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Supply Chain Value Stream Mapping. A new tool of operation management

1. Introduction

The issue of the supply chain has been given much attention in recent decades, both in the academic arena as well as in the business world. It has become so important that organizations have begun to directly manage the supply chain, appointing specific managers to perform this function. New challenges now include a focus on supply to determine the right time and place for product delivery (Chin *et al.*, 2004; Robinson & Malhotra, 2005). International business competition is no longer limited to organizations but now includes supply chains (Li *et al.*, 2006; Kuei *et al.*, 2001).

Even so, the delivery of a product or service along the chain remains a critical issue in the management of organizations. In fact, it has become a crucial component of the quality of the product and service. Both quality and delivery represent two competing factors in the efficiency of the supply chain (Krajeswki *et al.*, 2008). Thus, the customer or end user (at the receiving end of the supply chain), who has specific needs, expects to receive quality products and / or services provided at all times by the supply sources. Therefore, the relationship among product quality, delivery and supply chain becomes a critical issue in managing today's organizations with regard to customers or end users.

Vanichchinchai & Igel (2009) indicate a close relationship between Total Quality Management (TQM) and the supply chain regarding its philosophical and operational goals and perspectives. However, both TQM and the supply chain have been little analyzed and studied regarding a close link between the two (Gunasekaran & McGaughey, 2003; Robinson & Malhotra, 2005; Casadesus & de Castro, 2005). Cox (1999) indicates a possible origin of the supply chain in the relationship of Toyota's TQM with its suppliers and distributors. Similarly, Gimenez (2004) notes that supply chain management is very similar to Toyota JIT or Lean Manufacturing.

In the same line of thought, Lean Manufacturing uses Value Stream Mapping as a necessary tool to eliminate muda (waste) from organizations. However, both in literature and in practice there are few tools that allow a visualization of the supply chain from the perspective of Lean Thinking or Kaizen (continuous improvement) (Vokurka *et al.*, 2007). Understanding and visualizing supply chain management is a crucial practice for all managers seeking to deliver quality products and / or services. Lee (2004) goes even further by indicating that only organizations that devise agile, adaptable and aligned supply chains will be able to continue competing in today's environment. Therefore, observing and measuring the supply chain at all times is critical for today's organizations. The purpose of this article is to describe the implementation of a tool called Supply Chain Value Stream Mapping (SCVSM) in order to thoroughly understand competitive priorities of volume and delivery (On-time Delivery) for any supply chain in organizations.

This article starts with a literature review based on the analysis of the original tool of Lean Thinking, Value Stream Mapping, which generates the new tool applied in the supply chain (SCVSM). It continues with the relationship in literature between TQM and the supply chain, referred to as supply chain quality management. These two sections create the necessary theoretical framework for the new tool proposed in this article. This article then describes the research methodology used, supported by case studies, and continues with the implementation of the tool SCVSM in two case studies. The article concludes with the main results of the implementation, their managerial implications and final conclusions.

2.- Lean Manufacturing and Value Stream Mapping

The term Lean Manufacturing was developed by Kraffkit (1988); Womack & Jones (1990) as a management principle different from Western production methods. This management approach has been recognized for its effectiveness in productivity, continuous improvement, product quality and timely delivery to customers (Gjeldum et al., 2011), as well as for its wide potentiality, through a variety of tools, to identify waste within value chains (Cookson et al., 2011). Value Stream Mapping is one of these tools and it is used to visualize a full production system, which helps identify activities that do not add value (Shararah, 2013).

Value Stream Mapping is a tool that shows the key elements of a production system based on the precepts of lean manufacturing and indicates how each interacts with the others. By observing how the flows of information and materials are related, it helps to visualize how the production system works from the time a customer initiates an order until it is delivered (Shararah, 2013).

A key feature of Value Stream Mapping is that it maps both the flow of the product or service as well as the flow of information that triggers the flow of the product or service. In this sense, Value Stream Mapping includes in its design, though it is not limited to, customers, suppliers, production control, inventory, processes, mode of production and transportation equipment. All of these allow determining the scheme of the most appropriate process output, the optimal batch size, and eliminating redundant steps and assigning appropriate personnel to carry out the processes (Michael et al., 2013). The purpose of Value Stream Mapping is to consolidate the production processes with the help of activities that add value. Performance times are determined through Value Stream Mapping and are characterized by four time components: waiting, transportation, operation and service flow (Schwarz et al., 2011). The maps indicate how long each activity takes and, at the same time, what proportion the activities that add value represent (Shararah, 2013).

