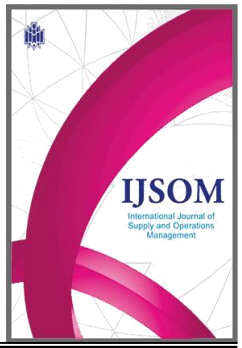
International Journal of Supply and Operations Management

IJSOM

February 2022, Volume 9, Issue 1, pp. 56-79
ISSN-Print: 2383-1359
ISSN-Online: 2383-2525
www.ijsom.com



Risks in the Automotive Industry Supply Chain

Patricia Cano-Olivos [a,*], Jorge-Fernando Sosa-Gallardo [a], Diana Sánchez-Partida [a], José-Luis Martínez-Flores[a,*]

[a] *Logistics and Supply Chain Management department, UPAEP, Puebla, Mexico.*

Abstract

This paper presents an action plan which to minimize the supply chain disruptions of trade automotive in Mexico. This research was carried out basically in 5 steps: (a) to apply surveys to suppliers of the automotive industry for (b) identifying and classifying the risk factors in the automotive supply chain. (c) Subsequently to evaluate them through the AHP (d) so that from the principle of Pareto, risk factors are prioritized and (e) finally, design an action plan to minimize or eliminate the risk factors that disrupt supply chain operations. The research finds the critical factors that jeopardize the excellent performance of the chain of supply of the automotive industry. Structured plans do not exempt supply chains from the possibility of risk. However, it helps enterprises prepare them much better to deal with risk, especially in changing, complex, global, and volatile. Risk management is vital in the excellent performance of an organization, and it is advisable to have protection mechanisms. That is part of a structured plan based on a rigorous understanding of the vulnerable points of the extended chain and the application of containment schemes and mitigation in the proper combination of redundancy and flexibility.

Keywords: SCM performance; Planning; Supply chain disruptions.

2. Introduction

With globalization, supply chains have become more complex; supply chain management (SCM) is more challenging because operations entail additional economic, political, competitive, cultural, operational, and infrastructural uncertainties, causing instability in the company and financial damages. Globalization has increased supply chain vulnerability, so fragility and frequent operational disruptions can significantly affect logistics control decisions making SCRM a vital issue and critical challenge. Although researchers and practitioners fully agree on its importance, most companies pay minimal attention to supply chain risks. The objective of supply chain risk management (SCRM) is to understand how these risks interact to mitigate and ensure the measures of adverse consequences of SC disruptions could be avoided or minimized and increase chances of a quick recovery.

This case study was applied to the Mexican suppliers of the automotive industry. The trade automotive in Mexico has established itself as one of the most significant contributors to its economic growth. However, the supply chain structures must make substantial changes in their operations to reduce costs and optimize processes to make a crucial difference in supply chain performance. The key is logistics deeply integrated to control the increasing complexity of the processes between the manufacturers and providers. This research evaluated risk factors in the supply chain by the analytic hierarchy process (AHP). Consequently, an action plan was designed to avoid or minimize the SC disruptions.

* Corresponding author email address: patricia.cano@upaep.mx
DOI: 10.22034/ijsom.2021.109227.2261

2. Literature Review

2.1. Supply Chain Management

A supply chain is a set of processes. The activities are related to the flow of information and the transformation of goods, from the raw material stage to the end-user (Ballou, 2004), and integrate supply and demand management (Lavastre *et al.,* 2014). According to Stadtler (2005), the supply chain is a network of organizations involved through uplinks and downlinks in different processes or activities that bring value to the products or services that reach the final consumer in a cohesive high-performance business model (Zsidisin and Ritchie, 2009). The organization should reduce costs and satisfy customers' needs, which depends on the effective management of the supply chain. In other words, the integration of the organization's processes through resources and information, from suppliers to the end-user, is known as the management of the supply chain, which has valued the product or service (Stock and Lambret, 2001). For Stadtler (2005), the integration of the organizational units along the supply chain is through the coordination of the flows of materials, information, and financial resources, to fulfill the client's demands and improve competitiveness (figure 1).

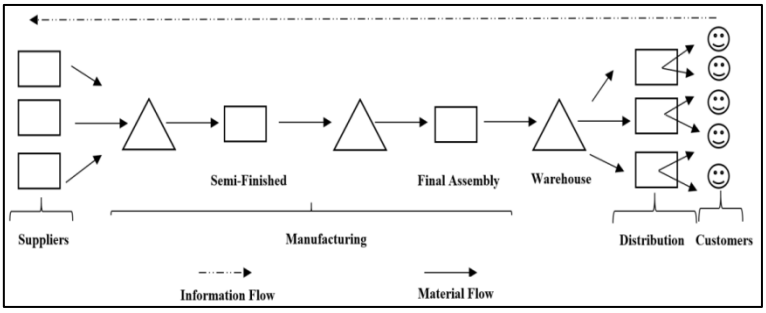


Figure 1. Supply Chain

Source: Stadtler, 2005

The main objective of the SCM is to find the balance between total costs, value, and customer service. Hence, various strategies must appear for:

- Ensure to respond to the client's demand
- Minimize the time between the production of a product and its sale to the end customer
- Maximize cash by reducing inventory.
- Ensure competitive advantages in the time of introduction of new products and services

Currently, the global competition is driving companies to supply companies, while logistics plays a crucial role in companies regardless of whether they are small or large (Cano *et al.,* 2015). Logistics is an indispensable process in the management of the supply chain since it is the one that plans, maintains, and controls the flow and storage of goods and services and information, from origin to the consumption, with the objective of satisfying customer requirements and also creates to value the capacities and resources must be used to bring the products and services to the shortest possible time and cost, and with the best quality (Gunasekaran *et al.*, 2001). For this, organizational structures have key performance indicators (KPIs) to identify the supply chain's strengths, weaknesses, opportunities, or threats.

2.2 Key Performance Indicators of supply chain

Defining quantitative and qualitative KPI's play a critical role in the alignment of organizational goals towards the voice of the client through stable and predictive processes. Qualitative indicators are based on flexibility and adaptability, while quantitative indicators are based on cost reduction or billing. On the other hand, the Project Management Institute (2013) argues that companies must have objectives and standards to define the metrics of the business model. It should be noted that these measures must be current and oriented towards the future and that they must provide a status of the current situation and act accordingly. According to Velimirović *et al.* (2011) can be through financial and non-financial measures because they reveal the fulfillment of the objectives; for this, you must define and standardize all processes within the organization. For organizations, it is vital to measure the performance of the strategic objectives of the supply chain (Gunasekaran and Kobu, 2007).

The purchasing process is considered critical since it has to guarantee the adequate performance of the supply chain through the management and acquisition of the products/services. The main objective of purchasing management is to satisfy the company's needs with external elements to it, maximizing the value of the money invested (economic criterion). However, this short-term (immediate) objective must be compatible with the rest of the departments to achieve the strategic goals, whether short-term (improving the benefit) or strategic (improving the competitive position) (Martínez, 2007). Likewise, the measurement and control of inventories become a crucial element for adequate performance in the competitive environment of the supply chain due to manages the raw materials, products in-process and/or completed for

the proper operation of the business (American Production and Inventory Control Society [APICS], 2008), including attention to customer orders (Toomey, 2000).

Inventory management increases the level of service to reduce purchase costs and minimize the variability of demand, and the financial costs of losses and administration increase. According to Sarabio (1996), the basic parameters in inventory management are the associated costs (preparation cost, launch or order, storage cost, and breakage cost), demand, and delivery time. Other factors also influence such as the nature of the suppliers, the requirements and conditions of the orders, the life cycle of the product, and limitations of means (capacity, space, budget, time, etc.). Furthermore, warehouse management is the process that regulates flows between supply and demand and optimizing distribution costs, and satisfies the requirements of specific production processes (Torres, 2006). Rouwenhorst *et al.* (2000) indicate that warehouse management is a set of processes such as the reception, storage, and preparation of orders that attend to customers' needs.

Ferrín (2007) mentions that the planning of storage and distribution operations requires quantifying many factors that determine the needs of the logistics system. For example, product characteristics, type of packaging, purchase lots to the supplier, stacking capacity, environmental storage conditions or safety requirements, foreseeable rotation, order picking frequency, and shipping system for transport. To Sánchez (2008), another critical process of the supply chain is production management. Murthy (2005) defines production management as the application of technology to transform the raw material into finished products, which allows satisfying customers' needs. According to Urzelai (2006), each company must design a distribution system according to their needs, and the contract must be the most appropriate means of transport to each case. An organization should have high levels of quality service, stock availability to keep orders within the required deadlines, delivery speed, and low costs. Moreover, the transport process allows the physical movement of the products through different modes (trucks, ships, airplanes, etc.) from origin to destination.

The distribution includes the activities of loading and unloading, and transporting the products between the origin-destination in the supply chain to satisfy the clients' needs in the time, place, and appropriate costs (American Production and Inventory Control Society [APICS], 2008). Finally, Tejero (2007) mentions that customer service should consider customers' needs in terms of information, product quality, compliance under agreed conditions, especially quantity and time right. Soret (2006); Navascués and Gasca and Pau (2000) indicate that the customers are the last link in the supply chain. Therefore the efforts of the logistics system must establish adequate service levels for satisfying the needs. This service is the final goal of the logistics system. Hence many companies first set the level of service to be competitive. The service components are delivery time and availability of the product, sales unit, payment terms, packaging of deliveries, and after-sales service. The planning and control of KPIs is key to achieving proper goals and detecting risk factors in the supply chain. Table 1 shows the essential performance indicators for measuring supply chain performance.

2.3 Supply Chain Risk Management

The business risk is the level of exposure to uncertainties that the enterprise faces (Deloach, 2000); this is universal as it will concern several activities (Lavastre *et al.*, 2014); also, it can be classified according to its origin (Gómez-Mejía *et al.*, 2008). A risk is an uncertainty (Zsidisin and Ritchie, 2009) that a particular adverse event occurs (Royal Society, 1992) like late delivery, financial burdens, business loss, among other activities (Holton, 2004; Mangla *et al.*, 2016) by internal, external and natural factors. In the context of SCM, risk is a multi-dimensional construct (Punniyamoorthy *et al.*, 2013) that is based on two main components, probability and impact (Table 2).

