC is an integration of business partners to enable new competencies in order to respond to rapidly changing, continually fragmenting markets".

Agarwal, Shankar and Tiwari [24] have shown that the deployment of agile SC paradigm depends on the following variables: market sensitiveness, customer satisfaction, quality improvement, delivery speed, data accuracy, new product introduction, centralized and collaborative planning, process integration, use of IT tools, lead-time reduction, service level improvement, cost minimization, costumer satisfaction, minimizing uncertainty, quality improvement, trust development, and minimizing resistance to uncertainty.

Some of the main agile practices in the supply chain context are: i) to increase frequencies of new product introductions [24; 27]; ii) speed in improving customer service [24,]; iii) centralized and collaborative planning [24]; iv) use of IT to coordinate/integrate activities in manufacturing [24, 27]; v) speed in improving responsiveness to changing market needs [27]; vi) to produce in large or small batches [28]; vii) ability to change delivery times of supplier's order [27].

C. The Resilient Paradigm

Today's marketplace is characterized by higher levels of turbulence and volatility. As a result, SC are vulnerable to disruption and, in consequence, the risk to business continuity has increased [29]. Whereas in the past the principal objective in SC design was cost minimization or service optimization, the emphasis today has to be upon resilience [30].

Resilience is referred as the SC ability to cope with unexpected disturbances. The goal of SC resilience analysis and management is to prevent the shifting to undesirable states, i.e., the ones where failure modes could occur. In SC systems, the purpose is to react efficiently to the negative effects of disturbances (which could be more or less severe). The aim of resilient paradigm has two manifolds [31]: i) to recover to the desired states of the system that has been disturbed, within an acceptable time period and at an acceptable cost; and ii) to reduce the disturbance impact by changing the effectiveness level of a potential threat.

The ability to recover from a disturbance occurrence is related to development of responsiveness capabilities through flexibility and redundancy [32]. Hansson and Helgesson [33] proposed that robustness can be treated as an especial case of resilience, since it implies the system return to the original state after a disturbance occurrence. In this line, Tang [30] proposes the use of robust SC practices to enable a firm to deploy the associated contingency plans efficiently and effectively when facing a disruption, making the SC more resilient. This author proposes strategies based on: i) postponement; ii) strategic stock; iii) flexible supply base; iv) make-and-buy trade-off; v) economic supply incentives; vi) flexible transportation; vii) revenue management; viii) dynamic assortment planning; and ix) silent product rollover.

Christopher and Peck [34] state that resilience in SC's should be designed according to the following principles: i) selecting SC strategies that keep several options open; ii) re-examining the 'efficiency vs. redundancy' trade off ; iii) developing collaborative working across supply chains to help mitigating risk; iv) developing visibility to a clear view of upstream and downstream inventories, demand and supply conditions, and production and purchasing schedules; v) improving supply chain velocity through streamlined processes, reduced in-bound lead-times and non-value added time reduction.

A representative sample of main resilience practices in the SC's context founded in the literature is: i) strategic stock [34; 30; 35]; ii) lead time reduction [34; 30]; iii) maintaining a dedicated transit fleet [32]; iv) flexible supply base/ flexible sourcing [30]; v) developing visibility to a clear view of upstream inventories and supply conditions [35]; vi) demand-based management [35].

D. The Green Paradigm

Green supply chain management (GSCM) has emerged as an organizational philosophy by which to achieve corporate profit and market-share objectives by reducing environmental risks and impacts while improving the ecological efficiency of such organizations and their partners [36; 37]. The increased pressure from community and environmentally conscious consumers had lead to rigorous environmental regulations, such as the Waste Electrical and Electronic Equipment Directive in the European Union, forcing the manufacturers to effectively integrate environmental concerns into their management practices [38; 36]. In global SC's, focal companies might be held responsible for the environmental and social performance of their suppliers [39]. Although organizations adopted ecologically responsive practices to meet legislative requirements, ecological responsiveness also can lead to sustained competitive advantage, improving their long-term profitability [38].

Srivastava [40] defined GSCM as "integrating environmental thinking into SCM, including product design, material sourcing and selection, manufacturing processes, delivery of the final product to the consumers as well as end-of-life management of the product after its useful life." According to Bowen et al. [41], green supply practices include: i) greening the supply process; ii) product-based green supply; and iii) advanced green supply. Eco-design is defined as the development of products which are more durable and energy-efficient, avoid the use of toxic materials and can be easily disassembled for recycling [42]. However, the eco-design strategy poses certain disadvantages, including a high level of product obsolescence in fashion-driven markets, increased complexity and increased risk of failure, among others [42]. Another current GSCM practice is reverse logistics which focuses primarily on the return of recyclable or reusable products and materials into the forward SC [40; 43].