Value Stream Mapping allows the display of the activities that take place throughout the production process, the time each of them takes, both those that add value as well as those that add no value for the client but are essential from the perspective of the company (Michael et al, 2013). Thus, it permits the identification of potential causes of waste as well as process improvements, while recognizing that not all identified processes that add no value can be eliminated from the processes (Cookson et al., 2011). By means of maps of the value chain, information is gathered and analyzed, identifying opportunities for improvement, selecting those to be considered in the design and implementation of the future value chain maps. Later, the results are reviewed and the outputs of the new map are determined (Michael et al., 2013).

The importance of Value Stream Mapping lies in the fact that it becomes a living reference to create, redesign or improve business processes for the whole enterprise. This requires the integration of process-mapping of the value chain with other improvement methods and tools, and at a basic level, the integration of Lean Thinking to eliminate waste and basic analysis of six sigma for problem-solving (Burton, 2014). The identification of non-value-added activities is the first step in identifying waste in the production system (Shararah, 2013).

3. The new concept of Supply Chain Quality Management - a Possible Link

The new concept of supply chain quality management is becoming important because companies rely on supply chains which are dependent on the partners involved in the supply chain to ensure the success of quality initiatives, volume and delivery of products and services (Ramos et al, 2007; Rashid & Aslam, 2012). Foster & Ogden (2008) suggest that the efforts of supply chain and quality management in turn improve each other's performance and that the integration between the two functions may be beneficial for an organization in many ways. The transition to supply chain quality management requires knowledge in two key areas of management: processes (quality, volume and delivery), and the supply chain (Fish, 2011).

On the other hand, Ross (1997, p. 36) defined supply chain quality management as the participation of all members of a supply channel network and synchronized improvement of all processes, products, services and work cultures focused on generating sources of productivity and differentiation and the active promotion of market-winning product and service solutions that provide total customer value and satisfaction. Meanwhile Foster et al. (2011) define it as a system-based approach to performance that leverages opportunities created by upstream and downstream linkages with suppliers and customers.

With their study Robinson & Malhotra (2005) propound that the literature topics related to supply chain quality management have historically been separated by both scholars and professionals into: (1) intra-organizational coordination (or traditional quality management) within an internal context of and focus on the supply chain and (2) the inter-organizational integration which interconnects supply chain and quality methodologies from an external context of and focus on the supply chain. They also propose that from an intra-organizational point of view the issues and strategies for supply chain quality management can be categorized into: integration of processes, strategy, leadership for quality and quality practices, whereas from an external point of view they must not only integrate their processes but also create formal environments that foster collaboration, including the integration of service and production processes through the supply network, beyond individual firms (Robinson & Malhotra, 2005).

Supply chain quality management is an approach based on systems for performance improvement that integrates the members of the supply chain and leverages opportunities created by the linkages upstream and downstream with a focus on value creation (Robinson & Malhotra, 2005, Foster, 2008; Fish, 2011). One of the objectives of supply chain quality management is the development of cooperative systems extended to the whole company, which are able to promote cooperation among the business components in supply chain quality management (Xu, 2011).

Supply chain quality management based on the principles of TQM considers elements such as customer focus, leadership, involvement of people, process management, management system, factual approach to decision making and mutually-beneficial relationships with suppliers (Kuei et al., 2001, Chang, 2009). Its goal is to control and optimize quality management operations based on information provided by the flow of the work systems of the companies within the supply chain. This requires not only intra- but inter-organizational coordination processes (Xu, 2011). Fung & Wong (1999) show such a case study in the implementation of TQM in a supply chain in the construction industry in Hong Kong.

To ensure the quality of the final product, it is essential that all entities in the supply chain have the same definition of quality (Lai et al., 2005). This is particularly important as the quality of the final product is inherited from the supplier (Chow & Lui, 2003; Rashid & Aslam, 2012). Evidence has been found that supply chain management improves the performance of both suppliers and buyers, and this is especially true when quality and delivery are priorities for the buyer (Flynn et al., 1995; Ho et al., 2001; Shin et al., 2000; Kuei et al, 2001).

