Quality management system in the supply chain of the metal mechanical manufacturing industry

Sistema de gestión de la calidad en la cadena de suministro de la industria de fabricación metalmecánica

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Abstract

Successful supply chains manage product flows, information and funds to provide a high level of product availability to the customer. The fundamental challenge today is for supply chains to achieve coordination despite multiple ownership and increasing product variety. The objective then is to coordinate business processes from manufacturers, suppliers, transportation, warehouses, distributors, and partners to the customer in such a way that lower costs, shorter production times and product and service quality adapted to customer requirements are achieved. In the present work, a system is created that evaluates the behavior of the supply chain based on quality. To carry it out, focus groups and exploratory factor analysis with varimax rotation are used to compile the main components of quality management in the SCQM supply chain and the set of dependent variables associated with the determining factors. The results show the most valuable key factors and this is an instrument that allows their evaluation. In the development of the research, the review of impact literature is carried out, methods, techniques and tools such as interviews, document review, work with experts, brainstorming, descriptive analysis and exploratory factor analysis, diagrams or control graphs are used.

Resumen

Las cadenas de suministro exitosas administran flujos de productos, información y los fondos para brindar un alto nivel de disponibilidad de productos al cliente. El desafío fundamental hoy en día es que las cadenas de suministro logren la coordinación a pesar de la propiedad múltiple y la creciente variedad de productos. El objetivo es coordinar los procesos comerciales desde fabricantes, proveedores, transporte, almacenes, distribuidores y socios hasta el cliente para lograr disminuir costos y tiempos de producción, lograr calidad de producto y servicio adaptada a los requerimientos del cliente. En el presente trabajo se crea un sistema que evalúa el comportamiento de la cadena con base en la calidad. Para realizarlo, se utilizan grupos focales y análisis factorial exploratorio con rotación Varimax para recopilar los factores determinantes de la Gestión de calidad en la cadena de suministro y el conjunto de variables dependientes asociadas a dichos factores. Los resultados muestran los factores clave más valiosos y un instrumento que permite su evaluación. En el desarrollo de la investigación se realiza la revisión de literatura de impacto, utilizan métodos, técnicas y herramientas como entrevistas, trabajo con expertos, lluvia de ideas, análisis descriptivo y análisis factorial exploratorio, diagramas y gráficos de control.

Quality, Supply chain, Determining factors

Calidad, Cadena de suministro, Factores determinantes

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Introduction

The Quality Management approach has changed from the traditional scenario enterprise-focused to complete supply chain systems. This change in focus has caused a change in the competitive priorities of many companies, from only the quality of the product to the overall quality of the supply chain (Kuei & Madu, 2001, pp. 409,423). On the other hand, research in Supply Chain Management has been transformed from an operational and tactical level focused on cost, delivery, and risks, to a more complex and demanding strategic level (Melnyk, 2009, pp. 4629, 4653).

There is research in Asia and the United States of America that addresses quality in the supply chain but these studies call for practical implementation since they lack them. Not yet there are many investigations on the application of ISO 9001:2015 to the Quality Management of the Supply Chain but in the studies already described the advantage of this application is observed on the competitiveness of the organization; based on administrative management tools, throwing excellent results.

The Deming management method is currently adopted by many companies in the United States and worldwide (Hodgson, 1987); Its widespread popularity appears to stem from numerous studies of cases that attribute the organizational change to the influence of Deming's management method (Hodgson, 1987). The Management Model Deming bases his approach on statistical control, problem-solving, and refinement or continuous improvement.

Problem statement

Studying the theory and practices of quality in companies as individual entities is common, but there is little research on the integration of quality requirements in the design and planning of supply chains supply (Carmignani, 2009) and how to link these practices and management systems with all partners in the chain (Gylling, 2015).

Companies seek greater integration between the partners in the chain in order to strengthen the operational efficiencies and more flexibly meet market demand (KPMG, 2014). It's necessary then to study the critical factors of the quality, so that the problem of research on which the presentation is made is that: The metalworking manufacturing industry lacks a system that allows for adequate quality management in its supply chain.

Social impact

Proper management of the supply chain undoubtedly guarantees customer satisfaction and the success of the company, since it involves activities from the supply of raw materials, manufacturing, distribution, and delivery to the end-user. Failure to treat the supply chain as it is due causes the bankruptcy of the company to which it belongs. The lagoon region (Gómez Palacio, Torreón, Lerdo, Matamoros) has as its strength manufacturing as an industrial pillar with hundreds of workers who depend economically on this type of employment. Poor chain quality management of supply brings with it the loss of profitability of the company, which would greatly affect a hundred families in that region, to the companies to which it provides services, both health and transport which is fundamental in the development of any region.