Table 1. Key Performance Indicators of supply chain

Procurement Management (Navascués and Gasca and Pau, 2000)	**Inventory Management** (APICS, 2008; Toomey, 2000)	**Warehouse Management** (Torres, 2006; Rouwenhorst *et al.*, 2000)	**Production Management** (Murthy, 2005; Sánchez, 2008)	**Transport Management** (APICS, 2008)	**Distribution Management** (APICS, 2008)	**Customer Service** (Tejero, 2007; Soret, 2006)
Procurement cost Delivery time of the supplier for the order Percentage of complaints about products purchased and perfect deliveries Number of purchases from certified suppliers Cost of purchase order Rotation of materials inventory Average supply term (delivery time) The average cost of raw materials over the total sales Compliance with terms Average payment term Perfect order Order served	Rotation of inventories Inventory coverage Damaged and obsolete inventory Inventory cost	Cycle time in reception Percentage utilization of storage space or positions The efficiency of material handling equipment Accuracy of order preparation Inventory service level for orders Quantity of products not shipped Average of lines dispatched per hour Warehouse productivity and costs	Percentage of compliance with the master production schedule Production cycle time Production efficiency Preparation time or setup Batch size Manufacturing unit cost Fulfilment of the planning Average manufacturing time Rotation of work in process (WIP) Utilization of the manufacturing capacity Average product stock in process per week Defective returns The efficiency of the production line Average labor cost Equipment efficacy Relationship of the stoppage time planned about the time of planned production Lot size Planned stop time	Average transport cost per unit Cost of transport on sales Volume per mode (load mix) Load factor Cost per km Cost of transport per kg moved and by mode Transport utilization Percentage of the internal transfers cost on the total Deliveries in time Urgent shipments Percentage of direct shipments from the plant Number of shipments per order	The average cost of unit distribution Delivery time in the center Cost of the warehouse over sales Productivity in volume moved Service level per order and center Productivity regarding entries in stock Productivity regarding the outputs. Productivity refers to boxes complete selection (selection) Productivity refers to boxes formed through units selected releases (picking) Productivity of returns Use of space in the center distribution Distribution Units processed per meter Square	Reliability of orders to serve the customer Accuracy of documentation sent to the client Response time to the client's request Response to customer modifications The average cost of customer service

Table 2. Probability vs Impact Matrix

Economic Impact	**Likelihood**			
	Very Low	**Low**	**Moderate**	**Critical**
Critical	High	Critical	Critical	Critical
High	Moderate	High	High	Critical
Moderate	Low	Low	Moderate	Moderate
Low	Low	Low	Low	Low

Source: (Fernández and Munier, 2014)

Mitchell (1995) evaluates risk/probability of loss and impact with the following formula:

$$Risk(n) = P(n)x\ I(n) \quad (1)$$

Where:

P = probability is the percentage value that measures the likelihood of a threat occurrence or its materialization.

I = Economic Impact is the consequence of a risk. The impact can be measured as a monetary value and is classified as low, moderate, high, and critical.

Therefore, risks must be managed immediately to mitigate the impact in the supply chain, so an organization must implement risk management (SCRM) to reduce obstacles (Sharma and Bhat, 2012). It should be noted that SCRM ensures continuity, internal operations stability, customer and suppliers' interaction, and high service levels. As such, SCRM is the coordination among members (Christopher, 2002; Blos *et al.*, 2009) for identifying potential adverse events, determining the chance of occurrence, assessing the severity of their impacts (Varzandeh *et al.*, 2016), and reducing vulnerability (Kilubi, 2016) as a whole. Risk management identifies, assesses, and prioritizes the risks after coordinating the application of resources to minimize, monitor, and control the probability and impact (Trkman *et al.*, 2016) (Figure 2). A comprehensive understanding of SC internal and external conditions and all related activities (Kayis and Dana, 2012) can identify both the potential risks that affect directly and indirectly (Kwak *et al.*, 2018) and risk sources, triggers, and drivers (Rafi-Ul-Shan *et al.*, 2018). According to Kwak *et al.* (2018), risk assessment determines the impact of the risks identified for prioritizing it according to predefined criteria and looks for actions that reduce risk and its effects. Whatever the criterion is, a level of rigor and detail will be used to decompose an initial list of risks (Fang and Marle, 2012).

Figure 2. Supply Chain Risk Management
Source: Own elaboration

To manage global supply chain risk, companies need to follow a path from risk identification to strategies to deal with risks. Two trends affecting the dynamics of global supply chains are the globalization and consolidation of firms, with increased uncertainty both for the firm making these changes and its competitors (Abrahamsson *et al.*, 2003). Difficulties in logistics operations exist at strategic, tactical, and operational levels (Schmidt and Wilhelm, 2000). These uncertainties become further pronounced by the challenges in the global environment, such as escalating oil prices and security problems. All these factors should consider in the design of multi-national logistics systems. Further, incomplete information on whether some issues (e.g., concerns regarding bribery in some developing countries) are "negotiable" or "rigid" also contributes to uncertainties faced by global supply chains.

Another feature of global competition is uncertainty over competitive advantages, including the lack of historical rules regarding initial moves and competitive reactions (Kogut, 1985). On a macro level, there are fundamental shifts in the comparative advantages of countries. An example is the shifting of manufacturing bases to Asian countries such as China and India. On a more micro level, local firms in different countries may be radically different in their approach to, and priorities in, conducting business. Two other factors critical to the performance of a global supply chain are the uncertainty of lead times and supplier reliability (Schmidt and Wilhelm, 2000). All logistics activities can be affected by lead-time uncertainty (Speh and Wagenheim, 1978). Bowersox and Calantone (1998) mention that to eliminate some aspects of extended lead times using advanced IT, the physical transport of goods necessitates long transit times characterized by uncertainty. In sum, global supply chains are complex, continually evolving, face multiple difficulties, and are of importance to all levels of the organization.

Similarly, risks in the supply chain are classified as quantitative or qualitative. Quantitative hazards include stock-outs (lost sales), overstocking, obsolescence, customer discounts, and inadequate availability of components and materials in the supply chain. Qualitative risks include a lack of accuracy, reliability, and precision of the parts and materials in the supply chain. The sources of risk are divided into supply risks, operations risks, demand risks, security risks, macroeconomic risks, policy risks, competitive risks, and resource risks (Table 3). Ho *et al.* (2015) claim that a wide range of factors could give rise to demand, manufacturing, and supply risks.

Table 3. Sources of risk

Risks	Source
Supply risks	Disruption of supply, inventory, schedules and technology access, price escalation, quality issues, technology uncertainty, product complexity, frequency of material design changes may cause failures from the supplier(s), such that the outcome is the inability of the firm to meet customer demand (Zsidisin *et al*., 2004).
Operational risks	Breakdown of operations, inadequate manufacturing or processing capability, high levels of process variations, changes in technology, changes in operating exposure may affect the internal ability to produce goods and services, quality and timeliness of production, and/or the profitability of the company.
Demand risks	Sources of demand risk could be delayed/inappropriate new product introductions (leading the firm to either miss market opportunities or inventory write-offs/stock-outs due to inaccurate forecasting), variations in demand (caused by fads, seasonality, and new product introductions by competitors), and chaos in the system (caused by overreactions, unnecessary interventions, and distorted information from the downstream supply chain members) (Johnson 2001; Wilding 1998).
Security risks	Information systems security, resource security, freight breaches from terrorism, vandalism, crime, and sabotage may or may not be a member of the supply chain and whose motivation is to steal proprietary data or knowledge (i.e., intellectual property) and destroy, upset, or disable a firm's operations. The sources of information security risk include individuals within the firm, leaking vital information to competitors, system hackers, and weak security/firewalls of members of the supply chain (Spekman and Davis 2004).
Macro risks	Economic shifts in wage rates, interest rates, exchange rates, and prices.
Policy risks	Actions of national governments like quota restrictions or sanctions.
Competitive risks	Lack of history about competitor activities and moves.
Resource risks	Unanticipated resource requirements.

Source: Own elaboration

The complex decision problems are converted into a hierarchical structure consisting of multiple levels, like a goal, criteria, sub-criteria (Dey and Cheffi, 2013; Govindan *et al.*, 2014; Madaan and Mangla, 2015). With the help of the Analytic Hierarchy Process (AHP), difficult problems are evaluated very easily (Luthra *et al.,* 2016) and allows policymakers to have optimal decisions in an organizational context. AHP is a decision analysis tool proposed by Prof. Thomas L. Saaty (1980). Moktadir *et al.* (2018) used the Delphi method and AHP techniques to select the relevant risks and determine their priorities associated with pharmaceutical supply chains. Ganguly (2014) presented a model for evaluating supply-related risk, which is based on the AHP method and the Dempster-Shafer theory (DST). Wu *et al.* (2006) determined the relative weights of individual risk factors by AHP. Schoenherr *et al.* (2008) combined action research with AHP for assessment risks. Ganguly and Guin (2013) used a fuzzy-AHP to determine the risk and potential impact on the supply chain.

3. Methodology

This study is developed in five steps (figure 3): a) intentional sampling for applying surveys; it consists of identifying the suppliers of the automotive industry, which will be an essential part of this research, b) identification and classification of risks factors; based on the results of the survey, the risk factors that are most frequent in the automotive industry supply chain are identified and classified, c) evaluation; AHP is used to assess risk factors, it is essential to highlight that managers actively participated in this stage, d) prioritize; once the weights of each factor are obtained with the Pareto principle these are prioritized, and e) action plan; finally, an action plan minimizes or eliminate the risk factors that interrupt supply chain operations.

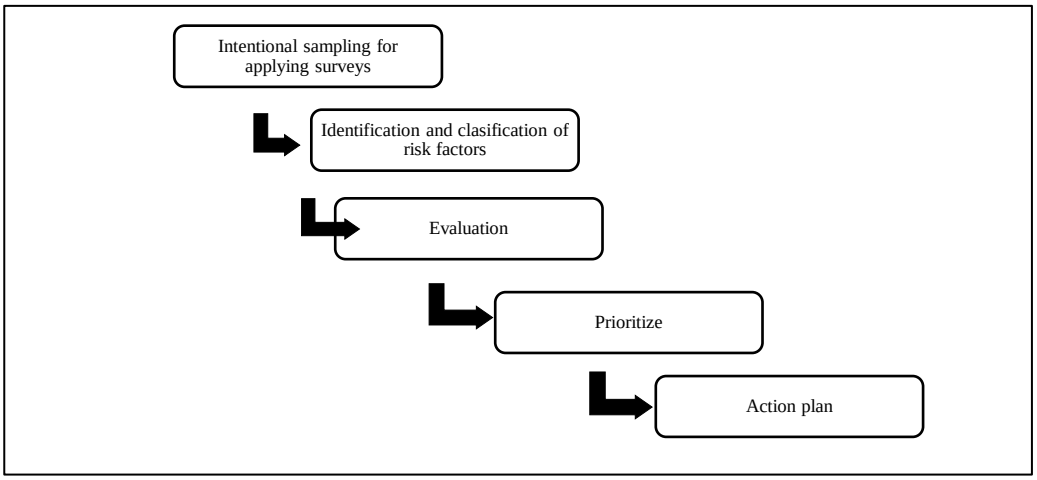


Figure 3. Methodology

Source: Own elaboration

4. Case Study

4.1. Intentional Sampling

It should be noted that the automotive industry represents 80% of the state of Puebla. This industry currently employs more than 45,000 people in this sector. According to the Mexican Association of the Automotive Industry (2019), automobile production grew by 21.9%, reaching sixth place as the largest automobile producer in Mexico. For this reason, this sector was considered for identifying risks in the supply chain. The following 32 companies (Table 4) are listed, which are the main suppliers in the automotive industry of the State of Puebla, and which the ones that provided relevant information through surveys were also. It should be noted that 64 surveys (Operations / Production and Logistics Managers) were sent via e-mail, of which only 55 responded.