The focus in TQM practices has changed from a purely company-focused one to one focused on the entire system of the supply chain. As a result, supplier quality management, the selection of suppliers, supplier participation and customer relationships are recognized as key elements for developing a quality supply chain (Kuei et al., 2001). That is, the narrow focus of TQM elements, which are supplier participation, design configuration of the supply chain and strategic planning, has broadened to include key strategic processes in manufacturing, product development, technology management, international sourcing and customer commitment (Fish, 2011).

Kuei et al. (2011) argue that the practices of supply chain quality management have significant effects on organizational performance. The statistical evidence shows that perceived improvements in organizational performance are associated with improvements in the practices of supply chain quality management. There is also a statistically significant association among improvements in supplier quality management, customer relations, and the selection of suppliers (Kuei et al., 2001). Finally, some authors criticize this integration by noting that the structure as well as the organizational culture, the screening system,

the amount or lack of communication through the processes have been identified as factors that inhibit the integration of TQM and the supply chain inside and outside the organization (Pagell, 2004).

When analyzing literature regarding the possible link between TQM and supply chain management it is important to highlight the necessity of finding more empirical work which will strengthen their possible theoretical relationship. Although the literature evidences some examples of quantitative work, it would be possible to explore certain elements from a qualitative viewpoint more, with more case studies to find theoretical constructs seeking this relationship.

4. Research Methodology

The research design of this article was based on the case study approach (Yin, 2004). This approach is very useful in understanding complex social phenomena. The purpose is thus to include a thorough understanding of a situation and its context, in order to propound possible theories arising from the understanding of the phenomenon (Eisenhardt and Graebner, 2007). For this type of methodology, sample selection is crucial. The continuous aim was to find cases where a wealth of theoretical data could be obtained (Yin, 2004). For our study, two company cases were selected with a consolidated supply chain and stable operating performance (see table 1). Thus, the main criterion for selection was that both supply chains would allow the identification of the variables of quality, volume and delivery for the components that make up the products (upstream) and for the finished products (downstream). Both companies are large with over 300 employees and engage in manufacturing production processes. The research project was conducted from January to June 2014.

Table 1. Case Studies seleccion criteria

Case Studies	Main Characteristic of TQM and Supply Chain	Selection criteria
A company that manufactures glass door display coolers	This multinational company has been present in Mexico for more than 20 years. Their products have always been synonymous with quality in terms of fulfillment of requirements, according to their customers and suppliers. Its ISO 9000 Quality Management System was established full-fledged in 2010. Since 2012 it has worked very hard on a supply chain project that was imposed by corporate headquarters.	The main selection criteria for this case study were: • Quality System established 4 years ago. • Products demonstrating consistent quality according to the customer. • Corporative Supply Chain project which integrates all the actors of/participants in the chain.
A soft drink and non-carbonated beverage bottling Company	A well-established company in Mexico. Its mass consumer products have also been on the market for around 30 years. Several of the bottling and logistic processes introduced a quality system based on Kaizen and ISO 9000 in 2002. Its supply chain is also recognized for its magnitude and distribution in Mexico.	The main selection criteria for this case study were: • Quality System established 12 years ago. • An established company in Mexico for several years. • Supply chain with strong distribution established in

		several regions in Mexico

For both case studies a research protocol for data collection was developed, which included an interview guide. The methods used to collect data were direct observation of the application of SCVSM in the supply chain, document analysis including warehouse, purchasing and inventory reports, as well as sales forecasts. Finally 12 interviews were conducted at the two companies, 7 at the first and 5 at the second. The persons interviewed were the Directors of both supply chains, purchasing managers, warehouse managers, and operators who work directly in the supply chain. All interviews averaged 45 minutes in length and were transcribed the day after being recorded. The interviews were conducted before and after the application of SCVSM in order to observe the usefulness in mapping the supply chain.

