

Tradeoffs among Paradigms in Supply Chain Management

V. Cruz Machado

**UNIDEMI, Faculty of Sciences and Technology
University Nova of Lisbon, Portugal**

Susana Duarte

**UNIDEMI, Faculty of Sciences and Technology
University Nova of Lisbon, Portugal**

Abstract

Supply chain paradigms have been explored, but it is still very difficult to integrate some concepts that seem to be contradictory. This paper explores production and supply chain paradigms such as lean, agile, resilient and green. Tradeoffs between these management paradigms are identified and explored to help organizations and their supply chains to become more efficient and competitive. This paper intends to find if (and how) these paradigms have been under researchers' attention, putting into perspective eventual contributions from integrated approaches

Keywords

Industrial engineering, Supply chain management, Production paradigms

1. Introduction

Supply Chain Management (SCM) has been a topic of interest among organizations. Organizations with a deep understanding of their supply chain, may find successful sources to be competitive in the global market [1]. In the definition of SCM it is possible to find a number of issues like cost, time and quality, as well as concepts such as lean, agile and responsiveness, and more recently, vulnerable and resilient [2] and green supply chains [3]. These paradigms have been explored from an independent point of view (usually at a specific production level system organization). However, the understanding of how these paradigms may be integrated in association with the supply chain does not seem to have been deeply explored. Further research in this domain is required to understand the basic mechanisms of new business models implementation to recognize and design new opportunities for SC improvement: the application of lean concepts in the SC involves value streams and processes improvement, removing activities that do not add value; the organizational agility allows to answer efficient and effectively, in real time, to the continuous and unpredictable market changes; a resilient environment provides the capacity of the organization to be able to return to his normal state, after having suffered a shock or disturbances (example: environmental disasters, and accidents not expected or sudden alterations in the markets); the environmental consciousness (green approach) causes an increased need for intervention at organizational thinking towards a sustainable development. These paradigms (lean, agile, resilient and green) should not be considered alone or in isolation within the supply chain, although sometimes, they show up with opposed characteristics. Neither paradigm is better or worse than the others. Indeed, tradeoffs between these management paradigms may help organizations and their SCs to become more sustainable and competitive. The objective of this research is to analyze if these paradigms are being well integrated at the SCM, putting into perspective additional opportunities for improvement. A better understanding of this process is expected to provide new insights and contributions for further studies. This paper addresses a characterization of actual SCM pressures and paradigms in face of the literature review; it tries to identify actual tradeoffs among these paradigms and to define a framework to explore which areas of the management paradigms will be of better usefulness to contribute for improved SCs.

2. Supply Chain Paradigms

Market globalization, technology innovation and customized demand are in growing faster [4]. In this context, SCM has become a new and promising way of obtaining competitive advantages in the market [5]. The SCM can be

defined as a set of interdependent organizations that act together to control, manage and improve the flow of materials, products, services and information, from the origin point to the delivery point (the end customer) in order to satisfy the customer needs, at the lowest possible cost to all members [6]. Christopher *et al.* [7] defined SC as “the network of organizations that are involved, through upstream and downstream linkages, in the different processes and activities that produce value in the form of products and services to the ultimate consumer”. In addition, providing the right products and services, at the right place, at the right time, in the right quantities with the required specifications, to the customer (in an efficient and effective way), must be attended properly to assure a continuous flow in the supply chain [8]. To realize its objective, the supply chain is challenged with an increased number of management paradigms. It is suggested that modern management strategies should address the following paradigms to manage the supply chain.

2.1 Lean Supply Chain

The management system developed by Taiichi Ohno at Toyota Motor Corporation, creates what became known as the Toyota Production System (TPS). TPS has continuously evolved and became known in the West, initially as just-in-time (JIT) production [9, 10], and was subsequently popularized as lean production or lean thinking [10, 11]. According to Venkat *et al.* [12], lean thinking provides a way to: specify value, determine the best sequence for value-creating steps, perform these activities without interruption when a customer requests them, and continually improve the process. To create a lean SC, it is necessary to examine each process and to identify unnecessary resources which can be measured in costs, time or inventory [8, 9, 13]. Thus, improvements in competitiveness and overall profitability are expected [13]. According to Naylor *et al.* [14], the lean paradigm can be applied to the supply chain upstream of the decoupling point (point at which strategic stock is often held) as the demand is smooth and standard products flow through a number of value streams. More recently, Reichhart *et al.*, [10] discussed lean distribution or downstream system and defined it as minimizing waste in the downstream supply chain, *i.e.*, by demanding a certain quantity of a product that information propagates upstream through the supply chain, and the right amount of product moves downstream in the fastest possible time with a minimum of waste.

