



# Critical factors to improve customer satisfaction and reduce operating costs in large and medium-sized manufacturing companies in Nuevo León and the impact caused by the COVID pandemic

*Los factores críticos para mejorar la satisfacción al cliente y reducir los costos operativos en las grandes y medianas empresas manufactureras en Nuevo León y la afectación provocada por la pandemia del COVID*

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## Abstract

The objective of this document is to determine how transportation, trained personnel, customs procedures, preventive maintenance and inventory reliability impact customer satisfaction and operating costs in large and medium-sized companies in the State of Nuevo Leon, Mexico; Likewise, how they were affected by the pandemic caused by COVID. To carry out this research, a measurement instrument was developed, being of a non-experimental, descriptive and longitudinal type, where the results are first evaluated before the pandemic and after the presence of COVID. To analyze the collected information, the structural equation model was used with the method of partial least squares with the SmartPLS3 software. The results are initially presented globally, and later two groups were formed by type of company, those with Mexican and foreign capital; In this way, the approaches of each group and the impact of the factors on the response variables can be evaluated. The results presented in this article are expected to guide companies to improve customer satisfaction and reduce operating costs with and without a pandemic.

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*Keywords:* COVID-19; customer satisfaction; operating costs

## **Resumen**

El objetivo de este documento es determinar como el transporte, el personal capacitado, los trámites aduanales, el mantenimiento preventivo y la confiabilidad de inventarios impactan en la satisfacción del cliente y en los costos operativos en las grandes y medianas empresas del Estado de Nuevo León, México; así mismo, como se vieron afectados por la pandemia provocada por el COVID. Para realizar esta investigación se elaboró un instrumento de medición, siendo de tipo no experimental, descriptiva y longitudinal, en donde los resultados son evaluados primeramente antes de la pandemia y después de la presencia del COVID. Para analizar la información recopilada se utilizó el modelo de ecuaciones estructurales con el método de mínimo cuadrados parciales con el software SmartPLS3. Los resultados se presentan inicialmente en forma global, y posteriormente se formaron dos grupos por tipo de empresa, las de capital mexicano y extranjero; de esta manera se puede evaluar los enfoques de cada grupo y el impacto de los factores en las variables de respuesta. Se espera que los resultados presentados en este artículo sirvan de guía a las empresas para mejorar la satisfacción del cliente y reducir los costos operativos con pandemia y sin ella.

*Código JEL:* C01, Y1, Y10

*Palabras clave:* costos operativos; COVID-19; satisfacción del cliente

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## **Introduction**

From the creation of the companies to the present day, customer satisfaction in terms of delivery of goods in time and form has been an important factor and later it was emphasized in the operating costs of the entire value chain. Both factors caught the attention of the researchers, who have studied the variables that influence them. The importance of international transport is emphasized as a fundamental element within the logistics of foreign trade, because it specifically guarantees the transfer of the relevant good and/or product from the place of origin to the target market, thus achieving the satisfaction of the final consumer, taking into account that on many occasions international shipments need to use more than one type of transport. It is important that cargo agencies have alliances or depend on an international consortium since these large logistics operators produce a reduction in costs, time and generate better communication with the customs agency, international transport operator, shipping company, among other intermediaries that They are part of the export or import operation, taking into account that they all work hand in hand for customer satisfaction. (López, Moreno, & Vidal, 2018)

Global manufacturing output grew by 2.8% in October 2021 compared to the same month in 2020, pointing to a modest recovery after the COVID-19-related drop in output in 2020. However, manufacturing Global manufacturing is currently facing headwinds due to disruptions in the global supply

chain, delaying the distribution of raw materials, components and other products. Additionally, new strains of the coronavirus threaten economic gains by forcing governments around the world to reintroduce restrictions that limit economic activity. (Facevicova & Kynclova, 2020)

Even when these and other investigations have been carried out, at present there are still problems in meeting the needs of customers in a timely manner, and in operating costs in the value chain, in addition to the impact caused by the pandemic. This is the reason for developing this document to show the impact that transportation, trained personnel, customs procedures, preventive maintenance and inventory reliability have on customer satisfaction and operating costs, ending with the conclusions.

## **Problem statement**

One of the main concerns of any manufacturing company anywhere in the world is that customers receive their products in a timely manner; They also want to optimize their resources during the manufacturing process. For this reason, this research aims to find out how various factors affect customer satisfaction and produce with low operating costs. Because, by not complying with these conditions, the preference of the clients would be lost and the necessary profits to remain in business would not be obtained.

This research has the objective of evaluating how the transport factors, trained personnel, preventive maintenance, customs procedures and inventory reliability currently impact customer satisfaction and operating costs in large and medium-sized companies in Nuevo León, Mexico, and the behavior that they had after the pandemic and that this serves as a guide to companies.

## **Literature review**

Jamid Islam along with other researchers conducted a study in India that was applied to guests of luxury hotels in New Delhi, through a survey that was evaluated by an expert panel composed of three academic experts. 395 surveys were collected and analyzed using structural equation modeling. The results reveal a positive effect with respect to the quality of the service offered by better trained personnel, which reinforces the client's commitment to the brand and the intention to return. This study is in line with my research with the concept of having trained personnel with the relationship of customer satisfaction. (Islam & al., 2019)

Juan Izar, Carmén Ynzunza and Jaime Garnica conducted a study in Querétaro and Colima for logistics and transportation companies, where two models of waiting lines were identified that apply to each organization. In the first of them, the mean arrival time between each client and the mean and standard deviation of the service time are required; while for the second case with the average arrival and

service time is sufficient, then the parameters of each system were estimated to obtain the optimal service rate, which was compared with what was calculated with the equations developed for it (cost system = cost of delay + cost of service). The result showed that in both cases, as the ratio of service/delay costs increases, the optimal number of service providers decreases and this causes an increase in the cost of the system. This relationship between service time and transportation cost is considered in my research. (Izar & Inzunza, 2018)

The present research work was carried out by Luis Julca, aimed at the development of a design and implementation of a total productive maintenance (TPM) management system to reduce operating costs in the platform production line of the company Fabricaciones Metálicas. Carranza S.A.C. in Trujillo, Peru. To solve this situation, Total Productive Maintenance (TPM) tools were used, such as: Preventive Maintenance Plan, Documentation Management, Maintenance Procedures and an Annual Training Program that contains the aforementioned topics. Finally, an economic evaluation was carried out, obtaining a value of S/. 103,149.77, IRR: 26.03%. Which concludes that the improvement proposal is viable and profitable for the company. With this research, it was possible to reduce the number of failures by 10%, which reduced the cost of spare parts from S/. 41,890.00 to S/. 33,512.00, which represents a 20% reduction. (Julca, 2018)

In the research by Zamora and Navarro, it evaluates, through the analysis of principal components, the competitiveness of customs within the framework of international trade. For this, the most important variables that affect the competitiveness of customs in twenty-nine countries were considered, being the most competitive in customs matters (according to the variables analyzed and in descending order) Panama followed by China, India, Germany, Korea, Sweden, Singapore, Turkey, Thailand and Chile. The conclusions obtained are that the variables with the greatest weight in the competitiveness of customs are: taxes on foreign trade and commercial flow with 32.21% and quality, transparency and efficiency in foreign trade with 14.61% of the variance. explained. (Zamora Torres & Navarro Chávez, 2015)