Table 4. Suppliers of the Mexican automotive industry

#	**Company Name**	#	**Company Name**	#	**Company Name**
1	SMP	**12**	Plastic Omnium	**23**	Thyssenkrupp
2	Benteler	**13**	Allgaier	**24**	Pelzer
3	Faurecia	**14**	Geni	**25**	Otscon
4	Gestamp	**15**	Geni	**26**	TI Group
5	Draexlmaier	**16**	A&P	**27**	CA Automotive
6	SKH (TLMOS)	**17**	Aksys	**28**	Gonvauto
7	Kautex Textron	**18**	Mecaplast	**29**	Concorde
8	Inteva	**19**	HBPO	**30**	Rassini
9	Webasto	**20**	Autotek	**31**	Truck and Wheel
10	Schaeffler	**21**	Kayser	**32**	PSW
11	Lear	**22**	Nemak		

Source: Own elaboration

It should be noted that the survey is designed strategically to detect the various external and internal factors of risk in the supply chain. This approach allows refining the responses of managers to avoid dispersion of results and loss of valuable information. Table 5 shows the areas, factors, and risks that are considered important for this study.

Table 5. Important considerations for the survey

Area	Factor	Risk
Supply	• Failure to make delivery requirements • Lack of integration with suppliers • Failure to handle volume demand changes • Low technical reliability • Failure to meet quality requirements • Cannot provide competitive pricing • Contractual agreements	Acquisition cost risk is the variation in the cost of raw materials caused by uncontrollable factors.
		Supplier low-quality risk is associated with the defective raw material that can generate reprocesses.
		Shortage risks are the errors in delivery, resource planning, and loss of materials, among others which can cause production delays due to missing.
		Supplier loss risk generates a shortage of raw material and delays in production operations.
		The risk of demand variability is associated with market uncertainty.
Manufacturing	• Product quality and safety • Insufficient breaks • Warehouse disruptions • Insufficient maintenance • Production capabilities/capacity	Design risks are human errors, machinery failures, or interruption of material flow.
		Risk of non-compliance technical product specifications
		Occupational hazards are accidents and occupational diseases.
Demand	• Demand variability • Competitor moves • Deficient or missing customer relation • Management errors • Order fulfillment errors	The risk of demand variability is associated with market uncertainty.
		Risks of non-payment are the customer's default payments that may have adverse effects on the organization due to insufficient budgets for future projects.
		Technological risks can generate information damage or service interruption.
		Competition risk can cause a loss of customers.
		The risk of changes in product specifications may cause an interruption in the current project.
Resources	• Transit time variability • Information delays • Higher costs of transportation	Risks in the operations of the logistic actors can prolong the delivery times of raw material or inputs due to uncontrollable external factors.
		The risk of non-payment of a customer is interruptions in delivery operations due to unforeseen events that result in the extension of the product's distribution time.
		Strategic risk is loss caused by decision-making based on inappropriate strategies.
		The risk of over costs is the variation of resource costs.
		Risks of government policies are government modifications at the business level.
		Security risk in communication channels is the alteration of business information due to the use of communication channels with poor security, and which entails the loss of customer reliability.
		Legal risks are regulatory provisions that may lead to lawsuits or restrictions.
		Financial risks are fluctuations of investments in the stock market, prices of inputs and products, exchange rates, and interest rates.
Macro Management	• Terrorist acts • Climate change • Earthquakes • Tsunami • Eruption	Security risk in communication channels is the alteration of business information due to the use of communication channels with poor security, and which entails the loss of customer reliability.
		Shortage risks are the errors in delivery, resource planning, and loss of materials, among others which can cause production delays due to missing.

Source: Own elaboration

4.2 Identification and classification of risk factors

The information collected from the survey shows the occurrence of the factors of risk which there face every day in the areas of the automotive industry's supply chain (Table 6).

Table 6. Occurrence of risk factors

Area	Factors	% Per Factors
Supply	Failure to make delivery requirements	50%
	Lack of integration with suppliers	31%
	Failure to handle volume demand changes	4%
	Low technical reliability	4%
	Failure to meet quality requirements	4%
	Cannot provide competitive pricing	4%
	Contractual agreements	4%
Manufacturing	Insufficient maintenance	24%
	Production capabilities/capacity	47%
	Product quality and safety	12%
	Insufficient breaks	6%
	Warehouse disruptions	12%
Demand	Demand variability	60%
	Competitor moves	10%
	Deficient or missing customer relation	5%
	Management errors	5%
	Order fulfillment errors	20%
Resources	Transit time variability	22%
	Information delays	32%
	Higher costs of transportation	46%
Macro Risks	No answer	0%

Source: Own elaboration

The following figure shows the presence of various risks in the supply chain.

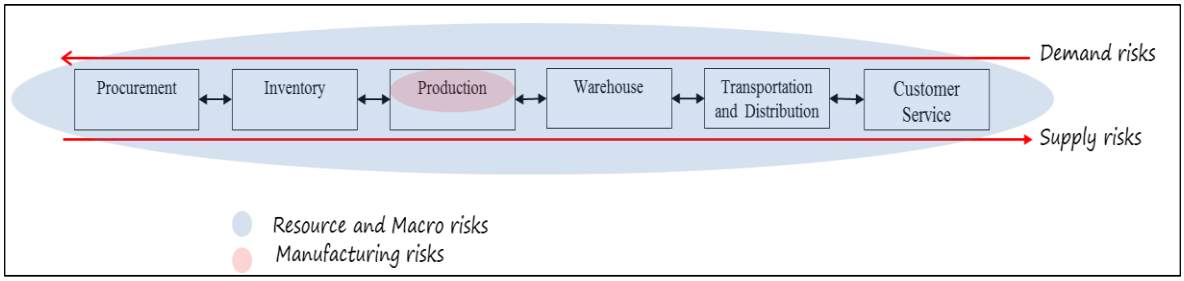


Figure 4. Supply Chain Risks

Source: Own elaboration

4.3 Evaluation

Analytical Hierarchy Process (AHP), developed by the mathematician Thomas Saaty at the end of the '60s, was created to evaluate alternatives from several criteria based on the principle of the experience and knowledge of the experts in the process. AHP allows the measurement of subjective and objective factors with numerical, verbal, or graphic estimates. The fact that having defined a general scale used for any situation allows the universality of the method. Table 7 shows the range used to give priorities based on the preference of one element over another (Osorio and Orejuela, 2008).

Table 7. Saaty scale

The intensity of Importance on an Absolute Scale	Definition	Explanation
1	Equal importance	Two criteria equally contribute to the objective
3	Moderate importance of one over another	Experience and judgments of the expert favor one criterion over the other
5	Strong importance	Expert experience and judgments significantly favor one criterion over the other
7	Very strong importance	A criterion is strongly favored, and its dominance has been demonstrated in practice.
9	Extreme importance	One criterion is totally favored over the other
2, 4, 6, 8	Intermediate values between two adjacent levels	When a medium level is necessary

Source: Own elaboration

AHP models the problem through a hierarchical structure and breaks it down (Saaty, 2008) as follows:

1. Define the problem and determine the type of knowledge sought. Structure the hierarchy of decisions from above to make a suitable decision, then set the goals, from a broad perspective, through the intermediate levels (criteria on which the subsequent elements depend) to the lowest level (set of alternatives). Figure 5 shows the hierarchical structure for evaluating supply chain risks.

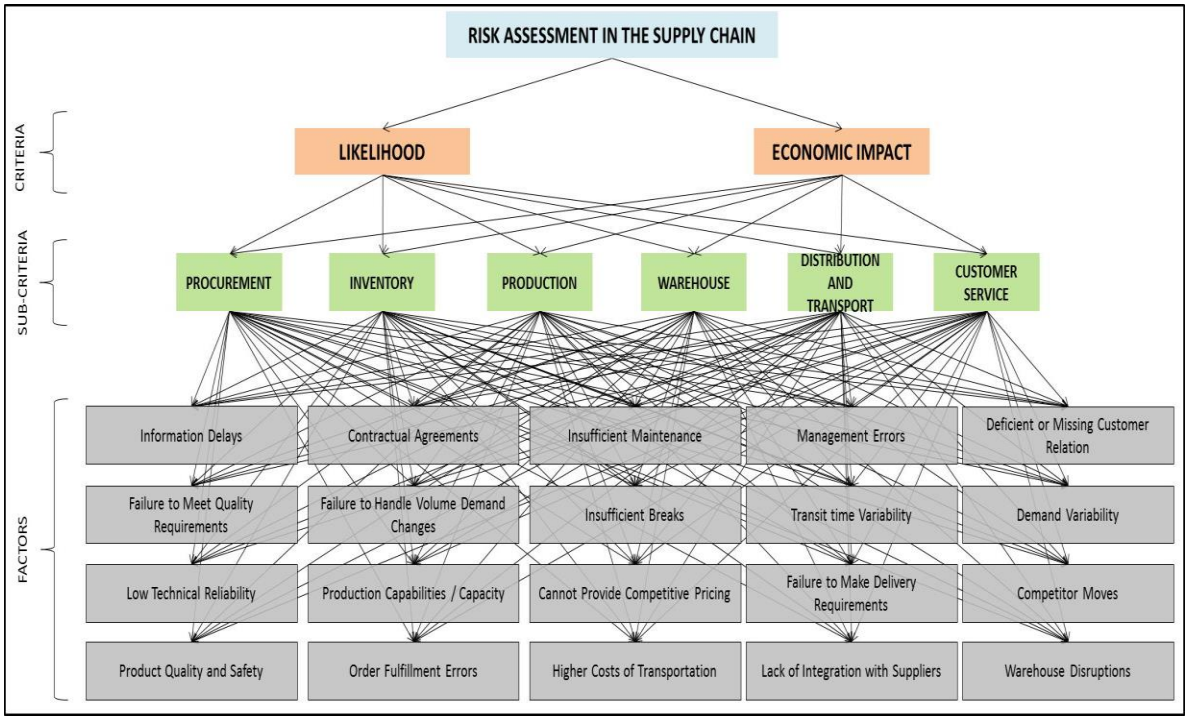


Figure 5. The hierarchical structure of supply chain risks

Source: Own elaboration

2. The first phase was carried out, comparing the criteria vs sub-criteria (Table XIII-XV) and sub-criteria vs factors (Table 16 -21). Values were weighted according to the Saaty scale (Osorio and Orejuela, 2008); these values were analyzed with the managers of each supply chain process.

3. Consistency ratio (RC) measurement of paired judgments, [quotient between the consistency index of A (IC) and the random consistency index (IA)]. If RC ≤ 0.10, RC is acceptable, and the process can carry on. If RC > 0.10, RC is unacceptable, the judgments must be reconsidered before continuing with the analysis.

$$RC = \frac{IC}{IA} \tag{2}$$

where *IC* is:

$$IC = \frac{n_{max} - n}{n - 1} \tag{3}$$

n= number of items that are compared
n_{max} = It is the unique largest eigenvalue of a matrix

Each matrix is compared to the relative weights in order to get the n_{max} (Table 22 - 24).

and *IA* is

$$IA = \frac{I.98(n-2)}{n} \tag{4}$$

The summary of consistency indices shows in tables 8 and 9. It is concluded that all RC results are below or equal to 0.10; that is to say, RC is acceptable. Therefore, the decision process can continue.