Routroy [44] state that the impact of the antecedents and drivers for a green SC may be diverse across different SC's with different manufacturing processes, with different raw materials, conversion processes, product characteristics, logistics/reverse logistics activities, etc.. According to Srivastava [40], GSCM can reduce the ecological impact of industrial activity without sacrificing quality, cost, reliability, performance or energy utilization efficiency; meeting environmental regulations to not only minimize ecological damage but also to ensure overall economic profit.

Some of the SC green practices found in literature are: i) environmental collaboration with suppliers [45]; ii) ISO 14001 certification [45, 37]; iii) minimization of waste [36]; iv) reverse logistics [36]; v) to work with product designers and suppliers to reduce and eliminate product environmental impacts [37; 45; 38]; vi) reduction in the variety of materials employed in products manufacturing [46].

III. Supply Chain Performance Measurement

Performance measurement is critical to better SCM [47]. There are sets of research studies that address the design and implementation of performance measures in a SC's context [3, 48].

According to Lambert and Pohlen [49], the lack of appropriate SC metrics may compromise customer satisfaction, sub-optimization of the organization performance, missed opportunities to outperform the competition and conflicts within the SC. Performance measurement is therefore crucial to better SCM [50]. It can facilitate inter-understanding and integration among the partners in the SC while revealing the effects of strategies and potential opportunities in SCM. There are sets of research studies that address the design and implementation of performance measurements in a SC context [51; 47 ;52].

Additionally, various sets of measurements and rules have been proposed as means to evaluate SC performance. Askariazad and Wanous [53] had prioritise SC performance measures according to their importance in the evaluation of value-added activities (supply, manufacturing, logistics, marketing and sales, and support activities) in the entire SC considering and qualitative, quantitative, financial, non-financial, input and output criteria.

Aramyan et al. [54] to evaluate the impact of quality assurance systems on agri-food SC's suggest a performance measurement system composed by the following measures: efficiency, flexibility, responsiveness and quality. The lead time as a SC performance measure is highlighted by Chaharsooghi and Heydari [55] since, according to the authors, lead time uncertainty is a type of supply uncertainty that affects ordering policies, inventory levels, and product availability level.

More recently Lin and Ho [56] suggest financial and non-financial measures to analyze the influence of a set of factors related to the RFID technology deployment on SC performance. Chan [57] has proposed a SC performance measurement system which includes qualitative and quantitative measures. The qualitative measures are those which aren't measurable, such as customer satisfaction, flexibility, information and material flow integration, and effective risk management. The quantitative performance measures are measurable. These measures attempt to evaluate the SC performance in terms of strategic planning, order planning, suppliers, production and delivery: (i) metrics to evaluate the strategic planning ability of the SC, including level of customer-perceived product value, variances against budget, order lead time, information processing cost, net profit versus productivity ratio, total cycle time, total cash-flow time and level of energy utilization; (ii) metrics to evaluate the order planning ability of the SC, including customer query time, product-development cycle time, accuracy of forecasting, planning-process cycle time, order entry methods and the productivity of human resources; (iii) metrics to evaluate suppliers, including supplier delivery performance, supplier lead time versus the industry norm, supplier pricing versus the market, efficiency of purchase-order cycle time, efficiency of the cash-flow method and supplier booking in procedures; (iv) metrics to evaluate the production performance of the SC, including percentage of defects, cost per hour of operation, capacity utilisation, range of products and services and utilisation of economic quantity; (v) metrics to evaluate the delivery performance, including quality of delivered goods, on-time delivery of goods, flexibility of service, customer needs, effectiveness of the enterprise-distribution planning schedule, percentage of finished goods in transit and delivery reliability performance.