The result of a study by Martínez and Milian 2016 entitled "Proposal 52" for staff training to improve the service quality of the SUMAQ - Chiclayo restaurant, it was concluded that there is a significant relationship between both variables, finding that the restaurant did not carry out training staff and therefore customers were dissatisfied. This situation is explained by the fact that training should consider optimizing the work performance of workers for better customer service. (Román & Leyva, 2021)

Cano Ramírez's research studies and analyzes the relationship between the development of logistics skills and effective inventory management through measurables: inventory reliability and obsolescence costs, considering a sample of micro, small and medium-sized enterprises (MSMEs).

registered in the automotive production chain of the Mexican Business Information System (SIEM) in Ciudad Juárez, Chihuahua. The data was collected through the application of a direct survey developed based on a literature review, using a Likert scale with values between 1 and 5. It was investigated to determine whether or not training has an impact on inventory reliability levels, and obsolescence costs. The results obtained show that there is a relationship between trained personnel with inventory reliability and obsolescence costs, as demonstrated by the following equations: (Cano Ramirez & al., 2016)

$$\text{Reliability in inventories} = 0.33 \times \text{training for the development of logistics skills} + \text{error}$$

$$\text{Costs due to obsolescence} = 0.39 \times \text{reliability in inventories} + 0.33 \times \text{training for the development of logistics skills} + \text{error}$$

The general objective of Llauce Pizarro's research was to describe how inventory management is related to the efficiency of the production processes of the company Servicios de Manufactura S.A.C. from Peru. The research design was non-experimental, cross-sectional and correlational. The population under study was made up of 45 employees from the production and warehouse area. We worked with the total population, that is, we worked with a census sample. The technique that was used was the survey that obtained a Cronbach's alpha of 0.901, which means high statistical reliability, and a content validation of 90% by the experts. It is concluded that there is a positive relationship between inventory management and the efficiency of production processes; the coefficient is statistically significant at 0.05. (Llauce Pizarro, 2019)

The COVID-19 pandemic and the potential for natural and man-made disasters to become more frequent and intense raise important questions about the resilience of the global economy to such shocks. Because of its interconnectedness, international trade can increase an economy's exposure to risk and help shocks spread. On the other hand, international trade can strengthen economic resilience, particularly if supported by national policies and effective international cooperation. Trade is an engine of economic growth that generates the resources and knowledge needed to prepare for crises. Furthermore, by facilitating the supply of goods and services needed to deal with crises, it can help countries recover. (Organización Mundial del Comercio, 2022)

The state of Nuevo León in 2019, made imports for 33,243.1 and exports for 42,317.7 million dollars, information provided by the Secretary of Economy and Labor of Nuevo León. To carry out these commercial activities, the companies had to carry out customs procedures. Similarly, for the transfer of goods in imports and exports, different types of transport were required. (Economista, 2021)

In the last century supply chain management involves materials management, functional logistics, logistics integration, and the supply chain. Ellington adds value for organizations where associates negotiate costs relative to part of their processes to achieve a competitive advantage. (Zerón, 2012). The integration of business functions from the end user through original suppliers that offer

products, services and information that add value to customers and other stakeholders. (James R. Stock, 1992, vol. 3 No. 1)

The scope of the supply chain defines the logistics system, considered as: the set of physical and informational elements, necessary for the realization of a certain flow of material, along multiple rows of suppliers and customers (Crespón, 2003) . The chains they operationalize are intended to allow a consistent flow of goods and information from the suppliers of raw materials to the final consumer. (Rueda, 2005)

Industrialization and competitiveness require logistics to be part of continuous improvement, since quality is a race that has no end, day by day, technology and economic, scientific and technological changes mean that industries that do not evolve with the world sink. This research shows that the factors that influence customer satisfaction and operating costs have been studied for a long time. (Ariza & Rodríguez, 2022)

The main causes of the problems of high operating costs in the company María del Monte Carmelo SAC are the absence of a maintenance plan, lack of adequate control of fuel, poor supply of explosives, lack of proper management of suppliers and lack of control in the arrival of materials. Costs were reduced with the implementation of Preventive Maintenance of critical equipment, the Programming of fuel orders, the Improvement of the storage system and the implementation of the SRM tool for supplier management. (Peña, 2017)

Cargo logistics management was improved to reduce the operating costs of the transport company Ave Fénix Sac, through the implementation of a process operations diagram, registration forms, organization and functions manual, training plan and procedure manuals. which were determined as critical factors with a positive influence on costs. (Gonzales, 2019) Transportation is a key activity for the competitive performance of companies, since it is responsible for around 50% of their logistics costs. (Zapata, Vélez, & Martín, 2020)

The concept of competitiveness has evolved over time, tariff and non-tariff barriers have been eliminated, markets have been increasingly compacted and companies have better possibilities of accessing other markets and transcending. In a context of growing trade, it is important to assess the logistics competitiveness of maritime transport. The port competitiveness of the country must be analyzed considering the concept of logistics chain, in which the port is a link in the transport of export and import goods. (Munguía, Canales, & Becerril, 2018)

The increase in various threats and risks in international supply chains has meant a greater responsibility on the part of companies to ensure supply. The AEO certification is aimed at providing fluid access to trade, streamlining customs procedures and helping to achieve an integrated international supply chain. (Vázquez & Martínez, 2022)

The New Customs Regulation in Colombia, unifies the import process in a single platform, automating the operations that are currently handled (manually), including new operations and new foreign trade operators, relying on the logistics and foreign trade production sector, through an excellent information system that allows importers, exporters and foreign trade operators to comply with the obligations and formalities required by the new regulations. (Nuñez Rudas, 2017)

Maintenance is a value generator, thanks to its contribution to the safety of people, care for the environment, its contribution to meeting production and cost goals (strategic objectives of the organization), and the sustainability of the company. corporate image, (Ortiz Plata, 2019). In another study, a maintenance plan based on reliability was proposed, allowing the critical machines of the productive system to be identified; An analysis of failure modes and effects was carried out, identifying the breakdowns and failures of each machine, and through an RCM decision tree, with this it was reflected in the reduction of costs per breakdown, resulting in a benefit for the company. (Reaño Ramos, 2019)

The importance of training human talent in the productivity of a company. Emphasis is placed on the skills that an employee must have in order to achieve successful and efficient performance in any job position that is requested, making the company optimize resources (Changuán, 2020). Another study aims to establish whether or not there is a correlation between the staff training variable and the productivity variable in the manufacturing industry that deals with the production of food products in the Manta-Ecuador canton. As a conclusion, the existence of a relationship between personnel training and productivity in these industries is determined. (Álvarez & Defaz, 2019)

The article by Adolfo González (2020) presents a methodology for inventory management in a leading company in Chile in the field of bolts and screws; in a multiproduct environment and with variability in demand. He proposed a four-stage methodology: the first identifies and/or places the company's strategy in relation to service levels; the second stage establishes a classification of the products; in the third stage, a demand forecast is made; in the fourth stage, it is oriented to the selection of an inventory policy. With these strategies, an increase in the level of service was obtained, towards 98% (Gonzalez, 2020). Another article analyzed inventory control and its impact on the financial statements of the company FRASCO S.A, and it was found that not having a correct control of them causes errors in the financial statements of the company and also high costs due to shortages and work stoppages. late production and deliveries to customers. (Arroba, Angulo, & Naula, 2018)

This research shows that the factors that influence customer satisfaction and operating costs have long been studied.