Data triangulation was applied among the three methods, as the use of data triangulation validates research (Patton, 2005). The results of the implementation were analyzed, discussed and observed iteratively with those involved in the application of both case studies in order to achieve a final version of the maps that are generated by the implementation of SCVSM. To be able to integrate all the information, data bases were created extracting the information from direct observation, documentary analysis and in-depth interviews. Once the data base was completed, a cross-tabulation analysis was done to generate internal validity. For example, when directly observing On Time Delivery (OTD) data in the supply chain warehouse for each case study, it was checked in documents, and finally, on the basis of the transcriptions of the interviews, patterns related to this variable or indicator were defined.

5.- Applying Supply Chain Value Stream Mapping

As indicated in section 2, the Supply Chain is the network of services, material, and information flow that link a firm's customer relationship, order fulfillment, and supplier relationship processes to those of its suppliers and customers (Krajewski et al., 2008). Considering this definition, managing a supply chain consists of at least three flows o three indicators among the players involved. These flows are the material flow, i.e. the supply of raw materials or inputs for the source company who requests them for processing; the information flow, including the traditional purchasing function to generate the purchase order with information regarding both volume and delivery times of raw materials; and finally, the cash flow, credit or cash movement within the supply chain.

In the same vein, following the definition of Krajewski et al. (2008) and Heizer & Render (2001), all supply chains consist of operational processes which have at least three operating variables for an efficient supply chain: 1) Volume or Quantity – the number of units that must be supplied; 2) Consistent Quality - compliance of requirements or specifications by the client, usually measured in percentage or standard deviation (number of errors-sigma); and 3) On-Time Delivery - the measure of time needed to fulfill the order both by the distributor and by the supplier to the company that made the order (Mizuno, 1988; Fisher, 1997). The aforementioned points are underpinned in traditional quality management literature, which considers these three indicators an elementary part of material and information flow, i.e., consistent quality such as required, OTD, as well as a balance between cost and volume (Mizuno, 1988; Juran, 1990).

Each of these operational variables or indicators is executed in the supply chain and is the basis for measuring their performance. Christopher (1998) defines supply chain as the management of supplier and customer relations in order to deliver superior value to the consumer at a lower cost for the entire chain. In this way, each supply chain has at least four major players in the relationship or network that develops among them. These players are: 1) a manufacturing company that can produce products or services; 2) suppliers that provide inputs (material) for the manufacturing company (upstream); suppliers are often identified by their position in the supply chain. For example, tier 1 suppliers provide materials or services used directly by the firm, tier 2 suppliers supply tier 1 and so on; 3) distributors, intermediaries who go from the manufacturing company to the customer or end consumer (downstream); 4) customer or consumer, the final recipient of the output (product or service of the chain) (Conner, 2004 Trent, 2004; Krajewski et al., 2008).

Considering the importance of the supply chain in the operations of organizations, its relationship with TQM and Kaizen, and the use of Value Stream Mapping in Lean Manufacturing, the tool called Supply Chain Value Stream Mapping (SCVSM) was developed. SCVSM is helpful because it creates a visual "map" of every supply chain involved in the flow of materials and information in a product's value chain. Therefore, it can be defined as a tool which allows taking a snapshot of the current situation of a supply chain by observing its material and information flow, as well as the volume and on-time delivery variables. The methodology to create the tool can be seen in figure 1.

Figure 1. Supply Chain Value Stream Mapping (SCVSM) methodology

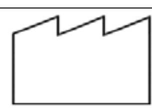
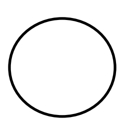
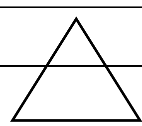
Insert Figure 1

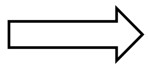
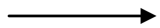
The following explains the method for constructing SCVSM (see table 2):

1. On a blank sheet of paper the manufacturer is placed in the center. The manufacturer is the core element of Supply Chain Value Stream Mapping, because he is at the origin of the supply chain. He functions as a pivot for downstream and upstream in the supply chain. The manufacturer is represented by the factory symbol.
2. Suppliers related to the manufacturer are identified and drawn. Suppliers relate to the manufacturer with regards to information, material flow and financial information. Suppliers have a direct impact on consistent product quality, volume compliance and On-Time Delivery in relation to the final consumer. In order to draw the suppliers in their different tiers, the symbol of a large circle is used.
3. The distributors down to the end consumers are identified and drawn, representing the actors downstream in the supply chain. They are represented by large triangles.