2.2 Agile Supply Chain

An agile supply chain has to have the capability to rapidly align its activities and operations for responding to changes in needs of customers and markets, both in terms of volume and variety [14, 15, 16]. The agile chain has a stronger impact on competitiveness in today's business as it enables mobilization of global resources to track evolving changes in technology and material development as well as market and customer expectations [17]. The main key components of agile capabilities are considered to be speed, quality, flexibility and responsiveness [13, 15, 16]. According to Baramichai [16], “an agile supply chain is an integration of business partners to enable new competencies in order to respond to rapidly changing, continually fragmenting markets. The key enablers of the agile supply chain are the dynamics of structures and relationship configuration, the end-to-end visibility of information, and the event-driven and event-based management. An agile supply chain is a key enabler for an enterprise's agility.” To be a reality, agile supply chain must have four characteristics [18]: market sensitive, is closely connected to end-user trends; virtual relies on shared information across all supply chain partners; network-based, gains flexibility by using the strengths of specialist players; and process integration, has a high degree of process. According to Naylor *et al.* [14], the agile paradigm definition passes through agility: that “means using market knowledge and a virtual corporation to exploit opportunities in a volatile market place”. For these authors the agile paradigm must be applied downstream from the decoupling point where demand is variable and the product varies.

2.3 Resilient Supply Chain

Over the last years, there were many types of unpredictable disasters, including terrorist attacks, wars, earthquakes, economic crises, tsunamis, strikes, computer virus attacks, hurricane, storms, extreme weather conditions, diseases, political instability, vandalism, theft [19, 20], among others. Historical data indicate that the total number of natural and man-made disasters has risen dramatically over the last 10 years [19]. Today's marketplace is characterized by higher levels of turbulence and volatility [20]. When major disruptions occur, many SCs tend to break down and take a long time to recover [19]. Xu [2] expose that “resilience, in materials science, is the physical property of a material that can return to its original shape or position after a deformation that does not exceed its elastic limit”. According to this author, resilience potentially can be a competitive advantage if you can respond more favorably to disruption than the competition. The resilient paradigm focuses on how well an organization resists to disturbances and how quickly it return to its original state or move to a new one, more desirable, after being disturbed [7, 21].

The frequency of events may be minimized by promoting best practices to increase safety. However, it is impossible to control all risk factors and accidents, and eventually they may happen [20].

2.4 Green Supply Chain

Organizations are becoming aware of environmental issues and global warming. They became even more complicated when entire SCs are considered [12]. Supply Chain Management starts to experience a paradigm shift with the growth of environmental movement, particularly the global consensus about human impact on climate change [1]. Customers will be asking about the products they are purchasing and therefore organizations will have to expect questions about how green their manufacturing processes and supply chain are. Because of this, there is a growing need for integrating environmentally choices into SCM research and practice [22]. Green supply chain management [3] or environmentally sustainable (green) supply chain management [23] has its influence and relationships between SCM and the natural environment [22, 24]. Despite the focus being moving a green supply chain, the goals of visibility, efficiency and cost reduction do not have to be discarded. It is generally perceived that green SCM promotes efficiency and synergy among business partners and their direct organizations, and helps to enhance environmental performance, waste eliminating and achieve cost savings [24], resource saving and productivity [7], improving ecological efficiency [23]. The perspective then changes from greening as a burden to greening as a potential source of competitive advantage [7, 24]. For Rao *et al.* [24], the concept of green SCM pass through: inbound logistics; production or the internal supply chain; outbound logistics; and reverse logistics. In addition, Srivastava [7] considers that key challenges of green SCM are divided in two main areas: green design (where the important issues are the environmentally conscious design and life-cycle analysis of the product) and green operation (that was sub-divided into: green manufacturing and remanufacturing; reverse logistics and network design; and waste management). For Lu *et al* [1], one of the most important measures in SCM is the impact on climate change as carbon emission. Venkat et al. [12] apply metrics for measuring environmental performance that include scrap or non-product output, materials use, hazardous materials use, energy use, water use, air emissions, hazardous waste, and water pollution. Srivastava [7] concluded that green SCM can reduce the ecological impact of industrial activity without sacrificing quality, cost, reliability, performance or energy utilization efficiency. It involves a paradigm shift, going from end-of-pipe control to meet environmental regulations to the situation of not only minimizing ecological damage, but also leading to overall economic profit.