Research Questions

1. What are the most important factors influencing quality management in the supply chain? 2. How are supply chain quality management (SCQM) practices in companies' metalworking companies in the region?

Supply Chain

For Lee and Billington (1993) a supply chain represents a network for the functions search for material, its transformation into intermediate and finished products, and the distribution of those finished products to end customers.

Schroeder (2005) defines the supply chain as a sequence of business processes and information that delivers a product or service from suppliers to production and distribution to the customer, ultimately.

Correa & Gómez (2009) suggest that the supply chain proposes the integration and coordination of the company's internal activities and processes with external processes, to achieve a better use of resources and minimize operating costs.

Mentzer (2011) defines a supply chain as the set of three entities that are directly involved in the flows of products, services, finances, and information from the main source of production to the final customer.

The supply chain is defined as a succession that links elements such as customers and suppliers, through manufacturing and services so that the flows of materials, financing, and information effectively meet the purpose of the business (Morales, Rojas, Hernandez, & Rodriguez, 2013).

The supply chain in the health sector integrates manufacturers, distributors, suppliers' third-party logistics, transport companies, hospitals, and finally customers (Moreno, Mendoza, & Rojas, 2015).

A supply chain seeks to meet customer requirements, involves direct and indirectly their functions, they are involved in receiving and fulfilling a request from the client, the transport, warehouse from wholesale to retail, manufacturing, distribution, finance, and customer service. Decisions about the design, planning, and operation of the supply chain play an important role important in the success or failure of a company (Chopra & Meindl, 2017).

Successful supply chain management requires making many decisions related to with the flow of information, products, and funds. Each of these should be taken to increase the DC surplus" (Chopra & Meindl, 2017).

Currently, customers evaluate the quality of the product, or its added value and its availability in a timely manner, hence the need to streamline the processes that help to improve products (Olivos, Orue, Martinez, Mayett, & López, 2015).

Supply chains in an environment driven by globalization develop an analysis known as Global Value Chains (GVC), which come to generate a greater understanding of how companies face globalization

The goal of a supply chain should be to maximize its total profitability. This is the difference between the income generated by the client and the sum of the costs incurred in all the stages of the supply chain. Decisions about it have a great impact on the success or failure of each firm since they significantly influence the income generated as in the cost incurred. Successful supply chains manage flows of products, information, and funds to provide a high level of product availability to the customer while keeping costs low (Chopra & Meindl, 2017).

The introduction of new products with first-class processes, implies cooperation between suppliers and the company to improve the position of existence of products in the market, at the minimum cost of operation.

Each supply chain has its own identity, according to the product it offers to the consumer, the main condition in how it is distributed, the goal is to look for more common problems that occur frequently throughout the supply chain.

Managing the supply chain seeks to generate impact value by promoting both efficiency and customer service, which implies the best coordination and operation of components object that is sought to be constantly improved (García & Wilmer, 2016).

The term supply chain evokes the image of a product or supply moving along across it, from suppliers to manufacturers to distributors to retailers. In effect, this is part of the supply chain, but it is also important to visualize the information flows, funds, and products in both directions from it. The term supply chain can also imply that only one participant intervenes in each stage. The manufacturer can receive material from various suppliers and then supply it to various distributors.

Quality control and its management in organizations

It has become practically impossible to create a sustainable competitive advantage utilizing tangible product. Therefore, to be successful in a business, you need to install barriers to entry. incorporating a "service" as a complete package to the client, composed of processes, practices, and varied features and tangible and intangible results difficult to overcome by a competitor.

The client wants value for the money they pay. In most cases, it gives more importance to the quality of the service received than to the quality of the products purchased. The service, therefore, represents a formidable strategic weapon, thanks to which a company can obtain a differential advantage in the market.

The term quality is defined in ISO 9001:2015 as "the degree to which a set of inherent characteristics of an object meets the requirements". This covers all activities of the society and is not limited to the areas of production and services; for this reason, people can define it from their professional and individual experiences, their expectations and their education.