Table 8. Criteria and sub-criteria consistency indexes

Criteria	n_{max}	n	IC	IA	RC
Likelihood and Economic Impact	2	2	0	0	0
Likelihood vs Sub-criteria	6.41	6	0.082	1.32	0.062
Economic Impact vs Sub-criteria	6.60	6	0.12	1.32	0.091

Source: Own elaboration

Table 9. Sub-Criteria vs factors consistency indexes

Sub-Criteria vs Factors	n_{max}	n	IC	IA	RC
Procurement vs Factors	23.10	20	.16	1.78	.092
Inventory vs Factors	23.094	20	.16	1.78	.091
Production vs Factors	23..08	20	.16	1.78	.091
Warehouse vs Factors	23.09	20	.16	1.78	.091
Transportation and Distribution vs Factors	22.67	20	.14	1.78	.079
Customer Service vs Factors	23.08	20	.16	1.78	.091

Source: Own elaboration

4. Calculate the priority of the sub-criteria and factors (Table 10 and 11).

Table 10. Sub-Criteria priority

Sub-Criteria	Relative Weight Criteria		Priority
	Likelihood	Economic Impact	
Procurement	0.04	0.41	10%
Inventory	0.21	0.05	18%
Production	0.42	0.29	39%
Warehouse	0.12	0.04	11%
Transportation and distribution	0.16	0.13	15%
Customer Service	0.06	0.08	6%
Relative Weight Criteria	**0.83**	**0.17**	**100%**

Source: Own elaboration

Table 11. Sub- Criteria based on Disruption Factor Relative weights

Factors	Relative Weight Sub-Criteria						Priority
	Procurement	Inventory	Production	Warehouse	Transportation and Distribution	Customer Service	
1. Information delays	0.14	0.10	0.10	0.07	0.05	0.06	9.1%
2. Failure to meet quality requirements	0.02	0.15	0.02	0.01	0.01	0.12	7.6%
3. Low technical reliability	0.04	0.12	0.03	0.03	0.01	0.04	6.4%
4. Product quality and safety	0.02	0.02	0.02	0.01	0.03	0.02	2.0%
5. Contractual agreements	0.06	0.03	0.05	0.03	0.04	0.07	4.1%
6. Failure to handle volume demand changes	0.03	0.03	0.03	0.03	0.04	0.03	3.1%
7. Production capabilities / capacity	0.02	0.05	0.02	0.11	0.07	0.02	4.9%
8. Order fulfillment errors	0.03	0.01	0.19	0.14	0.01	0.03	6.0%
9. Insufficient maintenance	0.01	0.05	0.01	0.15	0.07	0.01	5.0%
10. Insufficient breaks	0.02	0.01	0.02	0.02	0.02	0.02	1.6%

Table 11. Continued

Factors	Relative Weight Sub-Criteria						Priority
	Procurement	Inventory	Production	Warehouse	Transportation and Distribution	Customer Service	
11. Cannot provide competitive pricing	0.06	0.02	0.05	0.04	0.02	0.07	3.5%
12. Higher costs of transportation	0.08	0.07	0.07	0.05	0.09	0.12	7.6%
13. Management errors	0.02	0.03	0.02	0.01	0.04	0.02	2.6%
14. Transit time variability	0.05	0.01	0.05	0.04	0.02	0.05	2.8%
15. Failure to make delivery requirements	0.04	0.06	0.03	0.03	0.15	0.04	6.2%
16. Lack of integration with suppliers	0.13	0.08	0.10	0.07	0.13	0.09	9.6%
17. Deficient or missing customer relation	0.08	0.08	0.07	0.05	0.11	0.07	7.9%
18. Demand variability	0.13	0.05	0.10	0.08	0.06	0.10	7.5%
19. Competitor moves	0.01	0.01	0.01	0.02	0.02	0.01	1.1%
20. Warehouse disruptions	0.01	0.02	0.01	0.01	0.02	0.01	1.6%
Relative weight sub- criteria	**0.10**	**0.39**	**0.18**	**0.11**	**0.15**	**0.06**	**100%**

Source: Own elaboration

4.4 Prioritize

Finally, once each factor response is got, decisions and related actions will be made to mitigate the risks and challenges arising in SCM. According to the Pareto principle (rule 80/20), the problems with the highest and lowest incidence must be separated (Rubio and Rubio, 2005). Figure 6 shows the Pareto Principle used to segregate the risk factors that affect automotive companies.

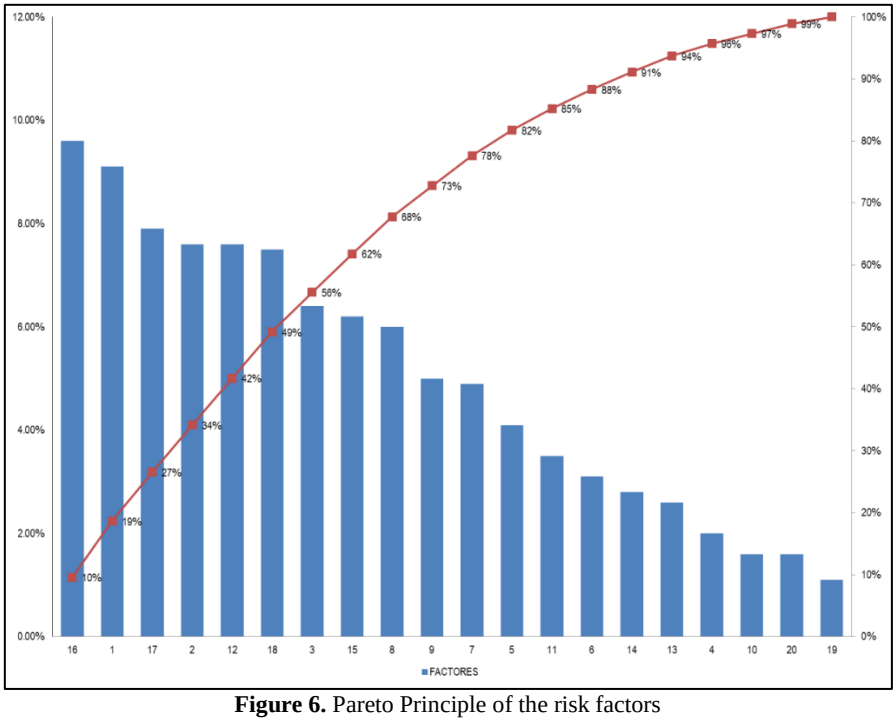


Figure 6. Pareto Principle of the risk factors

Source: Own elaboration

Thus, under this principle, those risk factors are determined, which must have a special treatment to reduce or eliminate their adverse effects on the supply chain (Figure 7).

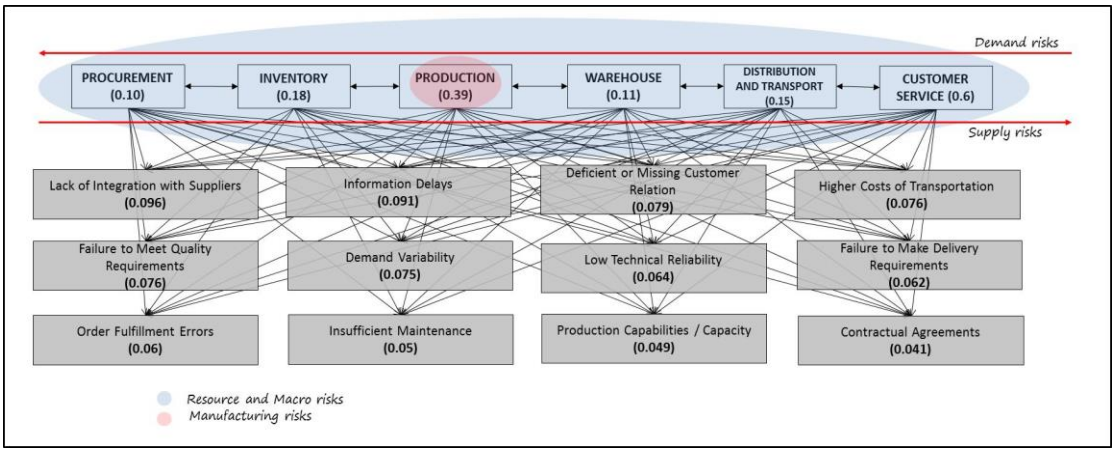


Figure 7. Risk factors in the supply chain

Source: Own elaboration

4.5 Action plan

Table 12 shows control of actions to mitigate more specific risk factors in the supply chain.

Table 12. Action plan

Potential effects of failure	Potential cause(s) of failure	Current design controls (Prevention)	Current design controls
Supply Lack of integration with suppliers. Failure to meet quality requirements Low technical reliability Failure to make delivery Requirements Contractual agreements	• Acquisition cost • Supplier low quality • Shortage • Loss of suppliers • Variability in demand	• Ensure the existence of solvent, reliable and competitive supplies. • Evaluate the development of the purchasing process by identifying and correcting possible deviations. • Collaborate with the departments to define the needs; formulate the suggestions of opportunities, and propose the standardization and the substitution of materials whenever it is opportune. • Ensure at least three suppliers are available. • The suppliers must be approved in quality, price, and efficiency.	• Periodic risk review • Project risk monitoring reports • Evaluation of compliance with the schedule, • Performance indicators • Quality control • Customer satisfaction surveys • Curve S
Demand Deficient or missing customer relation Demand variability Order fulfillment errors	• Variability in demand • Non-payment • Technology • Competition • Changes in product specifications	• Standardize delivery times with customers. • Have sales times within the system at the level of the finished product. • Sales evaluations with customers. • Know how the demand for some production orders or purchases was generated. • According to the client, have the process of integration and knowledge of the planning horizon with a forecast. • Define general planning policies and per client (according to contractual).	• Periodic risk review • Project risk monitoring reports • Evaluation of compliance with the schedule, • Performance indicators • Quality control • Customer satisfaction surveys • Curve S

Table 12. Continued

Potential effects of failure	Potential cause(s) of failure	Current design controls (Prevention)	Current design controls
Resources and Macro Information Delays Higher Costs of Transportation	• Operations of the logistic actors • Non-payment of customer • Strategic • Over costs • Changes in government policies • Security in communication channels-Legal changes • Financial changes	• Improve the communication system of all areas by providing the information requested. • Improve the process of transfer between warehouses (who sends, who receives) • Have process alerts for any deviation. • Improve the process of the output of the finished product. • Improve traceability and control within the system (real-time) of the location of orders shipped to initiate the collection and quality process correctly. • Availability of shipment information (status) is required. • Improve the information of arrival times, waiting Product, for the knowledge of operations. (It would be desirable for suppliers to arrive by appointment).	• Periodic risk review • Project risk monitoring reports • Evaluation of compliance with the schedule, • Performance indicators • Quality control • Customer satisfaction surveys • Curve S
Manufacturing Insufficient Maintenance Production Capabilities / Capacity	• Design changes • Non-compliance in the technical specifications of the product-Occupational hazards	• The financial information of the change of the national and international market needs to be updated. • Updated the financial information of the system provider • Financial payment planning. • Establish the payment business rules for suppliers. • Generate policies and constant financial information. • The forecast must be developed by the commercial area and with the production area. • Production must be contemplated in the possibilities by the capacity and the level of available material. • Relate the sales forecast with the chain budget item after the chain.	• Periodic risk review • Project risk monitoring reports • Evaluation of compliance with the schedule, • Performance indicators • Quality control • Customer satisfaction surveys • Curve S

