

Supply chain as a collaborative virtual network based on LARG strategy

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Abstract

The structure, organization and integration it is crucial to improve global supply chains performance and help them to achieve strategic and operational goals. Literature suggests that agile, resilient and sustainable supply chains strategies enable them to be more competitive in order to adapt to the dynamic and unstable scenario.

This paper aims to present a model for implementing a strategy based on LARG paradigms (Lean philosophy, Agility, Resilience and sustainability-"Green"), used to denote the necessary strategy for competitiveness in an international automotive supply chain.

Using "building theory approach", supported by a case study, conducted in four companies that integrated automotive supply chains, three hypotheses were defined to be validated through an explanatory model and Key Performance Indicators (KPI's) were defined to measure supply chain overall performance.

This study brings contributes to management knowledge by empirically investigate the main effects of LARG strategy on supply chain performance, proposing a process approach applied to a collaborative virtual network structure, in order to improve network efficiency.

Data analysis supports some interesting conclusions, as the more important KPI's to measure LARG strategy, and the evolution from Supply chain to Supply Network.

Keywords: Supply Chain, Collaborative network, Lean, Agile, Resilient and Green Supply Chain.

Introduction

Presently, the economic activities are global, so companies are aware that they cannot compete alone, being much easier to join up and do it [1]. This reality has led companies to develop new models of relationship, for example, cooperation management network model, that aims the effectiveness and efficiency of investments in resources, production and distribution of products or services, which allows them the ability to work as a single unit in real time on a planetary scale [2]. These networks are strong business alliances whose approach involves the integration of business and strategy, with the purpose of increasing the collective competitiveness, which requires a great coordination of activities and internal and external processes.

This article presents the results of a case study in automotive industry, from the perspective of the inter-organizational network relationships, based on LARG strategy.

The article is structured in five sections; it starts with a literature review in the first section, which seeks to clarify the notion of supply chain and supply network or cooperation network and "LARG" strategy. In the second section, network Key Performance Indicators were suggested and a proposal of conceptual model is presented. The third section describes the methodology used. In the fourth section, the preliminary results of the empirical study on developing a supply network in the automotive industry are presented. And the section five presents the main conclusions.

1. Literature Review

1.1. From Supply Chain to Supply Network

The concept of supply chain has evolved over time. In the past, vendors developed one to one relationships with their customers, protecting these relationships, projects and innovations; currently, these relations have evolved from various to many, working together, sharing resources, and reducing costs. Various supply chain definitions who question the linear view (chain), advocating a radial view (network) are arising (Fig. 1).

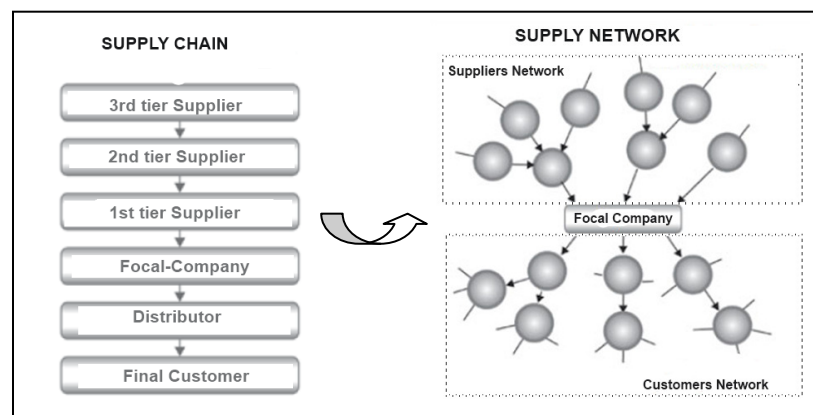


Fig. 1: From Supply Chain to Supply Network (Source: Adapted from [3])

“A supply chain collaborative network, refers to an integrated network of entities that associate with each other in a business environment, where the entities can be suppliers, manufacturers, distributors, retailers and customers” [4].

Harland *et al.* [5] corroborate this thought that a supply chain it is more a network, than a chain. Based on this approach, the supply chain in this paper was analyzed as a network of cooperation between customers, suppliers and distributors.

1.2. Supply Chain Network Design

Vertical integration, which in the past allowed the companies to assure all or part of the production process, does not allow sufficient agility and resiliency, and economies of scale necessary for competitiveness in the current market too unstable. All companies tend to be part of a supply chain, or even several. Business networks, dynamic networks or "webs of interest", appear as new forms of relationship and cooperation between companies to cope with the strong competition, the dynamics and the instability caused by the phenomenon of globalization, which has led to a market highly competitive.