As in the manufacture of products, the key to quality in the provision of the service is customer satisfaction, which translates into meeting their expectations, and being well managed as a fundamental element of the service., quality becomes the concern of all employees of the organization. Service quality is a subjective notion that depends entirely on the opinions that customers can give about the perception of the service. (Morales C, 2016).

Quality has become a problem in organizations because its sustainability is based on buyback and consumer recommendations. Every organization strives to make money. The speed of change in today's world has forced them to create a competitive advantage by increasing customers satisfaction. It requires them to focus not only on the process but on how to carry it out because each person perceives quality differently, not everyone appreciates it in the same way and does not have the same experiences. (Berdugo, R. Barbosa, & L. Prada, 2016).

González and Arciniegas (2016) state that quality is excellence that is manifested through a organizational culture in which all members of the company must be integrated, emphasizes that two people may receive a similar service, but each may have a different perception of its quality, taking into account that each client evaluates the attitude of the staff and the service, that is, the client will be the one who assesses the quality of the product or service provided.

For its part, ISO 9001:2015 establishes that quality management is defined as part of a system of quality management that includes the activities through which the organization identifies its objectives and determines the processes and resources necessary to achieve the desired results. Control the interactive processes and resources needed to create value and deliver results for the parties' relevant stakeholders, and allows management to optimize the use of resources, taking into account the long-term and short-term consequences of your decisions.

One of the basic principles of quality management established in the ISO 9001:2015 standard is the customer focus which establishes that quality management must be oriented to comply with the customer requirements and try to exceed their expectations. It is achieved when an organization attracts and maintains the trust of customers and other stakeholders. This can be achieved in the interaction with the client, creating more value and understanding their current and future needs. Contact with customers or between them responds to the described principle and is achieved in moments of service. Quality management is a living discipline of study in constant evolution and construction. Its concept and importance have been enhanced over time by considering many environments. Its application has been found in all types of businesses and for various types of products or services (Morales C., 2016).

Quality control and management based on the DEMING management method

The Deming managerial model bases its approach on statistical control, problem-solving and continuous improvement. The concept of continuous improvement receives more attention in part due to the character inherent in global competition that thrives on product progres, service and the process quality. The continuous improvement defines the purpose of Deming's management method. Point 5, for example, encourages organizations to constantly and forever improve the production and service system" (Deming, 1986: 49).

Supply chain management (SCQM) is defined as a system-based approach to supply chain performance improvement that takes advantage of opportunities created by uplinks and descendants with suppliers and clients (Jr T. F., 2008)

Quality must be treated seriously by organizations because, whether tangible or not, the customer demand to satisfy a need, for this reason, companies must achieve correct management of the same (Barbosa, 2012).

Research methodology

The proposed procedure is based on the DEMING cycle methodology for the continuous improvement of processes, for its elaboration, the referred antecedents have been considered and analyzed.

Planning

STEP 1.1: The creation of a diagnostic instrument allows verifying the degree of compliance with certain rules established a priori with an end. The first stage includes a documentary review of the variables identified in the literature, in addition, structured interviews are conducted with staff or direct employees of manufacturing companies (LEAR CORPORATION, PEÑOLES, LALA) and the National Chamber of the Transformation Industry (CANACINTRA). Looking for those factors is considered key to the success of organizations. Based on previous studies that bring together variables linked to the quality of the supply chain, making them converge in a that integrate the stages of the chain. The study "Description of SCQM practices" by Truong, 2016; "Key variables of a study" by Bastas, 2018; Kim, 2016; Soares, 2017; Wang, 2014; ISO 9001:2015, defined on eight key factors.

STEP 1.2. The second stage uses a focus group method (FG) with 12 people; 3 master's degrees, 5 doctors, and 4 businessmen. Participants are asked to analyze and validate the conceptual definitions and scales, the level of relevance and the clarity and precision of the formulation presented, as well as the option of proposing other items or factors. The FG exercise eliminated and/or reformulated a group of variables, obtaining finally a list of 24 variables that refer to quality practices in companies of the manufactory.

With the problem identified and the solution alternatives analyzed, an Analysis is carried out Exploratory Factorial (AFE) that allows data reduction to obtain the least amount of factors that explain the maximum number of variables necessary for the study.

This phase includes the selection of the sample, considering the requirements of the statistical method used. They indicate that it should not perform the analysis with a sample of less than 50 observations.