Source: Own elaboration

5. Results and conclusions

Globalization in markets has allowed the exponential increase in the complexity of supply chains. Consequently, the variability increases, whose effect can be negative, significant, and extended in operation and the company's financial result. There are internal risks that derive from interactions with the actors in the chain and external risks such as natural phenomena, disasters, and terrorism. According to this research, the main risks in the automotive industry supply chain are:

- Lack of integration with suppliers
- Failure to meet quality requirements low
- Order fulfillment errors
- Information delays
- Demand variability
- Insufficient maintenance
- Deficit or missing customer
- Low technical reliability
- Production capabilities/capacity
- Higher costs of transportation

- Failure to meet delivery requirements
- Contractual agreements

Each of them implies a series of particular difficulties, and the probability of anticipating a potentially catastrophic event is very remote. Therefore, any successful strategy must be based on mitigation and contingency plans at the business level and the agility and accuracy of the response. Multi-national companies accept that their operations are continually affected, and although many have mitigation and continuity plans, they are particularly vulnerable due to several current trends:

- They optimize the inventory, which depends on maintaining close contact with suppliers, customers, and carrie rs to get quick answers. Any failure puts the operation at risk.
- Elimination of routes or alternative suppliers in the supply. Which contributes to cost reduction but may increas e the company's risk exposure
- Lack of a comprehensive approach in decision analysis. Business cases try to consider all benefits but do not co nsider all potential costs.
- Lack of visibility of the most vulnerable points in chains before any sudden change

Risk management is vital in the excellent performance of an organization, and it is advisable to have protection mechanisms. That is part of a structured plan based on a rigorous understanding of the vulnerable points of the extended chain and the application of containment schemes and mitigation in the proper combination of redundancy and flexibility. Redundancy is constituted by security inventories, whether a finished product, products in the process, or raw materials; and flexibility is the ability to create redundancy without incurring the costs that it implies for example:

- Standardization of operations and facilities
- Interchangeability of components and finished products
- Integration of the different links in the chain
- Postponement
- Alignment of the procurement strategy
- Collaboration with members of the extended chain

Any strategy must be accompanied by an analysis that allows determining the trade-off between the degree of "leanness" and the degree of flexibility and redundancy, according to the following logic:

- The risks exposure
- Impact of potential disruption events
- Containment strategies (redundancy and flexibility analysis)

Additionally, a fundamental factor that can make a difference is the organizational culture against risk. There are several features that every organization must possess if it wants to guarantee an agile and efficient response to any disruption event:

- Continuous communication between employees
- Decentralization of decision-making.
- Conditioning to face disruptions.

Finally, structured plans do not exempt supply chains from the possibility of risk. However, plans help enterprises prepare them much better to deal with risk, especially in changing, complex, global, and volatile environments of the current business environment.

References

Abrahamsson, M., Aldin, N., and Stahre, F. (2003). Logistics platforms for improved strategic flexibility. *International Journal of Logistics Research and Applications*, Vol. 6(3), pp. 85-106.

American Production and Inventory Society [APICS]. (2008). Amer Production, The United States

Mexican Association of the Automotive Industry [AMIA] (2019), Dialogue with the automotive industry, http://www.amia.com.mx/boletin/dlg20182024.pdf

Ballou, R. (2004). *Logística: Administración de la cadena de suministro*, México: Pearson Educación,

Blos, M. F., Quaddus, M., Wee, H., and Watanabe, K. (2009). Supply Chain Risk Management (SCRM): a case study on Brazil's automotive and electronic industries. *Supply chain management: An International Journal,* Vol. 14(4), pp. 247-252.

Bowersox, D. J., and Calantone, R. J. (1998). Executive Insights: Global Logistics. *Journal of International Marketing*, Vol. 6(4), pp. 83-93.

Cano, O, P., Orue, C, F., Martínez, F, J. L., Mayett, M, Y., and Nava, L. G. (2015). Modelo de gestión logística para pequeñas y medianas empresas en México. *Contaduría y Administración.* Vol. 60(1), pp. 181-203.

Christopher, M. (2002). *Supply Chain Vulnerability*, UK: Cranfield University.

Deloach, J.W. (2000). *Enterprise-Wide Risk Management: Strategies for Linking Risk and Opportunity*, London: Financial Times/Prentice Hall.

Dey, P.K. and Cheffi, W. (2013). Green supply chain performance measurement using the analytic hierarchy process: a comparative analysis of manufacturing organizations. *Production Planning and Control*, Vol. 24 No. 8 - 9, pp. 702-720.

Fang, C., and Marle, F. (2012). A simulation-based risk network model for decision support in project risk management. *Decision Support Systems,* Vol. 52(3), pp. 635-644.

Fernández, M. and Munier, N. (2014). *Bases para la gestión de riesgos en proyectos*, España: Editorial de la Universidad Politécnica de Valencia.

Ferrín G, A. (2007). *Gestión de stocks en la logística de almacenes*, 2ª edición, Madrid: FC Editorial.

Ganguly, K.K. and Guin, K.K. (2013). A fuzzy AHP approach for inbound supply risk assessment. *Benchmarking: An International Journal,* Vol. 20(1), pp. 129-146.

Ganguly, K. (2014). Integration of analytic hierarchy process and Dempster-Shafer theory for supplier performance measurement considering risk. *International Journal of Productivity and Performance Management,* Vol. 63(1), pp. 85-102.

Gómez-Mejía, L. R., Haynes, K. T., Núñez-Nickel, M., Jacobson, K. J. L., and Moyano-Fuentes, J. (2007). Socioemotional Wealth and Business Risks in Family-controlled Firms: Evidence from Spanish Olive Oil Mills. *Administrative Science Quarterly*, Vol. 52(1), pp. 106-137.

Govindan, K., Kaliyan, M., Kannan, D. and Haq, A.N. (2014). Barriers analysis for green supply chain management implementation in Indian industries using analytic hierarchy process. *International Journal of Production Economics,* Vol. 147(B), pp. 555-568.

Gunasekaran, A., Patel, C. and Tirtiroglu, E. (2001). Performance measures and metrics in a supply chain environment. *International Journal of Operations & Production Management*, Vol. 21(1/2), pp. 71-87.

Gunasekaran, A. and Kobu, B. (2007). Performance measures and metrics in logistics and supply chain management: a review of recent literature (1995–2004) for research and applications. *International Journal of Production Research*, Vol. 45(12), pp. 2819-2840.

Ho, W., Zheng, T., Yildiz, H., and Talluri, S. (2015). Supply chain risk management: a literature review. *International Journal of Production Research*, Vol. 53(16), pp. 5031-5069.

Holton, G.A. (2004). Defining risk. *Financial Analysts Journal,* Vol. 60(6), pp. 19-25.

Johnson, M. E. (2001). Learning from Toys: Lessons in Managing Supply Chain Risk from the Toy Industry. *California Management Review*, Vol. 43(3), pp. 106–124.

Kayis, B., and Dana, K, P. (2012). SCRIS. *Journal of Manufacturing Technology Management*, Vol. 23 No. 7, pp. 834 - 852.

Kilubi, I. (2016). The strategies of supply chain risk management – a synthesis and classification. *International Journal of Logistics Research and Applications*, Vol. 19(6), pp. 604-629.

Kogut, B. (1985). Designing Global Strategies: Comparative and Competitive Value – Added Chains. *Sloan Management Review*, Vol. 26(4), pp. 14-29.

Kwak, D., Rodrigues, V., Mason, R., Pettit, S., and Beresford, A. (2018). Risk interaction identification in international supply chain logistics. *International Journal of Operations & Production Management*, Vol. 38(2), pp. 372-389.

Lavastre, O., Gunasekaran, A., and Spalanzani, A. (2014). Effect of firm characteristics, supplier relationships, and techniques used on supply chain risk management (SCRM): an empirical investigation on French industrial firms. *International Journal of Production Research*, Vol. 52(11), pp. 3381-3403.

Luthra, S., Mangla, S.K., Xu, L. and Diabat, A. (2016). Using AHP to evaluate barriers in adopting sustainable consumption and production initiatives in a supply chain. *International Journal of Production Economics*, Vol. 181(B), pp. 342-349.

Madaan, J. and Mangla, S. (2015). *Decision Modeling Approach for Eco-Driven Flexible Green Supply Chain, In Systemic Flexibility and Business Agility, New* Delhi: Springer.

Mangla, S.K., Kumar, P. and Barua, M.K. (2016). An integrated methodology of FTA and fuzzy AHP for risk assessment in the green supply chain. *International Journal of Operational Research*, Vol. 25(1), pp. 77-99.

Martínez M, E. (2007). *Gestión de compras. Negociación y estrategias de aprovisionamiento*, Madrid; Fundación Confemetal.

Mitchell, V.W. (1995). Organizational risk perception and reduction: A literature review. *British Journal of Management*, Vol. 6(2), pp. 115-133.

Moktadir, M. A., Ali, S. M., Mangla, S. K., Sharmy, T. A., Luthra, S., Mishra, N., and Garza-Reyes, J. A. (2018). Decision modeling of risks in pharmaceutical supply chains. *Industrial Management & Data Systems*, Vol. 118(7), pp. 1388-1412.

Murthy, P. R. (2005). *Production and Operations Management*, New Delhi: New Age Publishers.

Navascués, R. d., and Pau C, J. (2000). *Manual de logística integral*, Madrid: Ediciones Díaz de Santos.

Osorio, J.C., and Orejuela, J.P. (2008). El proceso de análisis jerárquico (AHP) y la toma de decisiones multicriterio. Ejemplo de aplicación. *Scientia Et Technica*, Vol. 14(39), pp. 247–252.

Project Management Institute (2013). *Guía de los fundamentos para la dirección de proyectos*, 5ta edición, Pensilvania USA: Global Estándar.

Punniyamoorthy, M., Thamaraiselvan, N., and Manikandan, L. (2013). Assessment of supply chain risk: scale development and validation. *Benchmarking: An International Journal*, Vol. 20(1), pp. 79-105.

Rafi-Ul-Shan, P. M., Grant, D. B., Perry, P., and Ahmed, S. (2018). Relationship between sustainability and risk management in fashion supply chains. *International Journal of Retail & Distribution Management*, Vol. 46(5), pp. 466-486.

Rouwenhorst, B., Reuter, B., and Stockrahm, V. (2000). Warehouse design and control: Framework and literature review. *European Journal of Operational Research,* Vol. 122(3), pp. 515-533.

Royal Society (1992). *Risk: analysis, perception and management*, Edición 6, London: Royal Society.

Rubio, R, J. C., and Rubio, G, M. D. (2005). *Manual para la formación de nivel superior en prevención de riesgos laborales*, España: Díaz de Santos.

Saaty, T.L. (1980). *The Analytic Hierarchy Process: Planning, Priority Setting, Resource Allocation,* New York: McGraw-Hill.

Saaty, T. L. (2008). Decision-making with the analytic hierarchy process. *International Journal of Services Sciences*, Vol. 1(1), pp. 83 - 98.

Sánchez, G. M.G. (2008). *Cuantificación y generación de valor en la cadena de suministro extendida*, España: Del Blanco Editores.

Sarabio V, A. (1996). *La investigación operativa: una herramienta para la adopción de decisiones,* Madrid: Universidad Pontificia Comillas de Madrid.