4. The material flow is mapped. This is a necessary step in the supply chain to understand the path the materials take and the relationships that exist between suppliers and distributors. It is represented by a large broad arrow.
5. Data regarding material flow is obtained and included. This activity identifies volume forecasts or volume of materials ordered in the purchase program (volume requested), as well as the volume received, i.e. the amount of material or raw material received at the warehouse (volume received). Finally, the time control variable is added as On-Time Delivery (OTD).
6. Mapping the information flow allows the identification of the path of the information which triggers the material flow from the supply chain. It is drawn as a thin continuous arrow.
7. The data from the information flow is obtained and included. This action identifies the delivery forecast of the purchase orders (in-response time). The purchasing program called Schedule Delivery (SD) is used. In addition, data from the On-Time Delivery (OTD) is obtained, i.e. the actual time in which the order was received at the warehouse.

Table 2. Symbols used in Supply Chain Value Stream Mapping (SCVSM)

No.	Symbol	Meaning
1		Manufacturer
2		Suppliers
		

3		Distributors
4		Material Flow
5		Information Flow

Like any tool for making diagnostics, there is a final step in data analysis with the volume and On-Time Delivery charts. The operation manager is able to quickly and easily determine the "gaps" that exist in material and information flows in his supply chain. When this analysis has been completed, the operation manager can make an action plan for improvement to alleviate the detected breaks in the analyzed supply chain, both in material flow and information flow.

6. Case Studies which apply Supply Chain Value Stream Mapping (SCVSM)

6.1. A company that manufactures glass door display coolers

The company under study manufactures glass door display coolers for its clients, who are mainly companies that sell end-user products such as soft drinks, beer, dairy products or meats. These companies in turn deliver to small grocery stores within traditional distribution channels and to other business formats such as restaurants, hotels and pharmacies, usually free of charge, so that the brands are showcased and the products are available to consumers. For this first case in particular, its context is a supply chain which operates in central Mexico with greater road infrastructure and distribution channels. It has several distribution centers in the country which help to improve the functioning of this supply chain. Therefore, the data and results obtained are confined to this specific context. The manufacturer's supply chain for these products was studied for six months from January to June, 2014. It should be noted that the analysis was performed exclusively for those critical parts or components needed for the cooler manufacture. Therefore, the data presented in the application of SCVSM is a semester average of the material and information flow of the components. The coolers have labels with those logos and advertisements on them requested by their customers. Other special features relate to illuminated glass, cooling capacity, voltage, dimensions and special numbering or identification to facilitate inventory control. For this reason, this research project only considered four critical components for the material and information flows used by the manufacturer: thermostats, specification plates, glass and logo labels.

1. The thermostat is one of the main components for proper functioning of the cooler. It is ordered from a supplier in Japan who offers the quality and innovation required by the company. This logistic situation generates a lead time of 90 days. Given the complexity of the component, there is only limited flexibility regarding the modification of the quantities ordered, both for reasons of production and delivery, and arrival time of the imported equipment.
2. The glass is important because it requires special resistance to temperatures, both cold and hot, as well as safety features for the consumer. It can also include personalized features and advertising requested by the customer, such as illumination, grinding, sand blasting and engraving. This component is purchased

locally with a lead time of 15 days. However, elaborate customization or special features complicate the production and may extend the lead time significantly.

3. The specification plates act as identification for the coolers. They are usually made of metal by a local supplier who stamps on the information the customer has requested, such as serial number, barcode, business unit, region or consecutive number. After completing the assembly of the cooler, the plates are welded on. Although it is a relatively simple component, its complexity lies in the special features that the customer requests. The specification plates have a lead time of 20 days and are manufactured by a local supplier.
4. The name and logo labels are the visual elements that contain the client's brand. They are placed on the cooler in order to be visible to the consumer. The customer is responsible for providing the design to be printed on the labels. They are as many variants as required by the customer. The customization in terms of label design, material and size requested generates a 30-day lead time.