Networking is an concept that designates the organization or network structure enabling collaboration between organizations and enables that facilitate its presence in various markets without having to be located in that place. This is only possible due to the development of Information and Communication Technology (ICT), providing a link between computers for multiple users located anywhere in the world and thus enabling the "shared data access", securing remote operations. Watts [6] argues that networks are dynamic because its elements are always in action, evolving with time. The organizations that comprise a network collaborate with their biggest skills, share information, communicate electronically, optimize the available resources, establish a cooperative relationship between the global dimension itself, overcoming the limits of time and distance between the partner organizations, or between the organization and the customer.

According to Agranoff and McGuire (*apud* Pereira [7], p.2), "networks are multi-organizational arrangements to solve problems that cannot be addressed, or addressed easily through a single organization." Another definition given by Börzel (*apud* Pereira [7] p.2) inserts the organizational design, a contemporary vision of virtual organizations, and network organization defines as "a set of relatively stable relationships, non-hierarchical and interdependent nature, linking a variety of actors who share common interests with respect to a policy and who exchange resources to meet these shared interests, recognizing that cooperation is the best way to achieve common goals."

A supply network is comprised of various entities, whose activity can be clearly distinguished. The structure and organizational culture, decision-making processes and management models vary from company to company. So there is not a common environment, which arises as a constraint to the definition of a structure and common strategy.

Supply chain network design is a strategic tool used to evaluate and recommend physical changes in supply chain, e.g. related to inbound movement of raw materials from suppliers, storage locations; manufacturing locations, and outbound of final products from storage locations and movement to customers, with the purpose of improve operations margins and asset utilizations and maintain service levels.

The importance of supply chain design is related with its impact on supply chain fixed costs. Adopting strategic supply chain network design, companies can achieve considerable cost reduction. However, design changes are decisions that require effort and cost, whereby it is important to make a detailed analysis of outcomes and scenarios (optimistic, pessimist and realistic). New products, new markets to serve, new strategy, alternative transportation modes for example, are situations that could trigger a new supply chain network design.

To manage supply network it is necessary to define a common strategy, setting the best way to operate the whole net, and maximizing value creation through the design of an efficient modeling of the structure and design of the network. The goal is to achieve optimization, maximum financial value and competitive advantage from their operations.

The new design should allow integration between all network elements. If a producer adopts the best practices and its suppliers adopt "the worst" practice, *e.g.* excessively high prices, or inefficient distribution channels in meeting customer expectations, so, in this cases the network performance is compromised. The main challenge is the co-creation of value, and the fair distribution of benefits in order to encourage active participation of each partner.

Organizational design was refer by contingency theories as the process of choosing and implementing a structural setting, and suggest that organizational structure must be designed to accommodate the company's strategy [8] and environmental uncertainty [9].

In the case study, the organizational design related to the network structure must also accommodate LARG strategy approach, described below.

KPI's, process management approach, as well as the management bodies of the supply network as a whole are other issues needing answers.

1.3. LARG Strategy

To cope with the strong competition and the instability caused by globalization, and convinced that the results depends on the strategic and structural choices, and also the process model, some characteristics considered essential for the survival of a pipeline in the industry automobile were identified. Lean approach presents itself as the dominant paradigm in this sector and enables improvements in productivity, quality, flexibility and adaptability of production to new economic, technological, social or environmental requirements operations. This strategy, focused on Lean philosophy, will have a positive impact on the management and performance of the network, helping to organize resources more efficiently, minimizing or eliminating waste, reducing stocks by the use of Just in Time (JIT) and Just in Sequence (JIS) methodology techniques.

Agility and resilience appear to be necessary to ensure rapid, appropriate and effective response to changes and cope with the instability and turbulence, which can lead to change and readjustment processes and work flows essential for network management and inevitably to new organizational configurations, which may involve changes in the relationships between

the various stakeholders as well as methods, processes and practices, and that will be reflected in the structure defined to the network.

The agile supply chain has the ability to respond quickly to customer requests and market changes. The importance of this attribute is related to the degree of customers' requirement, the life cycles of products and services the increasingly shorter and the technological development. This agility can be achieved through the products innovation, process innovation or organizational innovation, by new structuring of relations between the network partners.