Schoenherr, T., Rao Tummala, V.M. and Harrison, T.P. (2008). Assessing supply chain risks with the analytic hierarchy process: providing decision support for the offshoring decision by a US manufacturing company. *Journal of Purchasing & Supply Management,* Vol. 14(2), pp. 100-111.

Sharma, S. K., and Bhat, A. (2012). Potential barriers in supply chain risk management: an empirical exploration in Indian automotive industry. *International Journal Business Continuity and Risk Management*, Vol. 3(3), pp. 206-220.

Schmidt, G., and Wilhelm, W. E. (2000). Strategic, tactical and operational decisions in multi-national logistics networks: A review and discussion of modelling issues. *International Journal of Production Research*, Vol. 38(7), pp. 1501-1523.

Soret, I. (2006). *Logística y marketing para la distribución comercial,* Madrid: ESIC Editorial.

Stadtler, H. (2005). Supply chain management and advanced planning–basics, overview and challenges. *European Journal of Operational Research*, Vol. 163(3), pp. 575-588.

Speh, T. W., Wagenheim, G. D. (1978). Demand and lead-time uncertainty: The impacts on physical distribution performance and management. *Journal of Business Logistics*, Vol 1(1), pp. 95–113.

Spekman, R. E., & Davis, E. W. (2004). Risky business: expanding the discussion on risk and the extended enterprise. *International Journal of Physical Distribution & Logistics Management*, Vol. 34(5), pp. 414–433.

Stock, J., and Lambret, D. (2001). *Strategic logistics management*, USA: McGraw-Hill/Irwin.

Tejero, J. J. (2007). *Logística integral: La gestión operativa de la empresa,* Madrid: ESIC Editorial.

Toomey, J. (2000). *Inventory Management: Principles, Concepts and Techniques*, USA: Springer.

Torres, M. M. (2006). *Logística y Costos,* Madrid: Ediciones Díaz de Santos.

Trkman, P., Oliveira, M. and McCormack, K. (2016). Value-oriented supply chain risk management: you get what you expect. *Industrial Management & Data Systems,* Vol. 116(5), pp. 1061-1083.

Urzelai I, A. (2006). *Manual básico de logística integral*, Madrid: Ediciones Díaz de Santos.

Varzandeh, J., Farahbod, K., and Zhu, J. J. (2016). Global Logistics and Supply Chain Risk Management. *Journal of Business and Behavior Sciences*, Vol. 28(1), pp. 124-130.

Velimirović, D., Velimirović, M., and Stanković, R. (2011). Role and importance of key performance indicators measurement. *Serbian Journal of Management,* Vol. 6(1), pp. 63-72.

Wilding, R (1998). The supply chain complexity triangle: Uncertainty generation in the supply chain. *International Journal of Physical Distribution and Logistics Management*, Vol. 28(8), pp. 599- 616.

Wu, T., Blackhurst, J. and Chidambaram, V. (2006). A model for inbound supply risk analysis. *Computers in Industry*, Vol. 57 No. 4, pp. 350 - 365.

Zsidisin, G. A., and Ritchie, B. (2009). *Supply Chain Risk Management – Developments, Issues and Challenges, In Supply Chain Risk - A Handbook of Assessment, Management, and Performance*, Ohio: Springer.

Zsidisin, G. A., Ellram, L. M., Carter, J. R., and Cavinato, J. L. (2004). An analysis of supply risk assessment techniques. *International Journal of Physical Distribution & Logistics Management*, Vol. 34(5), pp. 397–413.

Appendixes

Table 13. Comparison between criteria

Criteria	Frequency	Economic Impact
Likelihood	1.00	5
Economic Impact	0.20	1.00

Source: Own elaboration

Table 14. Comparison likelihood vs sub-criteria

Sub-Criteria	Procurement	Production	Inventory	Warehouse	Transportation Distribution	Customer Service
Procurement	1	0.12	0.14	0.33	0.33	0.5
Production	8	1	3	2	5	5
Inventory	7	0.33	1	2	2	3
Warehouses	3	0.5	0.5	1	0.33	3
Transportation Distribution	3	0.2	0.5	3	1	3
Customer Service	2	0.2	0.33	0.33	0.33	1

Source: Own elaboration

Table 15. Comparison economic impact vs sub-criteria

Sub- Criteria	Procurement	Production	Inventory	Warehouse	Transportation Distribution	Customer Service
Procurement	1	3	7	7	3	5
Production	0.33	1	5	5	5	5
Inventory	0.14	0.2	1	3	0.25	0.33
Warehouses	0.14	0.2	0.33	1	0.33	0.33
Transportation Distribution	0.33	0.2	4	3	1	3
Customer Service	0.2	0.2	3	3	0.33	1

Source: Own elaboration

Table 16. Comparison procurement vs factors

Factors	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1. Information Del ays	1.0	5.0	3.0	8.0	5.0	5.0	7.0	5.0	5.0	5.0	5.0	3.0	8.0	5.0	5.0	2.0	2.0	2.0	9.0	3.0
2. Failure to Meet Quality Require ments	0.2	1.0	0.3	2.0	0.5	0.3	3.0	0.3	3.0	0.5	0.3	0.3	3.0	0.3	0.3	0.3	0.3	0.2	4.0	4.0
3. Low Technical Reliability	0.3	3.0	1.0	3.0	0.3	3.0	5.0	2.0	5.0	3.0	0.3	0.3	3.0	0.5	0.5	0.2	0.3	0.3	3.0	3.0

4. Product Quality and Safety	0.1	0.5	0.3	1.0	0.2	0.3	0.5	0.3	3.0	0.3	0.2	0.2	2.0	0.2	0.3	0.2	0.2	0.1	3.0	3.0
5. Contractual Agreements	0.2	2.0	3.0	5.0	1.0	4.0	7.0	4.0	7.0	5.0	0.5	0.5	3.0	0.5	3.0	0.3	0.3	0.2	3.0	5.0
6. Failure to Handle Volume Demand Changes	0.2	3.0	0.3	4.0	0.3	1.0	4.0	0.5	4.0	3.0	0.3	0.2	3.0	0.3	1.0	0.2	0.2	0.2	4.0	5.0
7. Production Capabilities / Capacity	0.1	0.3	0.2	2.0	0.1	0.3	1.0	0.2	2.0	0.3	0.3	0.3	2.0	0.2	0.3	0.1	0.2	0.2	2.0	3.0
8. Order Fulfillment Errors	0.2	3.0	0.5	4.0	0.3	2.0	5.0	1.0	5.0	3.0	0.3	0.2	3.0	0.3	0.5	0.1	0.2	0.2	3.0	5.0
9. Insufficient Maintenance	0.2	0.3	0.2	0.3	0.1	0.3	0.5	0.2	1.0	0.3	0.2	0.2	0.3	0.2	0.2	0.2	0.2	0.2	2.0	2.0
10. Insufficient Breaks	0.2	2.0	0.3	3.0	0.2	0.3	3.0	0.3	3.0	1.0	0.2	0.2	3.0	0.2	0.3	0.2	0.3	0.2	3.0	5.0
11. Cannot Provide Competitive Pricing	0.2	4.0	3.0	5.0	2.0	3.0	3.0	3.0	5.0	5.0	1.0	0.5	3.0	2.0	3.0	0.3	0.3	0.2	3.0	5.0
12. Higher Costs of Transportation	0.3	3.0	4.0	5.0	2.0	5.0	3.0	5.0	5.0	5.0	2.0	1.0	3.0	3.0	3.0	0.3	2.0	0.3	3.0	5.0
13. Management Errors	0.1	0.3	0.3	0.5	0.3	0.3	0.5	0.3	3.0	0.3	0.3	0.3	1.0	0.3	0.2	0.2	0.3	0.2	3.0	3.0
14. Transit time Variability	0.2	3.0	2.0	5.0	2.0	3.0	5.0	3.0	5.0	5.0	0.5	0.3	3.0	1.0	3.0	0.2	0.3	0.2	3.0	5.0
15. Failure to Make Delivery Requirements	0.2	3.0	2.0	3.0	0.3	1.0	3.0	2.0	5.0	3.0	0.3	0.3	5.0	0.3	1.0	0.2	0.3	0.2	3.0	5.0
16. Lack of Integration with Suppliers	0.5	3.0	5.0	5.0	3.0	6.0	7.0	7.0	5.0	5.0	3.0	3.0	5.0	5.0	5.0	1.0	3.0	2.0	4.0	4.0
17. Deficient or Missing Customer Relation	0.5	3.0	4.0	5.0	3.0	5.0	5.0	5.0	5.0	3.0	3.0	0.5	3.0	3.0	3.0	0.3	1.0	0.3	3.0	5.0
18. Demand Variability	0.5	5.0	3.0	7.0	5.0	5.0	6.0	5.0	5.0	5.0	5.0	3.0	5.0	5.0	5.0	0.5	3.0	1.0	8.0	8.0

Table 16. Continued

Factors	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
19. Competitor Moves	0.1	0.3	0.3	0.3	0.3	0.3	0.5	0.3	0.5	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.1	1.0	2.0
20. Warehouse Disruptions	0.3	0.3	0.3	0.3	0.2	0.2	0.3	0.2	0.5	0.2	0.2	0.2	0.3	0.2	0.2	0.3	0.2	0.1	0.5	1.0
Total	5.8	45.0	33.2	68.5	26.2	45.2	69.3	44.7	77.0	53.4	23.4	14.9	59.0	28.0	35.3	7.5	15.1	8.6	67.5	81.0