3. Tradeoffs among Paradigms

A lean company means nearly zero inventories; a resilient company must have enough inventories to react to the effects of disruptions that may occur in a supply chain. These concepts seem to be contradictory. However, it would be ideal to have both systems working together in a company. In addition, there is a need to develop a design for environment system, to assure that the production system management is really sustainable and that it continues maintaining its lean benefits. These facts advice for further research in production and supply chain management; lean, resilient and green concepts require to be modelled on a compatibility basis. The question is how to increase company resilience, without affecting (or significantly reducing) the maintenance of a lean manufacturing environment. Many authors report some paradigms mix in the SC. For them the challenges in today's business environment are:

- How to combine lean practices with an agile response [14, 15].
- How to combine lean paradigms when organizations are subject to disruptions and cannot be resilient enough to recover competitiveness.
- How compatible are green and lean paradigms [1, 12].
- How organizations may face obstacles to develop agility and resilience [25].
- How resilient paradigm is important so that the organization get to be green [26].

Table 1 shows a meaningful sample of papers to provide some understanding on the integration of actual paradigms in supply chain management. However, as it can be seen from Table 1, major contributions found in the literature are still partial; only bilateral relationships have been studied; they did not provide a complete and integrated understanding for the global paradigms that affect the supply chain.

Table 1: Contributions from previous research

Author	Main contributions	Lean	Agile	Resilient	Green
Florida, 1996 [27]	Examines the relationship between advanced production practices and innovative approaches to environmentally conscious manufacturing. The study was designed to collect original data on the relationship between advanced manufacturing systems and innovative approaches to environmentally conscious manufacturing.	X			X
Naylor <i>et al.</i> , 1999 [14]	Provides combined paradigms lean and agile with a total SC. A case study demonstrate the combination of the two paradigms within the same SC.	X	X		
Fiksel, 2003 [26]	A design protocol is presented. Focus on a resilience perspective for organizations to become more sustainable.			X	X
Christopher <i>et al.</i> , 2004	Provided a literature review on SC six sigma. Focus on how resilient SC might be managed by the application of six sigma procedures.	X	X	X	
Venkat <i>et al.</i> , 2006 [12]	Provided a simulation model of SC. Investigate a key performance indicator in lean SC.	X			X
AMA, 2006 [25]	Provided a literature review on building organizational agility and resilience. Attempt to gauge a range of change-management and practices in relation to organizational performance.		X	X	
Qi <i>et al.</i> , 2008 [15]	Provided a research in lean, agile supply chains. Compared the two paradigms and analyzed the similarities and differences between them. Describes a customized model.	X	X		

A contribution from Vachon *et al.* [22] refers that SCM has been studied based on the product and the process on both the upstream and downstream side of the SC. In addition, Naylor *et al.* [14] demonstrate the use of lean and agile paradigms combined. The combination of lean and agile is known as leagile in a total supply chain strategy particularly considering market knowledge and positioning of the decoupling point. The authors define that upstream of decoupling point (point at which strategic stock is often held) the processes are applied to be lean, and agile paradigm must be applied downstream from the decoupling point. Another contribution from AMA [25] shows that there is a lack of clarity about the functional knowledge and skills needed to help make individuals, teams, and organizations more agile or more resilient. For them the “distinction between agility and resilience is much less important than the fact that building and sustaining mutually is essential to survival in turbulent environments. Agility without resilience can create an overexposed organization that emphasizes leanness, boundary destruction, openness, and speed so much that severe shocks and disruptions can severely damage its performance, even threaten its survival.” Venkat *et al.* [12] pretended to investigate if lean supply chains were necessarily green. They used carbon dioxide emissions as the key performance indicator. The lean principles call for distances on a supply chain to be as short as possible, but in this age of global trade, very few SCs can consist entirely of short transportation links. Moreover, the low cost of labour in developing countries is an increasingly important factor in locating parts of the SC far from customers in the developed world. Tradeoffs between lean, agile, resilient and green management paradigms must be understood as they may contribute for a more efficient and sustainable competitiveness of SCs and organizations. The challenge in today’s business environment, where organizations need to answer to the market volatility, is the intent to find an approach to combine the four paradigms.

4. A Framework to Address Tradeoff Paradigms in SCM

Relevant literature sources on new paradigms in Supply Chain Management were investigated. The literature research was based in the following libraries databases: EBSCO; Emerald; IEEEExplore; Informa-world; ISI Web of Knowledge; ScienceDirect; SCIRIUS; SpringerLink; Wiley InterScience. The research revealed that 900 papers were addressing supply chain paradigms. A number of keywords were selected: lean (L), agile (A), resilient (R), green (G) and supply (S). The intention was to know if there was any interaction among these paradigms. In the following phase, papers with two or more keywords were selected. At the end, a total of 370 papers make up the research. This literature review exercise revealed that there are a number of papers addressing the lean paradigm in the supply chain (93), but other recognised paradigms are not well researched. These findings motivated us to propose a framework to address tradeoffs paradigms in SCM. The idea is to develop a framework (model and

methodologies) to improve the organizational agility design, in a lean and green environment, in order to speed-up the bridging between states that require more or less degree of resilience, at both the company and the supply chain levels (see Figure 1).