Resilient supply network has the ability to adapt to disturbances (*e.g.* complex situations, crisis, and strikes). Networks should develop a "culture of resistance" and adaptability, being able to serve as a catalyst to increase group cohesion, because the network is not homogeneous and the most "fragile" companies may have greater difficulty in dealing with this type of phenomena/events. It is important to strengthen the resilience throughout the network.

Finally, the green supply network aims to minimize environmental impacts and increase the sustainability of the network. During the last decade, the growth of environmental awareness, in the European organizations, governments and consumers in general, has boosted the development of policies for environmental sustainability and production and marketing of environmentally friendly products, creation of more restrictive legislation and the monitorization of the effectiveness measures.

Carvalho and Machado [10] submit that the simultaneous integration of the four LARG paradigms in the management of the supply chain can lead to supply chain efficiency, rationality and sustainability. However, different paradigms seem to be related conversely. For example, lean production, works in JIT or JIS, which presupposes the absence of stock or stock keeping close to zero. However, a resilient supply network should work with enough stock to allow it to react to the effects of a rupture or other disorder. This seems contradictory, and achieves the balance between these two attributes presents itself as a huge challenge. Balancing the four LARG attributes into a single strategy is presented as an even greater challenge.

2. Conceptual Model

A model is a tool, used to represent a reality and in order to understand, change, manage and control part of that reality. Models are abstractions or simplified representations of reality that help us understand the reality and act on it.

It seeks to present a model that put together a LARG quality approach and supply network management, based on the process approach, guiding companies, from defining the business strategy to the integration of the supply chain, assisting in the identification and definition of information needs, human resources, management and quality control.

Meixell and Gargeya [11], dedicated themselves to the study of models for decision support in global supply chains, based on a classification focused on emerging issues, that include the schema: the dimensions for making decisions; performance measures; the degree in which the model supports integrated decision processes and globalization. They concluded that, while

most models solve the problem associated with globalization, few address the practical problem of the design of global supply chain in whole.

The process approach applied to the definition of new organizational solutions have shown to be a very effective and easy deployment model to achieve results in the field of quality, and this allows to align the organization's processes with the goals to achieve, and then to perform the tasks effectively and efficiently. According to Pires [12], while process management is an instrument of horizontal coordination, the hierarchy established by the functional structure coordinates the allocation of staff and resources in their area of expertise.

The process approach presupposes the definition of processes, metrics and indicators for monitoring these processes, as well as the management responsibilities, aiming to increase productivity.

2.1. Network Key Performance Indicators (KPI's)

In a collaborative supply chain network, performance measurement is essential. It is the stage of monitoring and evaluation. According to Shah and Singh (*apud* Lam [4]), an appropriate performance measurement can help to measure and evaluate the effectiveness of a supply chain, and the analysis of the performance can help the enterprises to further improve the supply chain management of network.

Key Performance Indicators are measures of process performance in organizations are used as communication tools between top management and hierarchical levels below, since they reflect the mission and vision. KPIs can also be used for performance measurement of a supply network, allowing it to direct its goals and quantifying its effectiveness and efficiency. To evaluate supply network performance it is important to define KPIs that will measure different types of performance: economic, operational and environmental.

Economic performance is affected by the management of the supply network, whose impact can be measured in terms of sales, purchasing policy, operating expenses, and investment needs (*e.g.* R&D, technology, marketing, stocks). Economic performance is also affected by operational and environmental performance.

At the operational level is important to distinguish between the activities of production and logistics. Examples of indicators that measure the operating performance are: quality level, number or percentage of defects, delivery reliability, lead time delivery, flexibility and responsiveness to changes in demand.

Environmental performance can be optimized by implementing environmental awareness programs, and can be measured by environmental indicators; *e.g.* the reduction of energy consumption and atmospheric emissions of carbon (ecological footprint), the number of programs on environmentally conscious production implemented, the percentage of recovered and recycled materials, the treatment of solid and liquid waste.

According to Azevedo *et al.* [13], between the LARG practices, the ones that most influence the performance of the supply chain is the implementation of JIT (Just in time) and the relationship with suppliers. Operational performance of the network, is also influenced by the

"lead time" and the levels of stock, so the maintenance of low levels of stock, will contribute to the optimization of network performance.

The lead time and reliability of delivery are important performance indicators of the supply networks, since a delay by a supplier of materials, parts, or components or logistics operator may result in stoppage of the production line, and therefore many thousands of dollars of damage, and unhappy customers. Control of lead time between a company and a supplier is so critical and allows controlling the lead time between now and the end customer.