Source: Own elaboration

Table 17. Comparison inventory vs factors

Factors	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1. Information Delays	1.0	5.0	3.0	5.0	3.0	3.0	6.0	0.3	5.0	5.0	4.0	3.0	5.0	3.0	3.0	2.0	2.0	2.0	5.0	3.0
2. Failure to Meet Quality Requirements	0.2	1.0	0.3	2.0	0.5	0.3	3.0	0.1	3.0	0.5	0.3	0.3	3.0	0.3	0.3	0.3	0.3	0.2	4.0	4.0
3. Low Technical Reliability	0.3	3.0	1.0	3.0	0.3	2.0	4.0	0.2	5.0	3.0	0.3	0.3	3.0	0.5	0.5	0.2	0.3	0.3	3.0	3.0
4. Product Quality and Safety	0.2	0.5	0.3	1.0	0.2	0.3	0.5	0.3	3.0	0.3	0.2	0.2	2.0	0.2	0.3	0.2	0.2	0.1	2.0	3.0
5. Contractual Agreements	0.3	2.0	3.0	5.0	1.0	3.0	7.0	0.3	7.0	5.0	0.5	0.5	3.0	0.5	3.0	0.3	0.3	0.2	3.0	5.0
6. Failure to Handle Volume Demand Changes	0.3	3.0	0.5	4.0	0.3	1.0	4.0	0.2	4.0	3.0	0.3	0.2	3.0	0.3	1.0	0.2	0.2	0.2	4.0	5.0
7. Production Capabilities / Capacity	0.2	0.3	0.3	2.0	0.1	0.3	1.0	0.2	2.0	0.3	0.3	0.3	2.0	0.2	0.3	0.1	0.2	0.2	2.0	3.0
8. Order Fulfillment Errors	4.0	8.0	5.0	4.0	4.0	6.0	5.0	1.0	7.0	7.0	8.0	4.0	7.0	7.0	5.0	4.0	5.0	4.0	5.0	8.0
9. Insufficient Maintenance	0.2	0.3	0.2	0.3	0.1	0.3	0.5	0.1	1.0	0.3	0.2	0.2	0.3	0.2	0.2	0.2	0.2	0.2	2.0	2.0
10. Insufficient Breaks	0.2	2.0	0.3	3.0	0.2	0.3	3.0	0.1	3.0	1.0	0.2	0.2	3.0	0.3	0.3	0.2	0.3	0.2	3.0	5.0
11. Cannot Provide Competitive Pricing	0.3	4.0	3.0	5.0	2.0	3.0	3.0	0.1	5.0	5.0	1.0	0.5	3.0	2.0	3.0	0.3	0.3	0.3	3.0	5.0
12. Higher Costs of Transportation	0.3	3.0	4.0	5.0	2.0	5.0	3.0	0.3	5.0	5.0	2.0	1.0	3.0	3.0	3.0	0.3	2.0	0.3	3.0	5.0
13. Management Errors	0.2	0.3	0.3	0.5	0.3	0.3	0.5	0.1	3.0	0.3	0.3	0.3	1.0	0.3	0.2	0.2	0.3	0.2	3.0	3.0
14. Transit time Variability	0.3	3.0	2.0	5.0	2.0	3.0	5.0	0.1	5.0	4.0	0.5	0.3	3.0	1.0	3.0	0.2	0.3	0.2	3.0	5.0
15. Failure to Make Delivery Requirements	0.3	3.0	2.0	3.0	0.3	1.0	3.0	0.2	5.0	3.0	0.3	0.3	5.0	0.3	1.0	0.2	0.3	0.2	3.0	5.0
16. Lack of Integration with Suppliers	0.5	3.0	5.0	5.0	3.0	6.0	7.0	0.3	5.0	5.0	3.0	3.0	5.0	5.0	5.0	1.0	3.0	2.0	4.0	4.0
17. Deficient or Missing Customer Relation	0.5	3.0	4.0	5.0	3.0	5.0	5.0	0.2	5.0	3.0	3.0	0.5	3.0	3.0	3.0	0.3	1.0	0.3	3.0	5.0
18. Demand Variability	0.5	5.0	3.0	7.0	5.0	5.0	6.0	0.3	5.0	5.0	4.0	3.0	5.0	5.0	5.0	0.5	3.0	1.0	6.0	6.0
19. Competitor Moves	0.2	0.3	0.3	0.5	0.3	0.3	0.5	0.2	0.5	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.2	1.0	2.0
20. Warehouse Disruptions	0.3	0.3	0.3	0.3	0.2	0.2	0.3	0.1	0.5	0.2	0.2	0.2	0.3	0.2	0.2	0.3	0.2	0.2	0.5	1.0
Total	10.4	50.0	37.9	65.7	28.1	45.2	67.3	4.6	79.0	56.4	29.0	18.7	60.0	32.7	37.8	11.4	19.9	12.5	62.5	82.0

Source: Own elaboration

Table 18. Comparison warehouse vs factors

Factors	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1. Information Delays	1.00	5.00	3.00	5.00	3.00	3.00	0.33	0.25	0.25	2.00	4.00	3.00	4.00	3.00	3.00	2.00	2.00	2.00	5.00	3.00

2. Failure to Meet Quality Requirements	0.20	1.00	0.33	2.00	0.50	0.33	0.13	0.13	0.11	0.50	0.25	0.33	2.00	0.33	0.33	0.33	0.33	0.20	2.00	2.00
3. Low Technical Reliability	0.33	3.00	1.00	3.00	0.33	2.00	0.25	0.20	0.20	3.00	0.33	0.25	3.00	0.50	0.50	0.20	0.25	0.33	3.00	3.00
4. Product Quality and Safety	0.20	0.50	0.33	1.00	0.20	0.25	0.14	0.25	0.20	0.33	0.20	0.20	2.00	0.20	0.33	0.20	0.20	0.20	2.00	2.00
5. Contractual Agreements	0.33	2.00	3.00	5.00	1.00	3.00	0.14	0.25	0.14	3.00	0.50	0.50	3.00	0.50	2.00	0.33	0.33	0.25	3.00	5.00
6. Failure to Handle Volume Demand Changes	0.33	3.00	0.50	4.00	0.33	1.00	0.25	0.20	0.25	3.00	0.33	0.25	3.00	0.33	1.00	0.17	0.25	0.33	3.00	4.00
7. Production Capabilities / Capacity	3.00	8.00	4.00	7.00	7.00	4.00	1.00	0.50	0.50	3.00	3.00	3.00	9.00	3.00	3.00	3.00	5.00	2.00	9.00	9.00
8. Order Fulfillment Errors	4.00	8.00	5.00	4.00	4.00	5.00	2.00	1.00	0.50	6.00	5.00	4.00	7.00	6.00	4.00	4.00	4.00	4.00	5.00	8.00
9. Insufficient Maintenance	4.00	9.00	5.00	5.00	7.00	4.00	2.00	2.00	1.00	7.00	5.00	5.00	3.00	5.00	4.00	4.00	5.00	4.00	2.00	2.00
10. Insufficient Breaks	0.50	2.00	0.33	3.00	0.33	0.33	0.33	0.17	0.14	1.00	0.20	0.20	3.00	0.25	0.33	0.20	0.33	0.20	3.00	3.00
11. Cannot Provide Competitive Pricing	0.25	4.00	3.00	5.00	2.00	3.00	0.33	0.20	0.20	5.00	1.00	0.50	3.00	2.00	3.00	0.33	0.50	0.25	3.00	5.00
12. Higher Costs of Transportation	0.33	3.00	4.00	5.00	2.00	4.00	0.33	0.25	0.20	5.00	2.00	1.00	3.00	3.00	3.00	0.33	2.00	0.33	3.00	5.00
13. Management Errors	0.25	0.50	0.33	0.50	0.33	0.33	0.11	0.14	0.33	0.33	0.33	0.33	1.00	0.33	0.25	0.20	0.33	0.20	2.00	2.00
14. Transit time Variability	0.33	3.00	2.00	5.00	2.00	3.00	0.33	0.17	0.20	4.00	0.50	0.33	3.00	1.00	3.00	0.33	0.33	0.20	3.00	5.00
15. Failure to Make Delivery Requirements	0.33	3.00	2.00	3.00	0.50	1.00	0.33	0.25	0.25	3.00	0.33	0.33	4.00	0.33	1.00	0.20	0.33	0.20	3.00	4.00
16. Lack of Integration with Suppliers	0.50	3.00	5.00	5.00	3.00	6.00	0.33	0.25	0.25	5.00	3.00	3.00	5.00	3.00	5.00	1.00	2.00	0.50	3.00	3.00
17. Deficient or Missing Customer Relation	0.50	3.00	4.00	5.00	3.00	4.00	0.20	0.25	0.20	3.00	2.00	0.50	3.00	3.00	3.00	0.50	1.00	0.33	3.00	5.00
18. Demand Variability	0.50	5.00	3.00	5.00	4.00	3.00	0.50	0.25	0.25	5.00	4.00	3.00	5.00	5.00	5.00	2.00	3.00	1.00	3.00	4.00
19. Competitor Moves	0.20	0.50	0.33	0.50	0.33	0.33	0.11	0.20	0.50	0.33	0.33	0.33	0.50	0.33	0.33	0.33	0.33	0.33	1.00	2.00
20. Warehouse Disruptions	0.33	0.50	0.33	0.50	0.20	0.25	0.11	0.13	0.50	0.33	0.20	0.20	0.50	0.20	0.25	0.33	0.20	0.25	0.50	1.00
Total	17.4	67.0	46.5	73.5	41.1	47.8	9.3	7.0	6.2	59.8	32.5	26.3	67.0	37.3	42.3	20.0	27.7	17.1	61.5	77.0

Source: Own elaboration

Table 19. Comparison production vs factors

Factors	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
1. Information Delays	1.0	2.0	2.0	2.0	3.0	3.0	1.0	4.0	2.0	4.0	4.0	2.0	3.0	5.0	4.0	2.0	2.0	2.0	5.0	4.0
2. Failure to Meet Quality Requirements	0.5	1.0	2.0	5.0	3.0	5.0	5.0	2.0	5.0	9.0	9.0	4.0	4.0	9.0	5.0	2.0	3.0	5.0	6.0	3.0
3. Low Technical Reliability	0.5	0.5	1.0	4.0	4.0	4.0	5.0	8.0	3.0	8.0	4.0	4.0	5.0	3.0	4.0	3.0	3.0	5.0	5.0	3.0
4. Product Quality and Safety	0.5	0.2	0.3	1.0	0.3	0.3	0.2	3.0	0.2	3.0	3.0	0.2	0.3	3.0	0.2	0.2	0.3	0.3	3.0	2.0
5. Contractual Agreements	0.3	0.3	0.3	3.0	1.0	2.0	0.3	5.0	0.3	4.0	3.0	0.3	2.0	4.0	0.3	0.2	0.2	0.3	3.0	3.0
6. Failure to Handle Volume Demand Changes	0.3	0.2	0.3	3.0	0.5	1.0	0.3	3.0	0.3	3.0	3.0	0.3	2.0	4.0	0.3	0.3	0.3	0.3	3.0	3.0
7. Production Capabilities / Capacity	1.0	0.2	0.2	5.0	4.0	4.0	1.0	4.0	2.0	3.0	4.0	0.3	3.0	4.0	0.5	0.3	0.3	2.0	3.0	3.0

Table 19. Continued

Factors	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
8. Order Fulfillment Errors	0.3	0.5	0.1	0.3	0.2	0.3	0.3	1.0	0.3	0.5	0.5	0.2	0.3	0.5	0.3	0.2	0.2	0.3	0.5	0.3
9. Insufficient Maintenance	0.5	0.2	0.3	5.0	4.0	4.0	0.5	4.0	1.0	4.0	4.0	0.3	3.0	4.0	0.5	0.3	0.3	2.0	5.0	5.0
10. Insufficient Breaks	0.3	0.1	0.1	0.3	0.3	0.3	0.3	2.0	0.3	1.0	0.5	0.3	0.3	0.5	0.2	0.2	0.2	0.3	0.5	0.5