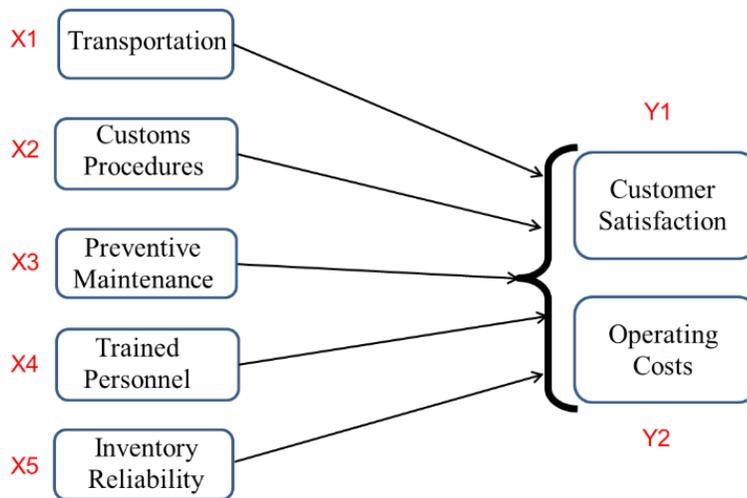


Figure 1. Graphic model of the variables

In reference to the reviewed literature, it is verified that transportation has an impact on business costs; efficient customs procedures help improve deliveries and reduce costs; preventive maintenance influences costs and productivity; trained personnel have a direct impact on customer service and operating costs; inventory control allows to be more productive and in a certain way these factors are correlated and are evaluated in different types of businesses and countries; Therefore, the following hypotheses are established:

## Hypotheses

H1 = Transportation, trained personnel, customs procedures, preventive maintenance and inventory reliability have a positive impact on Customer Satisfaction; for the purposes of this study, in manufacturing companies.

H2 = Transportation, trained personnel, customs procedures, preventive maintenance and inventory reliability have a positive effect on Operating Costs; for the purposes of this study, in manufacturing companies.

## **Methodology**

A quantitative and nonexperimental investigation was carried out, through a measurement instrument for the collection of data, which determine the relationship between the variables of transport, customs procedures, trained personnel, preventive maintenance and the reliability of inventories with customer satisfaction and operating costs. (Gillyard, 2003). It is also descriptive, since a description of the characteristics of reality is obtained according to the information collected with the measurement instrument and the effect on the dependent variables is determined. It is correlational, because it evaluates the effects between the independent variables with customer satisfaction and operating costs. And finally it is explanatory, to give a broader explanation of the causes and effects that the research variables would have with the resulting variables (Manterola, Quiroz, Salazar, & García, 2019) The design is non-experimental because there will be no control on the study variables; longitudinal because the factors were evaluated before the presence of COVID and after it and; estimate the proportion of industries that meet some specific characteristic (Hernández & Velasco, 2000). The research is documentary and bibliographic, because a review of the literature that is related to the research topics is carried out (Gómez, 2011), and in the field because a measurement instrument will be applied to companies to obtain the required information for research to use the multiple regression method and provide the relevant conclusions.

The measurement instrument has 55 questions (items) that are divided into 8 sections, where each section measures a variable. The survey was applied to operations managers and sent electronically to 150 companies that were randomly selected from the INEGI registry catalog, within the state of Nuevo León, of which 94 answered and returned the questionnaire and of those only 72 met the necessary requirements to be considered in the investigation. The questions (items) are composed as follows, 3 questions (items) are demographic in nature, 6 items are dichotomous, 2 items are 3-point Likert, 44 items are 5-point Likert.

The questionnaire has 3 demographic questions (items) in the first section; in the second section 5 questions (items) to evaluate the results of Customer Satisfaction; the third section 6 questions (items) to measure Operating Costs; the fourth section 10 questions (items) to evaluate the level of the Trained Personnel variable; the fifth section 6 questions (items) to measure Transportation; the sixth section 6 questions (items) to measure Customs Procedures; the seventh section 9 questions (items) to measure the level of Preventive Maintenance and the eighth section 10 questions (items) to measure the Reliability of Inventories.

With the information obtained from the surveys considered, the structural equation model was used with the partial least squares method through the SmartPLS3 software. First, the results obtained

from the surveys are shown globally in the periods before and after COVID; later, the analysis of the behavior of each group is presented after making a division by origin of the capital of the company; of Mexican capital (34) and foreign (38).

Table 1 establishes the coding used to identify the independent and response variables in the analyzes performed.

Table 1  
Coding of the variables

Code	Variable
CI	Inventory Reliability
CO	Operating Costs
MP	Preventive Maintenance
PC	Trained Personal
SC	Customer Satisfaction
TA	Customs Procedures
TR	Transport

Source: self made

## Reliability and validity of the construct

Reliability evaluates the internal consistency of the latent variables from their indicators, and can be determined by Cronbach's Alpha and the composite reliability of the construct, the measurement criterion of both is around 0.70. (Henseler, 2009). Average variance extracted (AVE) measures the amount of variance that a latent enabling variable captures from its measurement elements or indicators relative to the amount of variance due to measurement errors. (Fornell, 1981) stated that the AVE should be greater than 0.5, which means that at least 50% of the variance of the measurement is captured by the latent enabling variables. Indicators that have low loads should be eliminated since they have very little explanatory power of the model (A. Aibinu, 2010).

Table 2 shows the results obtained from the analysis of the global Cronbach's Alpha surveys, when using the model with the structural equations with the partial least squares method through the SmartPLS3 software, comparing both results before and after COVID. It can be verified that they are higher than 0.7. With this, the internal consistency of the latent variables that turn out to be reliable is checked. Shows also the values of the composite reliability and the average variance extracted (AVE) which are greater than 0.70 and 0.50 respectively, with which the constructs are validated, in both periods, before and after COVID, which means that more than 50% of the variance of the measurement is captured by the latent enabling variables.

Table 2

Variable	Cronbach's Alpha		Composite Reliability		AVE	
	Before COVID	After COVID	Before COVID	After COVID	Before COVID	After COVID
CI		1.000		1.000		1.000
CO	0.824	0.780	0.917	0.901	0.847	0.820
MP		0.886		0.917		0.688
PC	1.000	1.000	1.000	1.000	1.000	1.000
SC	1.000	1.000	1.000	1.000	1.000	1.000
TA	0.780		0.900		0.818	
TR	1.000	0.703	1.000	0.868	1.000	0.768

Source: Own elaboration with PLS3 software

## Analytical Results

This section shows the results obtained after the bootstrapping process of the structural equation model with the partial least squares method through the SmartPLS3 software. The results are analyzed to determine if it is proven that transportation, trained personnel, customs procedures, preventive maintenance and inventory reliability impact customer satisfaction and operating costs in large and medium-sized companies in Nuevo León, Mexico.