In order to facilitate the conceptual translation of the network organization and structure, a framework was designed (Fig.2). It defines the phases for implementation to be easier to implement. The Phase 1 - Identification of consumer needs and how to meet them encompasses the processes of demand management as well as design and development of products and processes. The definition of the strategy and structure for the network (Phase 2 and 3), includes the remaining processes that should be taken into account. Drivers are defined in alignment with strategy and provide the basis for defining indicators to measure them (Operational, Economic and Environmental KPIs).

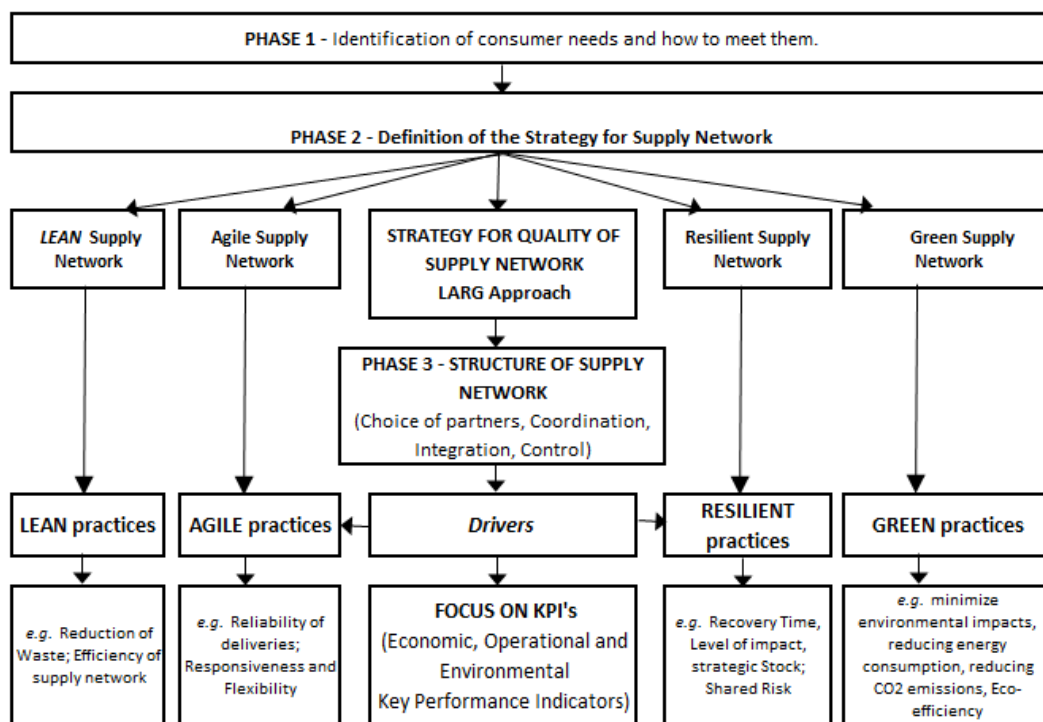


Fig. 2: Framework of LARG Strategy implementation process.

2.2. Conceptual Model

This article aims to propose a model that translate the importance of network LARG strategy, in network structure definition and in supply network performance to understand if it is a strategy to follow. The conceptual model it will be presented and will be tested later, based on a questionnaire survey with the aim of seeking to answer the three hypotheses (Fig.3), namely:

- H1 - The LARG approach strategy positively influences the structure of the supply network.
- H2 - The virtual structure of the supply network, positively influences the performance of the supply network.
- H3 - The LARG approach strategy positively influences the performance of the supply network.

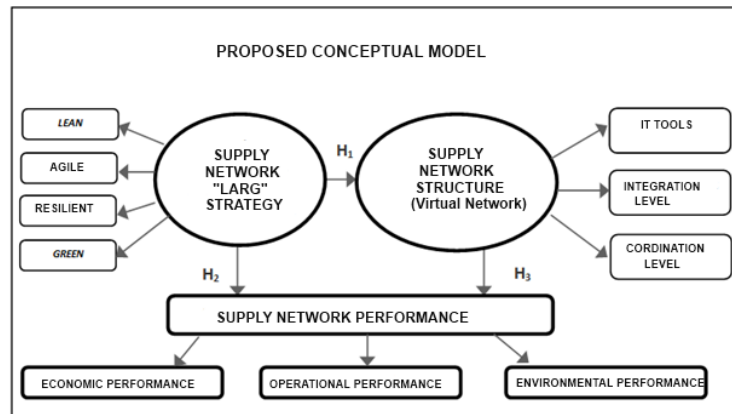


Fig. 3: Proposed Conceptual Model.