11. Cannot Provide Competitive Pricing	0.3	0.1	0.3	0.3	0.3	0.3	0.3	2.0	0.3	2.0	1.0	0.3	0.3	2.0	0.3	0.3	0.3	0.3	2.0	2.0
12. Higher Costs of Transportation	0.5	0.3	0.3	5.0	3.0	4.0	3.0	6.0	3.0	3.0	4.0	1.0	4.0	4.0	3.0	0.5	0.5	3.0	4.0	4.0
13. Management Errors	0.3	0.3	0.2	3.0	0.5	0.5	0.3	4.0	0.3	4.0	4.0	0.3	1.0	4.0	0.3	0.2	0.2	0.3	3.0	3.0
14. Transit time Variability	0.2	0.1	0.3	0.3	0.3	0.3	0.3	2.0	0.3	2.0	0.5	0.3	0.3	1.0	0.3	0.3	0.2	0.3	0.5	0.5
15. Failure to Make Delivery Requirements	0.3	0.2	0.3	5.0	4.0	4.0	2.0	4.0	2.0	5.0	3.0	0.3	4.0	4.0	1.0	2.0	0.3	0.5	2.0	2.0
16. Lack of Integration with Suppliers	0.5	0.5	0.3	5.0	5.0	4.0	3.0	5.0	3.0	5.0	3.0	2.0	5.0	4.0	0.5	1.0	0.5	3.0	4.0	2.0
17. Deficient or Missing Customer Relation	0.5	0.3	0.3	3.0	5.0	4.0	3.0	5.0	3.0	5.0	4.0	2.0	5.0	5.0	3.0	2.0	1.0	2.0	3.0	3.0
18. Demand Variability	0.5	0.2	0.2	4.0	3.0	3.0	0.5	3.0	0.5	4.0	4.0	0.3	3.0	4.0	2.0	0.3	0.5	1.0	4.0	3.0
19. Competitor Moves	0.2	0.2	0.2	0.3	0.3	0.3	0.3	2.0	0.2	2.0	0.5	0.3	0.3	2.0	0.5	0.3	0.3	0.3	1.0	0.5
20. Warehouse Disruptions	0.3	0.3	0.3	0.5	0.3	0.3	0.3	3.0	0.2	2.0	0.5	0.3	0.3	2.0	0.5	0.5	0.3	0.3	2.0	1.0
Total	8.6	7.7	9.2	55.2	42.0	44.7	26.8	72.0	26.9	73.5	59.5	18.9	46.0	69.0	26.5	16.1	14.0	28.0	59.5	47.8

Source: Own elaboration

Table 20. Comparison transportation and distribution vs factors

Factors	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
1. Information Delays	1.0	5.0	5.0	2.0	3.0	3.0	0.5	4.0	0.3	4.0	4.0	0.3	3.0	5.0	0.3	0.2	0.5	0.5	5.0	4.0
2. Failure to Meet Quality Requirements	0.2	1.0	2.0	0.2	0.3	0.2	0.2	2.0	0.2	0.3	0.3	0.2	0.3	0.3	0.2	0.2	0.1	0.2	0.5	0.3
3. Low Technical Reliability	0.2	0.5	1.0	0.3	0.3	0.3	0.2	2.0	0.3	0.3	0.3	0.2	0.2	0.3	0.2	0.2	0.2	0.2	0.5	0.3
4. Product Quality and Safety	0.5	5.0	4.0	1.0	0.3	0.3	0.2	3.0	0.2	3.0	3.0	0.2	0.3	3.0	0.2	0.2	0.3	0.3	3.0	3.0
5. Contractual Agreements	0.3	3.0	4.0	3.0	1.0	2.0	0.3	5.0	0.3	4.0	3.0	0.3	2.0	4.0	0.3	0.2	0.2	0.3	3.0	3.0
6. Failure to Handle Volume Demand Changes	0.3	5.0	4.0	3.0	0.5	1.0	0.3	3.0	0.3	4.0	4.0	0.3	2.0	4.0	0.2	0.2	0.2	0.3	3.0	3.0
7. Production Capabilities / Capacity	2.0	5.0	5.0	5.0	4.0	4.0	1.0	4.0	2.0	4.0	4.0	0.3	4.0	4.0	0.5	0.3	0.3	2.0	3.0	3.0
8. Order Fulfillment Errors	0.3	0.5	0.5	0.3	0.2	0.3	0.3	1.0	0.3	0.3	0.3	0.1	0.3	0.5	0.3	0.2	0.2	0.2	0.3	0.3
9. Insufficient Maintenance	3.0	5.0	3.0	5.0	4.0	4.0	0.5	4.0	1.0	4.0	4.0	0.3	3.0	4.0	0.2	0.3	0.3	2.0	5.0	5.0
10. Insufficient Breaks	0.3	3.0	3.0	0.3	0.3	0.3	0.3	3.0	0.3	1.0	2.0	0.3	0.3	0.5	0.2	0.2	0.2	0.3	3.0	2.0
11. Cannot Provide Competitive Pricing	0.3	3.0	4.0	0.3	0.3	0.3	0.3	4.0	0.3	0.5	1.0	0.3	0.3	2.0	0.3	0.2	0.3	0.2	2.0	2.0
12. Higher Costs of Transportation	4.0	5.0	6.0	5.0	3.0	4.0	3.0	7.0	3.0	3.0	4.0	1.0	4.0	4.0	0.3	0.5	0.5	3.0	4.0	4.0
13. Management Errors	0.3	4.0	5.0	3.0	0.5	0.5	0.3	4.0	0.3	4.0	4.0	0.3	1.0	4.0	0.3	0.2	0.2	0.3	4.0	4.0
14. Transit time Variability	0.2	3.0	3.0	0.3	0.3	0.3	0.3	2.0	0.3	2.0	0.5	0.3	0.3	1.0	0.3	0.3	0.2	0.3	2.0	0.5

Table 20. Continued

Factors	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
15. Failure to Make Delivery Requirements	3.0	5.0	6.0	5.0	4.0	5.0	2.0	4.0	5.0	5.0	4.0	3.0	4.0	4.0	1.0	2.0	3.0	5.0	4.0	4.0
16. Lack of Integration with Suppliers	5.0	5.0	6.0	6.0	5.0	5.0	4.0	5.0	4.0	5.0	5.0	2.0	5.0	4.0	0.5	1.0	2.0	5.0	5.0	5.0
17. Deficient or Missing Customer Relation	2.0	8.0	6.0	3.0	5.0	5.0	3.0	5.0	3.0	5.0	4.0	2.0	5.0	5.0	0.3	0.5	1.0	4.0	4.0	3.0
18. Demand Variability	2.0	5.0	5.0	4.0	3.0	3.0	0.5	5.0	0.5	4.0	5.0	0.3	3.0	4.0	0.2	0.2	0.3	1.0	4.0	3.0
19. Competitor Moves	0.2	2.0	2.0	0.3	0.3	0.3	0.3	3.0	0.2	0.3	0.5	0.3	0.3	0.5	0.3	0.2	0.3	0.3	1.0	0.5
20. Warehouse Disruptions	0.3	3.0	3.0	0.3	0.3	0.3	0.3	4.0	0.2	0.5	0.5	0.3	0.3	2.0	0.3	0.2	0.3	0.3	2.0	1.0
Total	25.3	76.0	77.5	47.4	35.6	39.0	17.5	74.0	21.8	54.3	53.3	12.1	38.3	56.2	6.1	7.3	10.6	25.6	58.3	50.9

Source: Own elaboration

Table 21. Comparison customer service vs factors

Factors	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1. Information Delays	1.00	0.25	3.00	3.00	0.50	4.00	3.00	4.00	3.00	3.00	0.33	0.33	5.00	3.00	3.00	0.50	0.50	0.50	7.00	3.00
2. Failure to Meet Quality Requirements	4.00	1.00	3.00	6.00	2.00	3.00	3.00	3.00	3.00	7.00	4.00	2.00	3.00	3.00	3.00	3.00	3.00	3.00	4.00	4.00
3. Low Technical Reliability	0.33	0.33	1.00	3.00	0.33	3.00	4.00	2.00	5.00	3.00	0.33	0.25	3.00	0.50	0.50	0.33	0.25	0.33	3.00	3.00
4. Product Quality and Safety	0.33	0.17	0.33	1.00	0.20	0.25	0.50	0.25	3.00	0.33	0.20	0.20	2.00	0.20	0.33	0.20	0.20	0.14	2.00	3.00
5. Contractual Agreements	2.00	0.50	3.00	5.00	1.00	4.00	7.00	4.00	7.00	5.00	0.50	0.50	3.00	0.50	3.00	0.50	0.50	0.50	3.00	5.00
6. Failure to Handle Volume Demand Changes	0.25	0.33	0.33	4.00	0.25	1.00	3.00	0.50	4.00	3.00	0.33	0.20	3.00	0.33	0.33	0.17	0.20	0.20	4.00	5.00
7. Production Capabilities / Capacity	0.33	0.33	0.25	2.00	0.14	0.33	1.00	0.50	2.00	0.50	0.33	0.33	2.00	0.20	0.33	0.50	0.20	0.33	2.00	3.00
8. Order Fulfillment Errors	0.25	0.33	0.50	4.00	0.25	2.00	2.00	1.00	5.00	3.00	0.33	0.20	3.00	0.33	0.50	0.14	0.20	0.20	3.00	5.00
9. Insufficient Maintenance	0.33	0.33	0.20	0.33	0.14	0.25	0.50	0.20	1.00	0.33	0.20	0.20	0.33	0.20	0.20	0.20	0.20	0.20	2.00	2.00
10. Insufficient Breaks	0.33	0.14	0.33	3.00	0.20	0.33	2.00	0.33	3.00	1.00	0.25	0.25	3.00	0.20	0.33	0.25	0.33	0.20	3.00	2.00
11. Cannot Provide Competitive Pricing	3.00	0.25	3.00	5.00	2.00	3.00	3.00	3.00	5.00	4.00	1.00	0.50	3.00	2.00	3.00	0.33	2.00	0.50	3.00	5.00
12. Higher Costs of Transportation	3.00	0.50	4.00	5.00	2.00	5.00	3.00	5.00	5.00	4.00	2.00	1.00	6.00	4.00	6.00	3.00	4.00	3.00	5.00	5.00
13. Management Errors	0.20	0.33	0.33	0.50	0.33	0.33	0.50	0.33	3.00	0.33	0.33	0.17	1.00	0.33	0.20	0.20	0.33	0.20	3.00	3.00
14. Transit time Variability	0.33	0.33	2.00	5.00	2.00	3.00	5.00	3.00	5.00	5.00	0.50	0.25	3.00	1.00	3.00	0.25	0.33	0.25	3.00	5.00
15. Failure to Make Delivery Requirements	0.33	0.33	2.00	3.00	0.33	3.00	3.00	2.00	5.00	3.00	0.33	0.17	5.00	0.33	1.00	0.25	0.50	0.20	3.00	5.00
16. Lack of Integration with Suppliers	2.00	0.33	3.00	5.00	2.00	6.00	2.00	7.00	5.00	4.00	3.00	0.33	5.00	4.00	4.00	1.00	3.00	0.50	4.00	4.00
17. Deficient or Missing Customer Relation	2.00	0.33	4.00	5.00	2.00	5.00	5.00	5.00	5.00	3.00	0.50	0.25	3.00	3.00	2.00	0.33	1.00	0.33	3.00	5.00
18. Demand Variability	2.00	0.33	3.00	7.00	2.00	5.00	3.00	5.00	5.00	5.00	2.00	0.33	5.00	4.00	5.00	2.00	3.00	1.00	5.00	4.00
19. Competitor Moves	0.14	0.25	0.33	0.50	0.33	0.25	0.50	0.33	0.50	0.33	0.33	0.20	0.33	0.33	0.33	0.25	0.33	0.20	1.00	2.00
20. Warehouse Disruptions	0.33	0.25	0.33	0.33	0.20	0.20	0.33	0.20	0.50	0.50	0.20	0.20	0.33	0.20	0.20	0.25	0.20	0.25	0.50	1.00
Total	22.5	7.0	33.9	67.7	18.2	48.9	51.3	46.6	75.0	55.3	17.0	7.9	59.0	27.7	36.3	13.7	20.3	12.0	63.5	74.0

Source: Own elaboratio