In the results analysis stage, the structural model is evaluated and performed through the  $R^2$  which can vary from 0 to 1. A value close to 0 indicates a small association, and a value close to 1 means a strong association. Table 3 shows the results obtained from  $R^2$ ; comparing results before and after COVID. According to this information, it is shown that the values of the SC variable present a strong association before and after COVID in these models, and the CO variable has a mean explanation before and after COVID. To evaluate the magnitude and weight of the relationships between the latent variables with the response variables, the standardized Path coefficient  $\beta$  is used, the boot procedure is used, the values are shown in Table 4. This table shows that the values reach the minimum value of 0.2 to indicate a strong relationship between the latent variables and the response variables. It is also observed that some latent variables have a negative value with the operating cost variable, which indicates that these factors impact on a decrease in cost.

The following section presents the significance obtained for each construct with the response variables, and as shown in table 5, the condition that the p value is less than 0.05 is met, thus working with a 95% reliability. Collinearity increases the standard errors. A common rule of thumb is that multicollinearity exists when the variance inflation factor (VIF) is greater than 4.0. Table 6 shows the values obtained before and after COVID, of the Variance Inflation Factor (VIF), and with the results shown this problem does not appear in both periods.

Figure 2 graphically shows the factor loadings of the global analysis before COVID and in figure 3, after COVID, which are greater than 0.70, considered good.

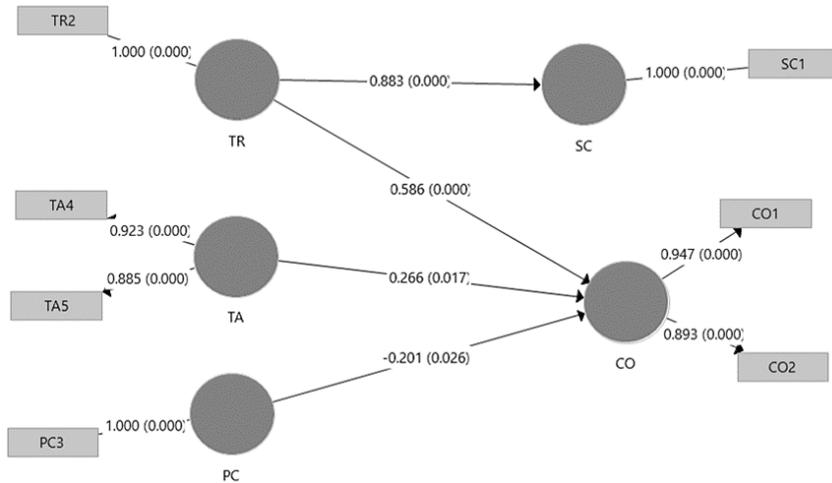


Figure 2. Global Analysis Before COVID, Measurement and structural model  
 Source: Own elaboration with PLS3 software

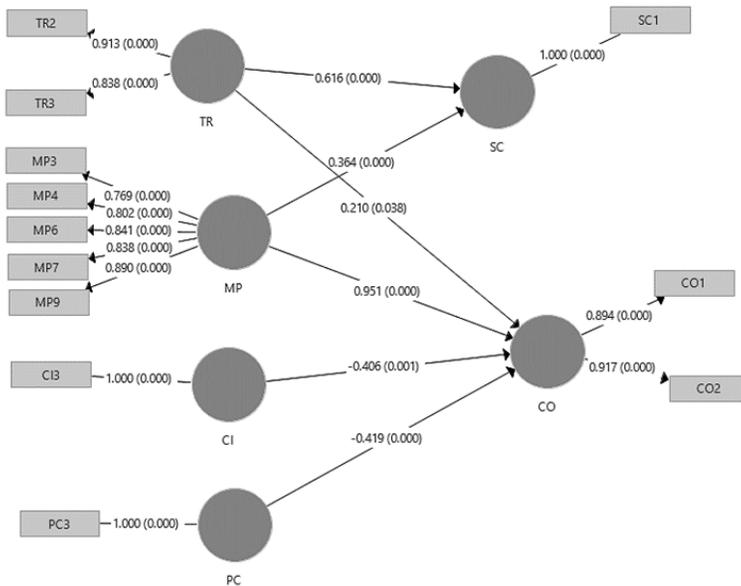


Figure 3. Global analysis after COVID, Measurement and structural model  
 Source: Own elaboration with PLS3 software

## Discussion: Variance explained by company type

The following section presents the results obtained from the two groups formed by the type of company, Mexican capital that is represented with the information collected from 34 surveys and foreign capital that is represented by 38 surveys, using the model of structural equations with the partial least squares method through the SmartPLS3 software for analysis.

### Analysis of R<sup>2</sup> results

Table 3 shows the results obtained in the values of R<sup>2</sup>, which show values greater than 0.3, which shows that there is a good relationship between the constructs and the response variables. When analyzing the global form, it is observed that there is no significant variation before and during COVID-19. However, when using the control variable and segmenting the companies into Mexican and foreign, it is shown that in Mexican companies before and during COVID-19 there are no significant variations in the values obtained. While in foreign companies, better R<sup>2</sup> values were observed once the pandemic entered in both response variables. In operating cost they went from (0.301) to (0.519) and in customer satisfaction from (0.574) to (0.831), which shows that they paid more attention to the aforementioned factors.

Table 3  
Value of R<sup>2</sup>

Variable	Before COVID			After COVID		
	Global	Mexican	Foreign	Global	Mexican	Foreign
CO	0.508	0.628	0.301	0.504	0.640	0.519
SC	0.780	0.866	0.574	0.795	0.803	0.831

Source: Own elaboration with PLS3 software

Table 4 shows the path coefficients, which define the impacts that each of the constructs presents with the response variables. This coefficient must have at least a value of 0.2, and ideally be above 0.3 which evaluates the importance of hypotheses, the starting procedure is used, in the values shown in the table it is verified that all are greater to the minimum established.

### *Global model path coefficients results (pre-COVID & COVID)*

Before COVID, preventive maintenance and inventory reliability did not present significant operational costs, but after the pandemic both factors had very important impacts. Preventive maintenance is the one that impacts the most (0.951), while inventory reliability (-0.406) contributes to a decrease in operating

costs. On the other hand, the trained personnel that influenced (-0.201) in the reduction of costs before COVID, after it, increases their contribution to the reduction (-0.419). Customs procedures that had an impact (0.266) before COVID, their significance disappears when entering the pandemic. Finally, transportation had an impact (0.586) and fell (0.210) after COVID.

Regarding customer satisfaction, before COVID, transportation was the only factor with significance and high (0.883); After the pandemic, its impact was reduced (0.616) and with the results obtained, preventive maintenance also had an impact (0.364) in this period.