De Winter et al. (2009) indicate that a sample of N = 50 observations is a reasonable minimum. The consultation is carried out with 75 strategically selected experts as "non-probabilistic representative samples based on the insertion in them of groups considered as typical by the researcher" (Hernández-Sampieri, 2006) with 15% engineers, 25% masters, 30% doctors, and 30% businessmen. It takes place over a two-week period in July 2020, using a questionnaire application on the Internet, developed with 24 practices carried out by the author using the Likert format and five responses in two successive rounds (See Table 1).

Supply chain	
FCRP	Specified due attention to the form and content of how the relationship is managed with suppliers
SC	Measure customer satisfaction
MCP	Established collaborative quality improvement activities with suppliers, partners, and other interested parties
PPNC	Aligned processes, products, and services with the needs of customers, and markets
II	Exchanged information, comments, experience, and resources with the parties that participate in the supply chain
SCPP	Consideration of the expectations of internal, and external customers in the planning of the processes
IPC	Considering the supplier as important as the customer
SNC	Tracked customer perceptions, and the degree to which they were meet your needs, and expectations
DMC	Implemented reliable, and secure data to make organizational and management decisions quality improvement
IC	Determined key indicators to measure quality objectives
PE	Meeting delivery deadlines to customers
AD	Exercised by senior management its responsibility so that the processes are in line with quality objectives
PCPP	Related (associated) quality practices with supplier participation
FLC	Trained the workforce with initiatives, and contributed to quality as requires
ASTM	Tests and quality tests ASTM (and other standards) carried out on the materials acquired
CMPP	Evaluated the quality of the raw material that enters the production process

RFL	Provided the workforce with the necessary resources, capabilities, and authority to drive quality improvement activities
OMC	Quality improvement objectives implemented at all levels of the organization
NCSC	Identified and prioritized the current, and future quality needs of all involved in receiving and fulfilling a customer request
EDP	Determined the stages and controls for the design and development of products
MVPO	Committed the leaders of the organization through a mission, vision, policies, and clear goals
TC	Verified the traceability, and calibration of the corresponding equipment.
NCC	Aware at all levels of the organization of the quality needs that customers demand
ID	Determined and controlled the documented information required by the Quality management

Table 1 Final structure of the research instrument based on the responses of the participants in this exercise
Source: Truong, 2016; Bastas, 2018; Kim 2016; Soares, 2017; Wang, 2014; ISO 9001:2015

At the end of the answers, they are analyzed through the SPSS software. Are used acronyms to reduce the space of practices.

Exploratory factor analysis method

Step 1.3: Based on the answers of the FG, the research instrument is created that will be validated by experts.

Step 1.4. It is based on a population of 75 experts with the capacity to answer the instrument for their relationship with this sector both from the company and from the academy and its well-known willingness to reply. According to Santos, 2000, empirically, when the concordance coefficient expressed in servings (Cc) ≥ 60% agreement is considered acceptable. In this case, the survey was answered by 63 experts who are 84% of the population with the capacity and willingness to respond, so what remains the sample taken is accepted.

Step 1.5.- The instrument is sent to the experts' emails and their responses are obtained.

Step 1.6.- The results are processed using SPSS and EFA.

Exploratory Factor Analysis (EFA) allows variables to be grouped into homogeneous groups.

All these elements can be correlated and grouped in a single factor Kahn, 2006, but also are relatively independent of the other elements that will be grouped into other factors. to evaluate if the application of the EFA is possible, we calculate the measure of the adequacy of sampling, Kaiser-Meyer-Olkin (KMO), which consists of comparing the observed correlation coefficients with the magnitude of partial correlation coefficients. If the calculated KMO value is less than 0.6, EFA should not be applied.

Another measure is Bartlett's sphericity test, which tests the null hypothesis (H0) to evaluate if the observed correlation matrix is an identity matrix. If the level of significance calculated is greater than 0.05, there is not enough evidence to reject H0. Next, it is validated if the application of AFE is possible or not is the value of the anti-image matrix. This test requires that values of the diagonal of the anti-image correlation matrix are high. The other necessary condition is that there must be high correlations between the variables.

Step 1.7.- the determining factors and their corresponding dependent variables are identified.

Data processing

The AFE processing is presented based on the applied instrument and the determining factors obtained. It is shown that all the requirements to apply the AFE are met. The measure of sampling adequacy (KMO) has a value of 0.913 and the value of the Bartlett test is 0.00 so that it is obtained that the correlations between the variables are small enough so that the factor analysis can be a good idea since there are significant correlations in the data. Too it is specified that the value of Cronbach's alpha coefficient is 0.93, which indicates the reliability of the results.