6.2. A soft drink and non-carbonated beverage bottling Company

The second case study is a company that bottles soft drinks and non-carbonated beverages for final consumption, after distribution in the southeast of Mexico. Once again, the supply chain of this manufacturing and distribution company was studied. The data presented in the application of SCVSM is a semester average of the flow of materials and information of the components. It must be pointed out that the data obtained in this second case study are confined to the context of this supply chain with its suppliers and specific non-carbonated drinks distributors in the south-eastern part of Mexico. This area has a particular infrastructure, such as highways with several toll sections and roads that are not in not very good condition. The four components and / or materials that are considered critical for the analysis of material and information flows are those necessary for manufacturing non-carbonated beverages: plastic containers, screw-on caps, orange juice concentrate and labels.

1. Plastic containers are ordered in different sizes, according to the number of units manufactured of each SKU. The order quantity varies according to forecasted demand and planned production. This information is shared with the supplier and is flexible, providing a lead time of 3 days, which is extended by the supplier during peak demand.
2. The screw-on caps are supplied by the same supplier as the plastic containers. However, the lead time for these is 5 days.
3. The juice concentrate is the most critical component for making juices as it contains the taste of the drink. This component is complicated in financial and production terms, since oranges are a commodity whose supply is affected by factors sometimes difficult to control. Weather conditions, for example, create important oscillations not only regarding price but also availability in the market, even when there are agreements with agricultural suppliers. The lead time is 20 days.
4. The labels are purchased from local suppliers. They receive the demand design for the batch. The design can vary for advertising campaigns or special events. The lead time for the labels is 15 days.

7.- Main Findings for applying Supply Chain Value Stream Mapping

By observing the SCVSM it was possible to find several disruptions in material and information flow, i.e., in the variables volume and On-Time Delivery. Thus, by considering the material flow map for the cooler manufacturing company the following was identified: for tier 1 suppliers, specifically regarding the components: labels, thermostats and specification plates, there was a divergence between the volume ordered and volume received, of 50, 99500 units, respectively (see Figure 2). Only the glass was available in the amount initially ordered. The most critical disruption in the material flow in the cooler company's supply chain was the thermostat, a key component in the production process. It resulted in 2% less than requested being delivered.

The information flow of tier 1 suppliers shows that OTD was longer. The reason for this is that the thermostats were imported with a delivery time of 90 days (see Figure 3). For our case study, OTD was fulfilled 100%, 3 days before of schedule. On the other hand, the labels for the coolers took about 30 days for delivery. Besides needing special characteristics in order to adhere to the cooler, they also differed depending on the unit's size, the design sent by the customer according to product brand for the cooler, any promotional campaign and / or colors. Thus, a disruption of the supply chain of 7 days was detected for the component labels, i.e., a 30% delay in delivery.

At the downstream end of the Supply Chain, there was a 1.11% deviation for the end user of coolers received, which resulted in a complaint from the end customer.

Figure 2. Supply Chain Value Stream Mapping for the cooler manufacturing company: Material flow

Insert Figure 2

Figure 3. Supply Chain Value Stream for the cooler manufacturing company: Information Flow

Insert Figure 3

The SCVSM of the bottling company identified two disruptions in the material flow of the supply chain (see Figure 4). The first was with respect to the labels, of which 1320 units were ordered but only 1300 were delivered, representing a shortfall of 20 units or 1.5%. In turn, in the case of concentrate, the difference in units was 500, which represents 16.7%. This disruption led to delays in the bottling of non-carbonated beverages. The reason given by the supplier of concentrates was that a tropical storm affected the production of oranges by rural producers.

In the case of information flow in the bottling company, the plastic packaging and screw-on caps met OTD 100% (see Figure 5). Only two gaps were identified: labels and juice concentrate in OTD. In the case of the labels, the gap of the OTD was 3 days, and in the case of concentrate 1 day of the OTD, although in the latter case the response time difference was not significant compared to that of the materials.

At the downstream end of the supply chain, at the distribution center, regarding material flow there was a difference of 5,964 units, representing a shortfall of 1% in the supply chain. This situation was created upstream, a kind of bullwhip effect in reverse, due to the non-compliance of the supplier of the juice concentrate. Finally, regarding the information flow, the distribution center met the delivery time two days in advance.