### *Path coefficients results (pre-COVID). Mexican vs foreign companies*

In operating costs, there is an alignment of the value obtained globally in trained personnel (-0.201) with the value of foreign companies (-0.233) and that is not significant for Mexican companies. Regarding customs procedures, the global impact (0.266) is less than that obtained with segmentation in both foreign companies (0.624) and Mexican companies (0.579). While the global impact of transportation is greater (0.586) than that obtained in the segmentation in Mexican companies (0.337) and it is not significant for foreign companies.

With reference to customer satisfaction, the main difference is that customs procedures are significant for foreign companies (0.464) when it is not globally. Another result is that transportation has a high impact globally (0.883) and when the division is made, there is a greater impact on Mexican companies (0.931) and reduces the impact (0.361) on foreign ones.

### *Path coefficients results (COVID). Mexican vs foreign companies*

Analyzing the results in operating costs, it is observed that globally the reliability of inventories has an impact (-0.406) that contributes to its decrease and segmentation, it is aligned with foreign companies (-0.345) but with Mexican companies it presents an opposite impact (0.551). Globally, preventive maintenance has a high impact (0.951) which is aligned with foreign companies (0.901) and which is not significant for Mexican companies. On the contrary, globally trained personnel have an impact (-0.419) that helps to reduce costs, and that is aligned with Mexican companies (-0.380) and that is not significant for foreign companies. While transportation globally also impacts costs (0.210), with segmentation an improvement is obtained in Mexican companies (0.592) and without significance for foreign companies.

When reviewing the results in customer satisfaction, it is observed that transportation has an impact globally (0.616) that is aligned with foreign companies (0.677), but that in Mexican companies there is an improvement (0.896). The other impact that occurs is due to preventive maintenance (0.364)

which suffers a small reduction in the impact (0.275) in foreign companies due to segmentation, without having significance in Mexican companies.

### *Longitudinal Path coefficients discussion. Mexican companies*

Before COVID, customs procedures (0.579) and transportation (0.337) were the factors that impacted operating costs; After the pandemic, customs procedures are no longer significant and transport increases its impact (0.592). In addition, the relevance in the impact of inventory reliability (0.551) and trained personnel (-0.380) is added. Regarding customer satisfaction, there are no significant changes.

### *Longitudinal Path coefficients discussion. Foreign companies*

Analyzing the factors that have an impact on operating costs before COVID, trained personnel (-0.233) and customs procedures (0.624) are no longer significant after the pandemic, and change due to inventory reliability (-0.345) and preventive maintenance (0.901). In relation to the factors that show impact on customer satisfaction before COVID, customs procedures (0.464) and transportation (0.361); After the pandemic, the first is no longer significant and the second increases its impact (0.677) and maintenance appears with relevance (0.275).

Table 4  
 Path coefficients of the latent variables

Variable	Before COVID						After COVID					
	CO			SC			CO			SC		
	Glo bal	Mexi can	Fore ign	Glo bal	Mexi can	Fore ign	Glo bal	Mexi can	Fore ign	Glo bal	Mexi can	Fore ign
CI							-0.406	0.551	-0.345			
MP							0.951		0.901	0.364		0.275
PC	-0.201		-0.233				-0.419	-0.380				
TA	0.266	0.579	0.624			0.464						
TR	0.586	0.337		0.883	0.931	0.361	0.210	0.592		0.616	0.896	0.677

Source: Own elaboration with PLS3 software

In the following section, the significance obtained for each construct with the response variables is presented, and as shown in table 5, the condition that the p value is less than 0.05 is met, thereby working with a 95% reliability, both for Mexican and foreign companies; before and after COVID.

Table 5  
 Significance of constructs with response variables p Value

Relationship	Before COVID			After COVID		
	Global	Mexican	Foreign	Global	Mexican	Foreign
CI→CO				0.001	0.001	0.042
MP→CO				0.000		0.001
MP→SC				0.000		0.030
PC→CO	0.026		0.053*	0.000	0.018	
TA→CO	0.017	0.000	0.002			
TA→SC			0.000			
TR→CO	0.000	0.020		0.038	0.004	
TR→SC	0.000	0.000	0.041	0.000	0.000	0.000

Source: Own elaboration with PLS3 software

To validate that there is no collinearity, the variance inflation factor (VIF) is calculated, which must be less than 4.0. Table 6 shows the values obtained before and after COVID, of the Variance Inflation Factor (VIF), and with the results shown, this problem does not occur in both periods, in Mexican and foreign companies.

Table 6  
 Value of the Variance Inflation Factor (VIF)

Item	Before COVID			After COVID		
	Global	Mexican	Foreign	Global	Mexican	Foreign
CI1						2.158
CI2					1.632	2.110
CI3				1.000	1.821	
CI4					1.967	1.202
CI9					2.966	
CO1	1.964			1.694	2.074	1.703
CO2	1.964			1.694	2.074	1.703
CO4			1.767			
CO6		1.000	1.767			
MP3				2.079		3.664
MP4				2.299		3.063
MP6				2.483		2.595
MP7				2.163		1.945
MP9				2.987		

PC2					1.000	
PC3	1.000			1.000		
PC9			1.000			
SC1	1.000	1.817		1.000	1.980	1.399
SC3		1.817	1.000		1.980	1.399
TA2		1.540				
TA3			1.822			
TA4	1.689		1.720			
TA5	1.689		1.856			
TA6		1.540				
TR2	1.000	1.000	1.702	1.415	1.632	1.758
TR3			1.702	1.415		1.758
TR4					1.632	

Source: Own elaboration with PLS3 software

Figure 4 and figure 5 graphically show the factor loadings of Mexican companies before and after COVID, respectively, and in figure 7 and figure 7, of foreign companies before and after COVID, which are greater than 0.70, considering themselves good.

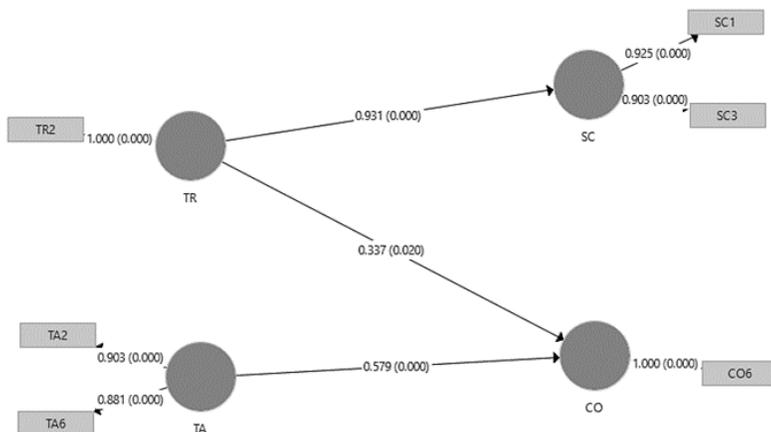


Figure 4. Mexican companies before COVID, Measurement and structural model  
 Source: Own elaboration with PLS3 software