TABLE I. SUPPLY CHAIN PERFORMANCE MEASURES

	Measures	*Indicators*	*Ref.*
Operational Performance	Quality	Customer reject rate	62
		In plant defect fallow rate	62; 63
		Increment products quality	61
	Customer satisfaction	After-sales service efficiency	61
		Rates of customer complaints	64; 65
		Out-of-stock ratio	8
	Delivery	On time delivery	61; 65
		Delivery reliability	65
		Responsiveness to urgent deliveries	65
	Time	Lead time	7
		Cycle times	66
		Delivery lead time	65
	Inventory levels	Finished goods equivalent units	67
		Level of safety stocks	68
		Order-to-ship	67
Economic Performance	Cost	New product flexibility	61
		Manufacturing cost	62
		Cost per operating hour	61
	Efficiency	Overhead expense	69
		Operating expenses	69
	Environmental revenues	Revenues from 'green' products	70
		Recycling revenues	70
		Cost avoidance from environmental action	70
	Environmental costs	Cost of scrap/rework	62
		Fines and penalties	70
		Costs for purchasing environmentally friendly materials	37
		Disposal costs	71
		Recycling cost = transport + storage costs	71
		R & D expenses ratio	61
Environmental Performance	Green image	Number of fairs/symposiums related to environmentally conscious manufacturing the organization participate	61
	Business wastage	Total flow quantity of scrap	71; 48
		Percentage of materials remanufactured	70
		Percentage of materials recycled /re-used	48
		Hazardous and toxic material output	70; 37
		Solid and liquid wastes	37
	Emissions	Energy consumption	70; 37
		Green house gas emissions	70
		Air emission	37

The cash-to-cash (C2C) metric is another important indicator because it bridges inbound material activities with suppliers, doing so through manufacturing operations and the outbound sales activities with customers. The C2C metric is important from the perspectives of accounting and SCM [57]. From an accounting perspective, it measures liquidity and value, meaning it measures the organization's assessment to cover obligations with cash flows [58]. From SCM perspective, the C2C bridges inbound material activities with suppliers, doing so through manufacturing operations as well as the outbound logistics and sales activities with customers.

As previous showed, various performance measurement systems have been used and proposed to evaluate SC performance, but there are also subject to criticism. According to Gunasekaran and Tirtiroglu [3] barely any performance measurement systems is adjusted to SC real necessities because they reveal the following drawbacks: (i) they're oriented toward short-term profit, so they encourage local optimisation but fail to support continuous improvement; (ii) they aren't connected to strategy; (iii) they lack a balanced approach to the integration of financial and non-financial measures; and (iv) they lack systematic thinking. From the perspective of Chan and Qi [59] SC performance is measured in oversimplified and counterproductive terms. Such measurements, they assert, essentially focus on cost in order to minimize individual costs but not to maximize the value to the end customer.

A SC performance measurement system shouldn't limit itself to local measurements of performance. Performance metrics should be integrated in order to measure overall SC performance instead of the performance of individual members [50]. Lambert and Pohlen [49] also criticised the measurements used to evaluate SC performance, because they don't provide information on how well the key business processes have been performed or how the SC has met customer needs, and fail to identify opportunities to increase competitiveness, customer value and shareholder value for each organization involved in the SC.

More recently a set of SC performance measurement systems have been proposed in a wide variety of contexts and with different goals such as: (i) to support quality improvement initiatives [54; 47; 52]; (ii) to analyse the impact of information systems on performance [56]; (iii) to study the influence of the relationship between different SC players on the performance [60], (iv) to evaluate the reverse/closed-loop SC performance [61].

Table 1 provides based on the literature review, an overview of the operational, economical and environmental measures that can be used for evaluate the influence of lean, agile, resilient and green paradigms on SC performance.

This table results from an effort to organize and systematize the several performance measures found in the literature on lean, agile, resilient and green SC context. As it is important to control and monitor the SC's in operational [50], economical [36] and environmental [61] terms, the main objective is to propose a typology of performance measures that makes possible an assessment of the performance of SC's in these three levels. It is important to asses the operational performance of the SC's to have information about its positioning in term of some important competitive priorities related to its more operational side, such as: the quality, the time/speed and the customer satisfaction. Also, the economical performance must also be monitored to evaluate if some of the paradigms that have being implemented help keep companies afloat long enough to survive the current economic climate. So it is crucial to have information about costs, economic value added, net operating profits, cash-to-cash cycle, etc. This systematization contemplate also environmental measures to assess if green initiatives in the SC can help the bottom line and still add value to the different SC' partners.

IV. CONCEPTUAL MODEL PROPOSED

In this section a conceptual model is proposed to explore the relationships between SCM practices (which belong to Lean, Agile, Resilient and Green paradigms, that is, LARG practices) and SC's performance (Figure 1).

This conceptual model is a first attempt to propose a set of management practices to help manufacturing SC's becoming simultaneously more lean, agile, resilient and green and also to explore the relationships between these kinds of practices and SC's performance. Next, the relationships between lean, agile, resilient and green practices and SC performance are explored.

