Causal Model for Evaluating the Performance Technological, Organizational, Capacity and Financial when Developing Suppliers

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Abstract

This research presents a model of structural equations to evaluate the effects of capacity, financial, technological, and organizational performance achieved when developing suppliers. The information was obtained from a questionnaire applied to engineers and managers working in manufacturing companies in Ciudad Juárez, Chih. Mexico already has a specific list of suppliers and collaborators; 200 completed questionnaires were obtained from approximately 50 companies. The results indicate that, when it is intended to develop existing suppliers, it is important first to measure and evaluate the technological performance that they have achieved by participating as a strategic company, and secondly, to consider organizational and capacity performance, since together all of them will directly and positively influence the financial performance obtained in companies. This referer to industrial practice, to incorporate suppliers through a supplier development program, a key factor is the assessment of the performances that they have achieved in a certain time, with the purpose that the long-term strategy between company-supplier works properly to remain competitive, especially in costs. The model presented validates the fact that when selecting suppliers to develop them, the choice and the prior evaluation of their performance in the short-, medium- or long-term influences.

Keywords
Supplier development, Performance, Partial Least Squares, SEM.

1. Introduction
Today, supply chains are complex and extensive, and controlling each logistics activity becomes difficult to overcome. A supply chain (SC) is conceptualized as multiple networks of material suppliers located in different geographical locations. Multiple production companies and distribution centers assemble and transform products to distribute to their customers (Sawik, 2018). All are connected by flows of materials, information, services, and money. Here logistics plays a key role in planning, implementing, and controlling the effective and efficient flow of materials from their origin to the destination to meet customers' needs. Managing logistics across the organization and its operations to optimize material and supply flows throughout the SC is a very complex planning process that requires some shared information (Christopher & Holweg, 2017). Therefore, it is necessary to develop certain competencies such as managing customers and suppliers, using integrative technologies, increasing collaboration, and improving operations. Concerning supplier management, the ideal is to promote real-time synchronization of buyers' requirements and supplier capabilities to reduce costs and improve quality to meet customers' expectations (Ross, 2015). Creating

strategies to take the supplier to another level of collaboration and working together would mean developing it. The development of suppliers (SD) today is an essential task carried out by companies and influenced by the diversity in their location and the complexity when seeking to reduce logistics costs. The SD is a process characterized by increasing the performance of existing suppliers and with whom it collaborates to acquire their raw materials (Glock, Grosse, & Ries, 2017). It is defined as a long-term business strategy instituted by a purchasing company to create, increase, expand and maintain the competencies and capabilities of its material suppliers (Olapoju, 2019).

The SD influences organizational performance across the administrative or managerial process. It has greater acceptance in certain industrial sectors, such as automotive, for being perhaps the best known when implementing such practices and for the demands on quality and service due to the type of product manufactured (Sucky & Durst, 2013).

Despite the importance of PD to increase companies' competitive strategy, it is currently observed that when a manufacturing company is mostly engaged in export, to a lesser extent, it develops local or national suppliers, compared to companies oriented to the local market. Hence the importance of creating strategies to capture interest in national industrial sectors, seeking first to analyze specific problems of the environment and outsource in an amplified way at a national and international level. Mexico's manufacturing companies, belonging to large global supply chains, rarely develop programs to promote, create, or strengthen domestic suppliers, because of perceived risk, uncertainty, ignorance, or lack of procedures. Despite being a sector that has a great economic contribution to the country. Regarding this, the contribution to the Gross Domestic Product is characterized by being achieved through maquiladora export companies dedicated to producing or assembling a wide variety of products that are then exported to another country. In 2019 the value of these exports amounted to more than 39 billion dollars (INEGI, 2019), being a notorious figure because Mexico is the 6th world producer of cars, with multiple assembly and manufacturing plants throughout its geographical area. On the other hand, the number of jobs at the end of 2020 registered at around 2,655,102 nationwide, which is considered important despite the health contingency caused by COVID-19 (AMAC, 2020).

Under these premises, the problems concerning SD derive from the absence of active practice in the management and development of the same, from the lack of unification of criteria to develop them, from the fact that each company uses its methodology to carry out the selection, evaluation and development; and that sometimes a quantification of the possible effects between these criteria and their impact on financial results is not included. In addition, ignorance of information in the buyer-seller relationship leads to magnified errors throughout the chain. All these undoubtedly diminish the results of competitiveness in companies putting at risk the efficiency in the SC and the proper functioning to meet the demands of requested products that meet the different needs of customers. The problem of this investigation focuses on the need to quantify the relationships between technological, capacity, organizational, and financial criteria when developing suppliers and causality to define the best decision strategy. From an industrial and practical point of view, to interpret the degree of importance that engineers experts in the industry give to the development of their suppliers.

2. Literature Review

2.1 Supplier Development (SD)

The SD is a fundamental part of purchasing management and refers to the activities that strengthen their capacities through lasting and trusting relationships with purchasing companies, adding value to the chain, improving performance and achieving mutual benefits. It is then a collaborative activity between manufacturing companies and their suppliers that focuses on improving buyer-supplier relations and CS performance (Rahayu, 2020; Tukiman, 2020). It focuses on achieving economic goals through capacity building on quality, cost and delivery. Managing the relationship with suppliers also includes aspects of commitment, trust, communication, collaboration, cooperation and coordination, which, applied to a greater extent, will achieve long-term benefits. Nowadays, environmental and social impact are also considered when selecting suppliers, so these aspects must include in their selection and development (Wan Mahmood, Tukimin, Muhamad, & Yusup, 2014). On the other hand, the technological capacity to communicate and manage logistics activities includes the capacity for EDI, level of interaction, and transport management, among others.