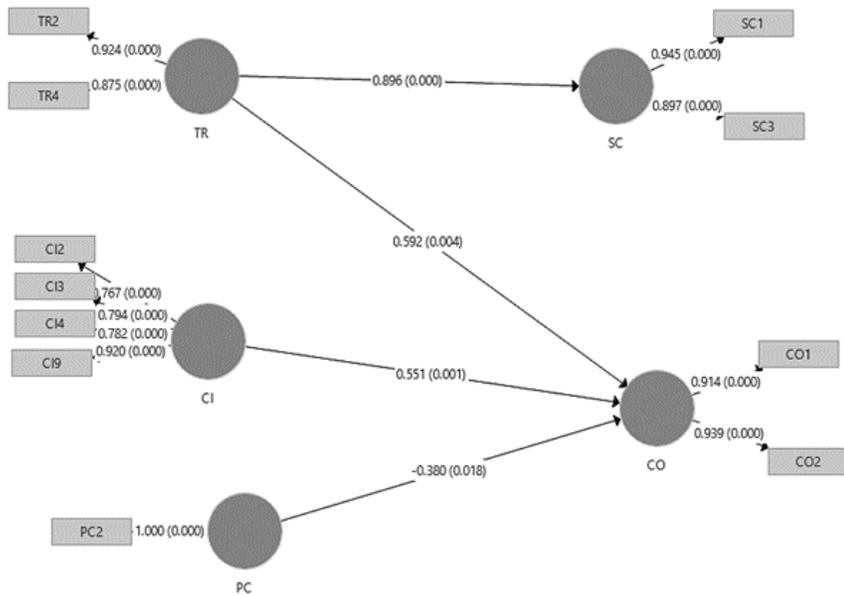


Figure 5. Mexican companies after COVID, Measurement and structural model  
 Source: Own elaboration with PLS3 software

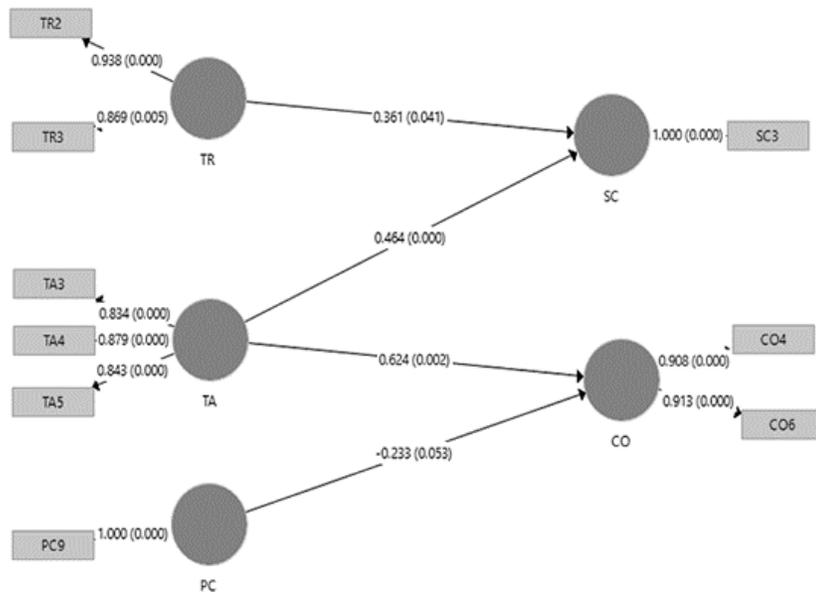


Figure 6. Foreign companies before COVID, Measurement and structural model  
 Source: Own elaboration with PLS3 software

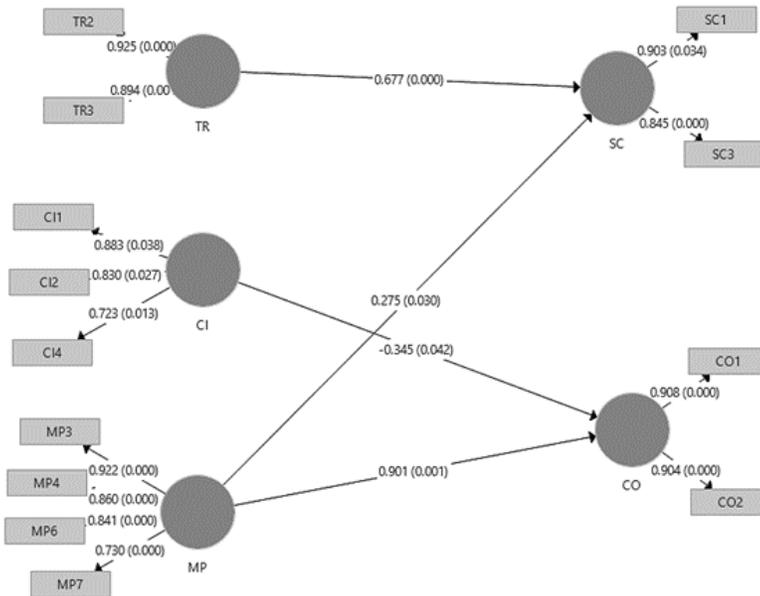


Figure 7. Foreign companies after COVID, Measurement and structural model  
 Source: Own elaboration with PLS3 software

## Conclusions

The study offers an analysis of the impact of the factors: transportation, customs procedures, preventive maintenance, trained personnel and inventory reliability on operating costs and customer satisfaction; in two periods, before and during COVID-19 and with the segregation of the origin of the companies: Mexican and foreign.

The analysis performed is presented in several sections validating the established hypotheses of the reviewed literature. In the first section, the analysis of the results obtained in the period before COVID and of the global number of companies surveyed, it is concluded that preventive maintenance and inventory reliability do not present significance in operating costs, while trained personnel influence a better performance. cost reduction, customs procedures and transportation have a positive impact on operating costs. After COVID, customs procedures cease to have significance in operating costs; preventive maintenance and transportation have a positive impact; the reliability of inventories and trained personnel influence the reduction of operating costs. In reference to customer satisfaction, before COVID transportation is the only significant factor; After the pandemic, transportation and preventive maintenance have a positive impact.

In the second section, the analysis of results obtained before COVID in the segmentation of Mexican companies, it is shown that customs procedures and transportation have a positive impact on operating costs; After the pandemic, customs procedures are no longer significant, while transportation, inventory reliability have a positive impact, and trained personnel influence the reduction of operating costs. Regarding satisfaction, only transportation had a positive impact before and after COVID.

In the third section, analyzing the factors that have a positive impact on operating costs before COVID, are customs procedures; while trained personnel influence their reduction, which cease to be significant after the pandemic, having preventive maintenance with a positive impact and inventory reliability that influences their reduction. In relation to the factors that show a positive impact on customer satisfaction before COVID, they are customs procedures and transportation; after the pandemic, the first ceases to be significant and the second maintains its impact along with maintenance.

As a general summary, hypothesis 1 is accepted since it is confirmed that transportation, customs procedures, preventive maintenance, trained personnel and inventory reliability impact operating costs in manufacturing companies. Hypothesis 2 is partially accepted because transportation, customs procedures, and preventive maintenance have an impact on customer satisfaction, while trained personnel and inventory reliability are not significant.