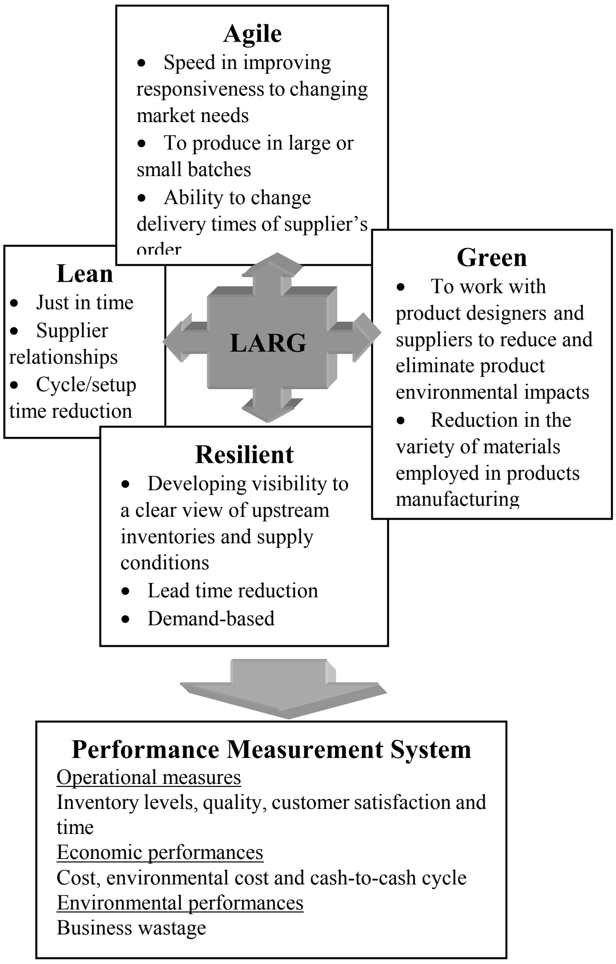

Figure 1. Conceptual model proposed

A. Supply chain performance

The model proposes a set of measures to evaluate the influence of these practices on SC's performance from an operational, economic and environmental perspective. Accordingly, in operational terms, the performance measures proposed are inventory levels, quality, customer satisfaction and time. From an economic perspective the measures recommended are cost, environmental cost and cash-to-cash cycle. Finally, from an environmental perspective the measure suggested is business wastage.

B. Supply chain management practices

The SCM practices suggested are based in the literature review and respect the main characteristics and purposes associated to lean, agile, resilient and green paradigms: all practices contributes to a SC with less waste (non-value-added activities), they are more responsive to the customer requirements, they are able to overcome disruption conditions and also to reduce environmental impacts. These practices were named "LARG practices". In this paper eleven LARG practices are proposed as following:

i. Just in time
ii. Supplier relationships
iii. Cycle/setup time reduction
iv. Speed in improving responsiveness to changing market needs
v. To produce in large or small batches
vi. Ability to change delivery times of supplier's order,
vii. Lead time reduction
viii. Developing visibility to a clear view of upstream inventories and supply conditions
ix. Demand-based management
x. Reduction in the variety of materials employed in products manufacturing
xi. To work with product designers and suppliers to reduce and eliminate product environmental impacts.

C. Supply chain management practices vs. performance

The proposed model suggests the following relationships between the LARG practices and the SC's performance measures (Table II).

The LARG practices contributing to *inventory levels* reduction are:

i. Just in time (producing and delivering the material when they are need);
ii. Supplier relationships (a suppliers cooperation allows to adjust the SC inventories);
iii. To produce in large or small batches (the WIP and FGI are adjust according to the customer needs);
iv. The ability to change delivery times of supplier's order (its supports the maintenance of low stocks levels);
v. Developing visibility to a clear view of upstream inventories and supply conditions;
vi. Demand- based management (produces exactly what the markets wants);
vii. Reduction in the variety of materials employed in manufacturing the products.

The LARG practices which contribute to a better *quality* of products along the SC's are:

i. Supplier relationships (it supports a close monitoring of materials quality problems and quick resolution);
ii. Developing visibility to a clear view of upstream inventories and supply condition (this makes possible to track the supplies quality);
iii. To work with product designers and suppliers to reduce and eliminate product environmental impacts (quality issues can also be address in the design stage).

Regarding *customer satisfaction*, the main LARG practices contribute to improving the fulfilment rate and on-time delivery are:

i. Just in time;
ii. Speed in improving responsiveness to changing market needs;
iii. To produce in large or small batches;
iv. Demand-based management;
v. Reduction in the variety of materials employed in manufacturing the products.