Figure 4. Supply Chain Value Stream Mapping for the company bottling soft drinks and non-carbonated beverages: material flow

Insert Figure 4

Figure 5. Supply Chain Value Stream Mapping for the company bottling soft drinks and non-carbonated beverages: information flow

Insert Figure 5

Just like Value Stream Mapping, Supply Chain Value Stream Mapping (SCVSM) allows us to visualize the disruptions and gaps in the supply chains of both case studies, as much regarding material flows as information flow. In this respect, the application of SCVSM can allow the company to better manage the relationships among the different players of the supply chain. This finding corroborates what the literature indicates concerning the link between TQM and the supply chain, i.e., the importance of the performance of each component in the supply chain in terms of quality, volume and delivery (Flynn et al., 1995; Ho et al., 2001; Shin et al., 2000; Kuei et al., 2001).

Another important result is that the the search for operational efficiency of the supply chain requires a tool which highlights problems and failures that can occur in each link of the chain (Fisher, 1997). The reality is that the organizations studied had no specific or detailed knowledge of their supply chain before applying SCVSM. When the production managers were asked: *"How is your supply chain doing in terms of volume, quality and On-Time Delivery?"* the answer was always, *"We are trying to control it."* According to Heizer and Render (2001), adding value to every link in the supply chain allows the control of the quality, volume and On-Time Delivery of input that goes to the processing plant and in turn to the distributors. Therefore, in accordance with the evidence found, SCVSM may be the appropriate tool to generate the management control required by supply chain managers.

Finally, compared to VSM literature, it is possible to say, in light of the data found in the two case studies, that SCVSM, just like the original tool, permits the recognition of those steps that do not add value to the chain for the quality, volume and delivery indicators, which corroborates the findings of Michael et al. (2013). The most significant difference is that SCVSM takes a "snapshot" outside of the company (the manufacturer) throughout the supply chain, while VSM does the same internally. In summary, in accordance with the evidence found, SCVSM was very useful for visualizing the management of the variables volume and On-Time Delivery. This means that any organization involved in efforts towards Lean Manufacturing can manage not only its internal processes, but also those outside the boundaries of the organization.

8.- Final Conclusions and managerial implications

The purpose of this research was to describe the implementation of SCVSM in order to visualize the operation of competitive priorities, volume and On-Time Delivery, of a supply chain. The evidence shows that it is possible to apply the tool to visualize the variables volume and On-Time Delivery in supply chains. In consequence, this research has made a small empirical contribution to the theoretical field of supply chain quality management.

Moreover, the ideas of TQM and Lean Manufacturing require tools that evaluate and measure the supply chain. SCVSM can be the vehicle with which to perform those functions. Additionally, the link between the supply chain and the principles of quality, continuous improvement and Lean Manufacturing can only be put into practice using techniques and tools that allow managers to apply them directly and easily. Below, at least four managerial implications are mentioned:

1. Quick and easy visualization of the company's supply chain. It can be performed both on paper and on an electronic device.
2. Ability to observe in detail the behavior of the supply chain regarding both material flow and information flow of critical components to be processed at the manufacturer's.
3. Prioritization and critical identification of disruptions and gaps in the supply chain regarding the competitive priorities volume and on-time delivery.
4. Creation of an action plan to improve both the relationships of the players in the supply chain and its continuous flow.

In the following, some lessons learnt from the case studies are presented:

1. There is a strong necessity to measure the supply chains of the organizations which operate in Mexico using more significant indicators (centered on both case studies).

2. The gaps between programmed and real variables and critical indicators in the supply chain of the studied cases are constant and common, which increases the importance of validating them even more.
3. Mapping, documenting and obtaining data from the supply chains of the organisations studied is complex and difficult, despite corporative efforts to implant supply chain programs.
4. Given the importance that the arrival of more companies from the manufacturing sector in Mexico has gained, the issue of local suppliers and an efficient supply chain has become fundamental. A tool such as SCVSM can be very helpful in the control and management of companies.
5. The link between TQM and the supply chain is an important subject in the studied organizations. Both management systems are crucial when managing a supply chain efficiently, while simultaneously adding value to each of the established links.

Finally, inasmuch as only two case studies were tested in the context of Mexico, it is difficult to make a general statement concerning the application of SCVSM as an instrument of Lean Manufacturing and TQM for supply chains. It is necessary to test this tool in a larger number of organizations, including service organizations in other cultures and other countries. However, a theoretical generalization can be made, based on the results and patterns found during this research.

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