The diagonal values of the anti-image matrix are greater than 0.75 with an average value of the anti-image matrix shows a diagonal with values very close to 1 and the rest below, the sedimentation shows that most of the residuals are below 0.05. The results shown by the AFE highlight the acceptance of 21 of the 24 variables analyzed. The three factors not included have a factor loading of less than 0.6. This analysis reduces the 21 variables into two main components, which explain 68.361% of variance.

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Varimax rotation is applied to achieve a better interpretation of the results. It is a method of orthogonal rotation of factors that seeks the best interpretation of the components or constructors. The factorial rotation aims to select the most interpretable solution. It consists of turning the four coordinate axes representing the factors/components. Continue the procedure until manage to approach the saturation of the components.

The two principal components (PCs) are identified as determining factors for success. I know assign names to these determining factors as follows: No. 1, Supply Chain; No. 2, Quality. The names assigned have to do with the nature of the variables that they identify each component. They are chosen according to the bibliographical analysis described.

Products obtained

The first results of this study correspond to two of the expected products:

1.- Research instrument that helps to detect, validate and prevent failures that may arise in the chain, improving the operation of the company's SGC and reducing the negative effects in the quality of the product and allows its application in metalworking companies; The instrument of research that allows its application in metalworking companies is shown in table 2 then of the conclusion of the AFE where it can be seen, 12 variables are associated or belong to the factor supply chain and nine variables associated with the quality factor and table 1 in which it remains structured the final result of this study.

2. -Determining factors of quality management in the supply chain; It is concluded that the two determining factors are quality and supply chain.

Chain Supply	Quality
FCRP	ID
SC	ASTM
MCP	CMPP
PPNC	RFL
II	OMC
SCPP	NCSC
IPC	MVPO
SNC	TC
DMC	NCC
IC	
PE	
AD	

Table 2 Organized rotated matrix
Source: Own elaboration

Conclusions

In Latin America it is necessary to develop this type of quality proces in the supply chain since the studies that the web highlights are mostly carried out in Korea and the US; it makes us consider the need to know this type of work in our area (Mexico). Example of this we have Kim, 2016 who presents the objects of this study classified in a 2×2 matrix according to the efficiency of buyers and suppliers, proposing that these be carried out in less measure as this classification may raise concerns about dichotomizing variables of scale by giving less consideration to the values in them (Kim, 2016).

On the other hand, we have Truong, 2016 which shows the need to guarantee the reliability and validity of these models, making it necessary to consolidate their rationality through studies empirical studies in different contexts and the empirical analysis, then, provide evidence to strengthen the relationship between SCQM practices and firm performance.

Soares, 2017 is limited to UK manufacturing companies proposing future studies of SCQM could test modeling research longitudinally. It is argued that the data Longitudinal 324 have the potential to identify improvement or quality throughout the supply chain over time and locate associated causes and effects of sleep that may not be apparent until later in the course of long-term supply chain relationships.

With the study carried out, the determining variables of success in the supply chain have been identified supply, being more influential in terms of its quality, divided into two factors determiners. As a result of them, a guide is made that allows registering and transmitting in orderly and systematic information obtained from the research instrument created, which allows its application in metalworking manufacturing companies; showing after factor analysis 12 variables that are associated or belong to the supply chain factor and nine variables associated with factor quality, being structured the final result of this study. The study has produced an evaluation of previous research regarding the management of the quality of the supply chain in the metalworking manufacturing industry. It shows little implementation of a study like this, allowing the use of new opportunities to FURTHER RESEARCH.

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Which highlights the possibility of implementation; being a different challenge for each organization but not impossible to apply. In general, there is a paucity of studies related to the implementation of a supply chain quality management system in metalworking manufacturing industries. Therefore, further research is required to allow carry out a practical situation of supply chain quality control (SCQM) in a metal-mechanical company, taking advantage of the possible proposals for improvement actions that are thrown from the same for future research.

For all the foregoing, it is also necessary to consider the reason for the lack of applicability of this type of supply chain management systems in metalworking manufacturing companies; which would allow to know the key factors that positively and negatively influence the management of the chain.

It is proposed the development of research related to the subject that demonstrates the feasibility of itself and it influence on the profitability of the organization. Furthermore, due to the complexity of the study in metalworking companies, it would be very good to simulate it that allows verifying how profitable the application of the quality management system can be in it.

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