Concerning *time* as the strategic SC's performance measurement, the LARG practices which help improve it by increasing the SC speed and responsiveness are:

i. Just in time;
ii. Supplier relationships;
iii. Cycle/setup time reduction;

iv. Speed in improving responsiveness to changing market needs;
v. To produce in large or small batches;
vi. Ability to change delivery times of supplier's orders;
vii. Lead time reduction.

TABLE II. LARG PRACTICES INFLUENCE ON MANUFACTURING SUPPLY CHAIN PERFORMANCE

Supply chain performance / **LARG supply chain practices**	**Operational performance**				**Economic Performance**			**Environmental performance**
	Inventory levels	Quality	Customer satisfaction	Time	Cost	Environmental cost	Cash-to-cash cycle	Business wastage
Just in time	↓		↑	↓	↓		↓	
Supplier relationships	↓	↑		↓	↓			↓
Cycle/setup time reduction				↓	↓		↓	
Speed in improving responsiveness to changing market needs			↑	↓			↓	↓
To produce in large or small batches	↓		↑	↓				
Ability to change delivery times of supplier's order	↓			↓				
Developing visibility to a clear view of upstream inventories and supply conditions	↓	↑			↓			↓
Lead time reduction			↑	↓				
Demand- based management	↓		↑				↓	
Reduction in the variety of materials employed in manufacturing the products	↓				↓	↓		↓
To work with product designers and suppliers to reduce environmental impacts		↑				↓		↓
Number of practices	*7*	*3*	*5*	*7*	*5*	*2*	*4*	*5*

Legend: ↑ increase the performance measure; ↓ decrease the performance measure

The LARG practices which positively influence the SC's *costs*, meaning those which help decrease them, are:
i. Just in time (it reduces cost with materials and unnecessary production);
ii. Supplier relationships (it supports sc overall cost reductions);
iii. Cycle/setup time reduction (it reduces cost with production process);
iv. Developing visibility to a clear view of upstream inventories and supply conditions (it reduces cost with sc inventories);
v. Reduction in the variety of materials employed in products´ manufacturing (it rationalizes the materials purchasing and inventories).

The LARG practices which have a positive and direct influence on *environmental costs*, meaning those which help decrease them, are:
i. Reduction in the variety of materials employed in products' manufacturing;
ii. To work with product designers and suppliers to reduce and eliminate product environmental impacts.

The two above practices contribute for the obsolete materials' reduction, and improving the product environmental performance from the design stage.

The SC's *cash-to-cash cycle* will decrease through:
i. Implementing just in time;
ii. A reduction in the cycle/setup time;
iii. Speed in improving responsiveness to changing market needs;
iv. Demand-based management.

These last four practices contribute to faster the physical flows of materials and final products and consequently the return on the investment done with production could be also faster gathered.

The *business wastage* (namely, disposal materials, water, and CO2 emissions) among SC's partners can be reduced implementing the following LARG practices:
i. supplier relationships;
ii. Speed in improving responsiveness to changing market needs;
iii. Developing visibility to a clear view of upstream inventories and supply conditions;
iv. Reduction in the variety of materials employed in products' manufacturing;
v. To work with product designers and suppliers to reduce and eliminate product environmental impacts.

V. CONCLUSIONS

The main purpose of this paper is to suggest a set of SCM practices to become the SC more lean, agile, resilient and green, which were named "LARG practices", and to propose a conceptual model that makes possible to analyze the influence of these LARG practices on operational, economic and environmental manufacturing SC's performance. The proposed conceptual model is theory-driven and can be applied to any manufacturing SC setting. From this model it is possible to see that the LARG practices suggested as more influencing SC performance measures are the just in time and also the supplier relationships. These two practices are directly related to the lean paradigm. Moreover, the SC performance measures with more LARG practices influencing them are the inventory level and the time.

Also, the proposed model contributes for a deeper understanding of lean, agile, resilient and green paradigms in SCM. From the managerial point of view, managers can use this model as a checklist to identify possible practices to achieve their strategic goals. Also, it offers an integrated model giving manager insights on how to make SC's leaner, agile, more resilient and greener to achieve the organization operational, economic and environmental performance objectives.

Despite the important contribution of this paper limitations of the study should be noted. The conceptual model was developed using anecdotal and empirical evidences present in the literature and no validation where performed. It is necessary to conduct further research concerning the influence of LARG practices on manufacturing supply chain performance, both in terms of testing the model herein proposed and to the greater understanding of this discipline.

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