Structural equation modeling will be used to validate the proposed model. The questionnaire survey is now available in Google Docs platform, to be answered. At the moment only the qualitative data obtained through semi-structured interviews are available, and will be presented.

3. Research Metodology

To validate some theoretical knowledge, namely the way supply network establish strategies and structural formats, a case study has been conducted in a Multinational Car Manufacturer MCM located in Portugal, and three of their 1st tier suppliers.

The data collection procedures consisted on interviewees to the middle and senior level staff of Supply Chain, Quality and Production departments.

The case study methodology allowed to collect and analyze both quantitative and qualitative data, observe behavior in its natural context and conduct interviews, administer tests or questionnaires applied [14].

In this particular case, has provided a thorough knowledge of a group of companies that integrate a supply network within an industry, which is a limitation, but also a motivation to pursue more comprehensive future work.

In constructing the semi-structured interviews, the assumptions of Lipnack and Stamps [15], Casarotto e Pires [16] were used, as well those of Almeida [17] with regard to the activities and processes integrated into networks of cooperation between companies. The studies of Azevedo *et al.*, [13] and Carvalho *et al.* [10] were used with regard to LARG approach.

4. Case Study - a Multinational Car Manufacturer (MCM)

MCM is an automotive industry company. The case study examined a supply network in the automotive industry, the car producer and three of the 1st tier suppliers.

The supply network was involved in the daily operation and manufacturing supply network of the fourth entities.

Data collection aimed to study the impact of LARG strategy on organizational design or structure and on network performance. Through the auscultation of the management we attempted to:

- Identify the importance of LARG strategy.
- Identify and characterize the current supply network strategy;
- Identify and characterize the current organizational structure and relationship with the 1st tier suppliers;
- Understand what changes occurred in the strategy or in the structure;
- Identify the importance of innovation in the organization's strategy and what were the major events of change;

Strategy based on LARG paradigm was considered very appropriate to deal with the current economic climate and with the unstable and turbulent market; “perhaps the one that will lead to good results and for survival” (was one of the answers).

In Automotive industry, quality was always the more important driver in the network strategy. All the companies betted on a culture of excellence and continuous improvement, that continues to be valued. Furthermore, all the companies consider that LARG strategy and the use of Key Performance Indicators to support management, is very important too. However, both, the LARG strategy as the use of KPI were defined at the individual level and not at the network level as would be desirable.

When we asked about the ideal design to the collaborative supply network, 68% of the interviewers choose the virtual network structure, in order to improve network efficiency and agility, supported by Information Technologies (*e.g.* EDI, CRM, ERP).

The changes that were most frequently mentioned by the directors were: stock reduction in order to costs reduction; environmental programs like "Think Blue Factory" in order to reduce energy consumes and carbon impact on environment; policy of long term relationship with suppliers in order to develop them.

The directors are unanimous in agreeing that innovation is a very important to contribute to the agility of business in response to market demands, technological development and decrease of products lifecycle. Innovation can occur in products, but it is also very important in terms of processes and information systems to support the processes of coordination and integration of partners in the network.

5. Conclusions

All interviewers were unanimous to accept that the supply chain concept has evolved to supply network.

This supply network relies on information and communication technology, which gave it a collaborative virtual network features. This format facilitated communication and allowed you to connect companies that are physically distant; causing the problem of distance is exceeded.

The LARG strategy and the definition of key performance indicators were still defined for each company individually. Mechanisms should be established to define the strategy and the Key Performance Indicators to the network as a whole and not just in an individual level.

From the point of view of organizational design applied to a network, the network would be expected to have a structure and strategy as well as a management entity, a network of transverse processes to various organizations, together with their managers and monitoring indicators.

Specifically in terms of the forms of network management, only the realization of weekly meetings between the supply chains teams of MCM and local suppliers were found. Thinking in terms of other areas of integration between the companies' processes, no solutions have been identified, except those relating to the transaction of raw materials between suppliers and customers. Even these were restricted to the monitoring of production needs and the flow of materials. No indicators were used to evaluate network performance.

Given the objectives of the investigation, we found no organizational management practices inside this network where we could find support to define a methodology for designing supply networks. Thus, we will define a conceptual methodology, for which we will invite the businesses leaders to give their opinion about its validity and opportunity.

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