The research has the limitation of having been carried out with companies in the state of Nuevo León and if these factors were analyzed in other entities of the country or in other countries, different results could be obtained. The recommendation to enrich this research according to the results obtained is to find the other factors that complete the explanation for COVID in foreign companies, which is the lowest value of  $R^2$  obtained in the study.

Likewise, the alternative of carrying out another study once the pandemic is over is recommended to compare the behavior of these factors with customer satisfaction and operating costs in a more normal scenario.

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## Annex

Note: It is attached in Spanish because it was applied in Mexico

# Encuesta de investigación de Satisfacción al Cliente y Costos Operativos

Con esta encuesta se desea investigar como los factores de Transporte, Personal Capacitado, Trámites Aduanales, Mantenimiento Productivo Total y la Confiabilidad de Inventarios mejoran la Satisfacción al Cliente y Reducen los Costos Operativos.

Favor de seleccionar la alternativa que refleje mejor la situación de su empresa.

\* Obligatorio

1. Nombre de la empresa \*

2. Tipo de empresa: \*

Mexicana

Extranjera

3. Cantidad de empleados: \*

	1-10	11-50	51-250	+ de 250
Total de Empleados	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

4. Giro de la empresa: \*

- Alimenticia
- Automotriz
- Bebidas
- Eléctrico
- Equipo de Cómputo
- Equipo de Transporte
- Maquinaria y Equipo
- Metal - Mecánico
- Químico
- Otro

5. ¿Cuál es el cumplimiento en las entregas al Cliente? \*

	0%	1-25%	26-50%	51-75%	76-100%
Antes de Covid-19	<input type="radio"/>				
Después de Covid-19	<input type="radio"/>				

6. El porcentaje de garantías que ha otorgado en relación a las ventas es: \*

	0%	1-5%	6-10%	11-15%	+ de 15%
Antes de Covid-19	<input type="radio"/>				
Después de Covid-19	<input type="radio"/>				

7. La relación de las devoluciones con respecto a las ventas es: \*

	0%	1-5%	6-10%	11-15%	+ de 15%
Antes de Covid-19	<input type="radio"/>				
Después de Covid-19	<input type="radio"/>				

8. Porcentaje de Clientes que han sido recurrentes \*

	0%	1-25%	26-50%	51-75%	76-100%
Antes de Covid-19	<input type="radio"/>				
Después de Covid-19	<input type="radio"/>				

9. ¿Cuál a sido el incremento de las ventas en promedio mensual? \*

	0%	1-5%	6-10%	11-15%	+del 15%
Antes de Covid-19	<input type="radio"/>				
Después del Covid-19	<input type="radio"/>				

10. El rendimiento de la empresa es: \*

	0%	1-5%	6-10%	11-15%	+del 15%
Antes de Covid-19	<input type="radio"/>				
Después del Covid-19	<input type="radio"/>				

11. El margen de contribución en general es: \*

	0%	1-5%	6-10%	11-15%	+del 15%
Antes de Covid-19	<input type="radio"/>				
Después del Covid-19	<input type="radio"/>				

12. Los costos de producción en comparación con las ventas son: \*

	0-12.5%	13-25%	26-37.5%	38-50%	+del 50%
Antes de Covid-19	<input type="radio"/>				
Después del Covid-19	<input type="radio"/>				

13. El costo de mantenimiento con respecto al costo total es: \*

	0-12.5%	13-25%	26-37.5%	38-50%	+del 50%
Antes de Covid-19	<input type="radio"/>				
Después del Covid-19	<input type="radio"/>				

14. El porcentaje del costo de capacitación de los empleados del costo total es: \*

	0-12.5%	13-25%	26-37.5%	38-50%	+del 50%
Antes de Covid-19	<input type="radio"/>				
Después del Covid-19	<input type="radio"/>				

15. El ratio del costo de distribución con respecto al costo total es: \*

	0-12.5%	13-25%	26-37.5%	38-50%	+del 50%
Antes de Covid-19	<input type="radio"/>				
Después del Covid-19	<input type="radio"/>				

16. Porcentaje de personal capacitado del total de personal \*

	0%	1-25%	26-50%	51-75%	75-100%
Antes de Covid-19	<input type="radio"/>				
Después del Covid-19	<input type="radio"/>				

17. Nuestros empleados son expertos en sus trabajos particulares y funciones \*

	Muy en desacuerdo	En desacuerdo	Aceptable	De acuerdo	Muy de acuerdo
Antes de Covid-19	<input type="radio"/>				
Después del Covid-19	<input type="radio"/>				

18. Nuestros empleados son creativos y brillantes \*

	Muy en desacuerdo	En desacuerdo	Aceptable	De acuerdo	Muy de acuerdo
Antes de Covid-19	<input type="radio"/>				
Después del Covid-19	<input type="radio"/>				

19. Nuestros empleados desarrollan nuevas ideas y conocimientos \*

	Muy en desacuerdo	En desacuerdo	Aceptable	De acuerdo	Muy de acuerdo
Antes de Covid-19	<input type="radio"/>				
Después del Covid-19	<input type="radio"/>				

20. Porcentaje de empleados que están capacitados para colaborar entre sí para diagnosticar y resolver problemas \*

	0%	1-25%	26-50%	51-75%	76-100%
Antes de Covid-19	<input type="radio"/>				
Después del Covid-19	<input type="radio"/>				

21. Porcentaje de empleados que comparten información y aprenden unos de otros \*

	0%	1-25%	26-50%	51-75%	76-100%
Antes de Covid-19	<input type="radio"/>				
Después del Covid-19	<input type="radio"/>				

22. Porcentaje de empleados que se asocian con clientes, proveedores, socios de alianza, etc., para desarrollar soluciones \*

	0%	1-25%	26-50%	51-75%	76-100%
Antes de Covid-19	<input type="radio"/>				
Después del Covid-19	<input type="radio"/>				

23. Porcentaje de empleados que aplican el conocimiento de un área de la organización a problemas y oportunidades que surgen en otro \*

	0%	1-25%	26-50%	51-75%	76-100%
Antes de Covid-19	<input type="radio"/>				
Después del Covid-19	<input type="radio"/>				

24. La cultura de nuestra organización (historias, rituales) contiene ideas valiosas, formas de hacer negocios, etc. \*

	Muy en desacuerdo	En desacuerdo	Aceptable	De acuerdo	Muy Deacuerdo
Antes de Covid-19	<input type="radio"/>				
Después del Covid-19	<input type="radio"/>				

25. El conocimiento de nuestra organización está contenido en manuales, bases de datos, etc. \*

	0%	1-25%	26-50%	51-75%	76-100%
Antes de Covid-19	<input type="radio"/>				
Después del Covid-19	<input type="radio"/>				

26. El Cliente recoge la carga o nosotros la entregamos \*

	Cliente retira	Nosotros entregamos	Ambos
Antes de Covid-19	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Después del Covid-19	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

27. El cumplimiento en la entrega de la carga es: \*

	0%	1-25%	26-50%	51-75%	76-100%
Antes de Covid-19	<input type="radio"/>				
Después del Covid-19	<input type="radio"/>				

28. El servicio de transporte es eficiente \*

	Muy insatisfactorio	Insatisfactorio	Aceptable	Satisfactorio	Muy Satisfactorio
Antes de Covid-19	<input type="radio"/>				
Después del Covid-19	<input type="radio"/>				

29. Cree usted que su mercadería está segura durante el envío \*

	Muy en desacuerdo	En desacuerdo	Aceptable	De acuerdo	Muy de acuerdo
Antes de Covid-19	<input type="radio"/>				
Después del Covid-19	<input type="radio"/>				

30. Cambiaría su proveedor transportista por menos costo \*

	Muy en desacuerdo	En desacuerdo	Aceptable	De acuerdo	Muy de acuerdo
Antes de Covid-19	<input type="radio"/>				
Después del Covid-19	<input type="radio"/>				

31. Cambiaría su proveedor transportista por mejor servicio \*

	Muy en desacuerdo	En desacuerdo	Aceptable	De acuerdo	Muy de acuerdo
Antes de Covid-19	<input type="radio"/>				
Después del Covid-19	<input type="radio"/>				

32. ¿Es una empresa que importa y exporta?