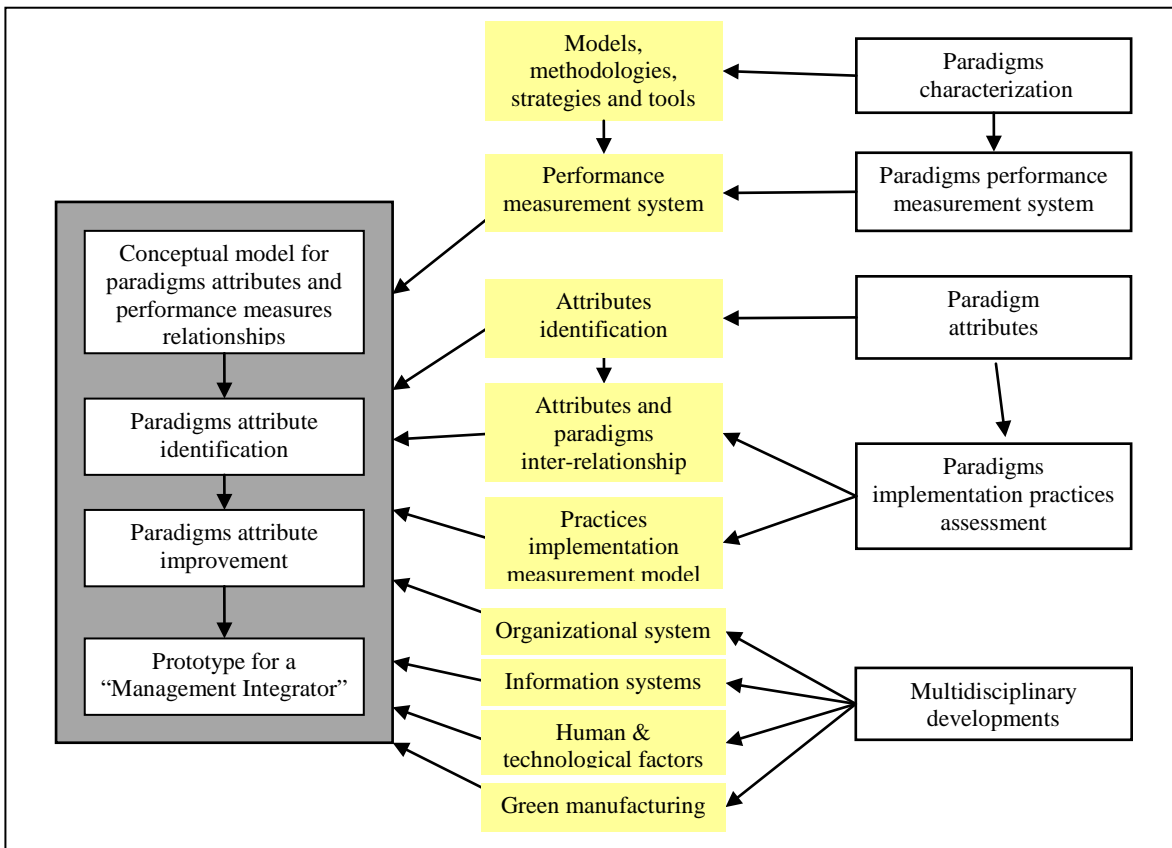


Figure 1: Framework to address tradeoff paradigms in SCM

The paradigms addressed in the framework include lean, agile, resilient and green paradigms as they were considered in the Supply Chain Management approach. The framework considers the need to characterize in detail all the paradigms, defining its performance measurement systems, as well as attributes, implementation practices and eventual multidisciplinary developments. As a result, it will be expected to design additional models, methodologies, strategies and tools to improve SCM performance; it should include developments at the performance measurement system, the organizational and information systems, and human and technological factors. A prototype for a “management integrator” is expected to provide the final approach to integrate tradeoff paradigms in SCM.

5. Conclusion

Actual market competition is very aggressive and supply chains must be designed to assure minimum lead time. The challenge in today’s business environment, where organizations need to answer to the market volatility, is to combine new paradigms and to integrate them in their supply chains. The understanding of major tradeoffs between lean, agile, resilient and green paradigms may contribute for a more efficient and sustainable competitiveness of SCs and organizations.

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