Si su respuesta es que "NO", pase a la pregunta 37 \*

	Si	No
Antes de Covid-19	<input type="radio"/>	<input type="radio"/>
Después del Covid-19	<input type="radio"/>	<input type="radio"/>

33. El servicio de su agente aduanal es:

	Malo	Regular	Bueno	Muy bueno	Excelente
Antes de Covid-19	<input type="radio"/>				
Después del Covid-19	<input type="radio"/>				

34. El tiempo que tarda en ser despachada la mercancía es:

	1-3 días	4-6 días	7-9 días	10-12 días	+ de 12 días
Antes de Covid-19	<input type="radio"/>				
Después del Covid-19	<input type="radio"/>				

35. La eficiencia en los trámites aduanales es:

	0%	1-25%	26-50%	51-75%	76-100%
Antes de Covid-19	<input type="radio"/>				
Después del Covid-19	<input type="radio"/>				

36. ¿Cómo evalúa al personal que realiza los trámites aduanales?

	Malo	Regular	Bueno	Muy bueno	Excelente
Antes de Covid-19	<input type="radio"/>				
Después del Covid-19	<input type="radio"/>				

37. ¿Cómo evalúa el tiempo de reacción ante un problema administrativo durante la actividad del trámite?

	Malo	Regular	Bueno	Muy bueno	Excelente
Antes de Covid-19	<input type="radio"/>				
Después del Covid-19	<input type="radio"/>				

38. ¿Se encuentra definido e implementado un Plan de Mantenimiento Programado? \*

	No	Casi no	Ni sí, ni no	Más bien sí	Sí
Antes de Covid-19	<input type="radio"/>				
Después del Covid-19	<input type="radio"/>				

39. ¿Sabe con exactitud cuál es el costo de pérdida de producción/servicio por falla? \*

	No	Casi no	Ni sí, ni no	Más bien sí	Sí
Antes de Covid-19	<input type="radio"/>				
Después del Covid-19	<input type="radio"/>				

40. La plantilla de mantenimiento se encuentra definida y cubierta en un: \*

	0%	1-25%	26-50%	51-75%	76-100%
Antes de Covid-19	<input type="radio"/>				
Después del Covid-19	<input type="radio"/>				

41. En qué nivel de capacitación es acorde a la tecnología del equipamiento \*

	0%	1-25%	26-50%	51-75%	76-100%
Antes de Covid-19	<input type="radio"/>				
Después del Covid-19	<input type="radio"/>				

42. Los operarios de los equipos realizan tareas simples de mantenimiento (mantenimiento autónomo) \*

	0%	1-25%	26-50%	51-75%	76-100%
Antes de Covid-19	<input type="radio"/>				
Después del Covid-19	<input type="radio"/>				

43. La lista de repuestos mínimos a mantener en stock actualizada en un: \*

	0%	1-25%	26-50%	51-75%	76-100%
Antes de Covid-19	<input type="radio"/>				
Después del Covid-19	<input type="radio"/>				

44. El cumplimiento del programa de trabajos programados de mantenimiento es: \*

	0%	1-25%	26-50%	51-75%	76-100%
Antes de Covid-19	<input type="radio"/>				
Después del Covid-19	<input type="radio"/>				

45. El control estadístico de los gastos de mantenimiento por equipos está cubierto en un: \*

	0%	1-25%	26-50%	51-75%	76-100%
Antes de Covid-19	<input type="radio"/>				
Después del Covid-19	<input type="radio"/>				

46. La planta cuenta con un listado completo de los equipos a mantener \*

	0%	1-25%	26-50%	51-75%	76-100%
Antes de Covid-19	<input type="radio"/>				
Después del Covid-19	<input type="radio"/>				

47. El manejo del inventario en el almacén ayuda a mejorar su confiabilidad de manera \*

	Baja	Adecuada	Alta
Antes de Covid-19	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Después del Covid-19	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

48. ¿En qué porcentaje, cree que los procesos de control actuales donde se hacen movimientos de materia prima minimizan las diferencias de inventario? \*

	0%	1-25%	26-50%	51-75%	76-100%
Antes de Covid-19	<input type="radio"/>				
Después del Covid-19	<input type="radio"/>				

49. ¿Cuál es la confiabilidad de inventarios que se tiene en la empresa? \*

	0%	1-25%	26-50%	51-75%	76-100%
Antes de Covid-19	<input type="radio"/>				
Después del Covid-19	<input type="radio"/>				

50. ¿Cuenta con un sistema integral para el control de inventarios? \*

	Si	No
Antes de Covid-19	<input type="radio"/>	<input type="radio"/>
Después del Covid-19	<input type="radio"/>	<input type="radio"/>

51. ¿Se cuenta con un sistema de conteos cíclicos? \*

	Si	No
Antes de Covid-19	<input type="radio"/>	<input type="radio"/>
Después del Covid-19	<input type="radio"/>	<input type="radio"/>

52. ¿Se utiliza el lector de código de barras? \*

	Si	No
Antes de Covid-19	<input type="radio"/>	<input type="radio"/>
Después del Covid-19	<input type="radio"/>	<input type="radio"/>

53. ¿El almacén tiene el área suficiente para la cantidad de materiales almacenados? \*

	Si	No
Antes de Covid-19	<input type="radio"/>	<input type="radio"/>
Después del Covid-19	<input type="radio"/>	<input type="radio"/>

54. ¿Las áreas de almacenamiento están ordenados e identificados? \*

	Si	No
Antes de Covid-19	<input type="radio"/>	<input type="radio"/>
Después del Covid-19	<input type="radio"/>	<input type="radio"/>

55. Los procedimientos para el control de inventarios, son efectivos en un: \*

	0%	1-25%	26-50%	51-75%	76-100%
Antes de Covid-19	<input type="radio"/>				
Después del Covid-19	<input type="radio"/>				

56. ¿En qué porcentaje está capacitado el personal en el manejo del sistema electrónico? \*

	0%	1-25%	26-50%	51-75%	76-100%
Antes de Covid-19	<input type="radio"/>				
Después del Covid-19	<input type="radio"/>				