2.2 Technological Performance

A performance attribute allows for measuring the direct result obtained in the processes or operations within any company and, in that sense, allows for monitoring the strategies carried out. Performance can be measured internally by controlling internal processes in companies and externally when controlling inter-company processes and relationships with suppliers or customers (Maestrini, Luzzini, Maccarrone, & Caniato, 2017a) (Maestrini, Luzzini, Maccarrone, & Caniato, 2017b), as far as this research concerns, the performance referred to suppliers.

When suppliers are developed, seeking to maintain a close relationship with them and in the long term, there is a relationship between investment in knowledge and competitiveness, as he says (Olea Miranda, Valenzuela Valenzuela, & Navarrete Hinojosa, 2018). And where it was investing in technology will be the most viable option to obtain competitive advantages. When this happens, the possibility of providing transnational companies is greater since innovation, adaptation to markets and better designs in the products are achieved. The economic level of the products can be a determinant in developing local suppliers, mainly due to the technological distance between the company and its supplier.

2.3 Capacity Performance

Manufacturing systems at both manufacturer and supplier barely have enough built-in flexibility to adapt to ups and downs and constantly support SDPs (C. S. Kumar & Routroy, 2018). Some authors agree that in a certain way, the installed capacity in your company may or may not be sufficient to cover the needs and specifications required by manufacturing companies when demanding large quantities of orders, reduced delivery times, so it becomes a critical aspect to maintain competitiveness (Sánchez, Rodríguez, & Ruiz, 2019).

2.4 Organizational Performance

Developing a supplier has a greater influence on the administrative process to achieve and improve organizational performance. Therefore, the company's success transcends the management of the relationship between customers and employees, including suppliers, competencies development and capabilities. Organizational criteria for developing suppliers include effective communication through information exchange and quality. The first refers to the communication process where specific information details are shared between supplier-buyer, using various resources and means. The second concerns the accuracy and credibility of what has been exchanged, including the sufficiency of the information.

Some authors comment that the cultural difference between the contexts of the supplier and buyer is a communication barrier, mainly due to the difference in the intra-organizational structure and the flow of information between both companies. In a global business environment, cultural distance affects organizational behavior and decision-making. Linguistic distance also influences communication, resulting in ignorance and inefficiency in the supplier-buyer relationship (Busse, Schleper, Niu, & Wagner, 2016). Collaboration within the supplier-buyer relationship and engagement can be an intercultural knowledge transfer issue (Busse et al., 2016; Kroenung & Eckhardt, 2015) involving errors in the process. It is understood as a commitment to correspondence using various resources to carry out the necessary activities in the purchase process and achieve greater integration and better decision making. On the other, collaboration is the willingness of the buyer-supplier to execute actions, correct errors, and establish agreements jointly to achieve better benefits. Efficient communication can strongly influence bad practices to develop suppliers (S. Kumar & Routroy, 2017; Sucky & Durst, 2013). In the literature, supplier-buyer collaboration relationships are reported through a model of structural equations to show the performance of CS that is achieved through capacity, commitment, satisfaction and collaboration in manufacturing companies (C. S. Kumar & Routroy, 2018).

Among the organizational aspects that develop suppliers, financial health is also considered, made up of two dimensions capacity and financial stability; the first refers to all the resources that give a company the means to take advantage of opportunities and react to the risks and threats towards its business. And the second refers to the ability of the organization to maintain its financial capacity. For others, on the other hand, it means a coefficient between two selected values with their financial statements and results obtained. The financial statements refer to liquidity, solvency, activity and profitability. The liquidity ratio measures the ability of the provider to pay to serve its creditors in the short term, that is, its ability to convert its assets into cash. The solvency ratio measures the level of participation of creditors in the company's financing, finding the levels of tolerance to such indebtedness. The activity ratio measures the efficiency in managing your available resources. Finally, the profitability ratio refers to the effectiveness

of the company's management concerned its ability to control the associated expenses and costs and thus convert sales into profits, whether operating margin, sales profitability, or gross margin (Deleg Sigua & Espinoza Nieves, 2020). The company's experience refers to the time that the supplier has to meet the demands of its customers, considering the number of years in said activity. That is important that sufficient experience and knowledge must be achieved in both international and national markets within the network of companies in the supply chain to achieve a high level of skills and support in the supply service. Under these premises, the following hypothesis is proposed that tries to quantify the effect that the adoption of technology has on the processes of companies on the organizational aspects when developing suppliers.

2.5 Financial Performance

Financial performance tries to measure the economic outputs of a company, such as sales growth, inventory turnover, and profitability, among others. As far as suppliers are concerned, financial performance refers to the costs associated with the delivery of the products, such as transportation costs, ordering costs, inspection costs (Avelar-Sosa, García-Alcaraz, & Maldonado-Macías, 2019), all related to the acquisition of products through the supplier and the process carried out in the purchase, acquisition and monitoring of the same.

Based on these premises, the following hypotheses are proposed:

H_1: The technological aspects directly and positively affect organizational performance.

H_2: The technological aspects directly and positively affect capacity performance.

H_3: The technological aspects directly and positively affect financial performance.

H_4: The organizational performance directly and positively affects capacity performance.

H_5: Organizational performance directly and positively affectS financial performance.

H_6: The capacity performance directly and positively affectS financial performance.

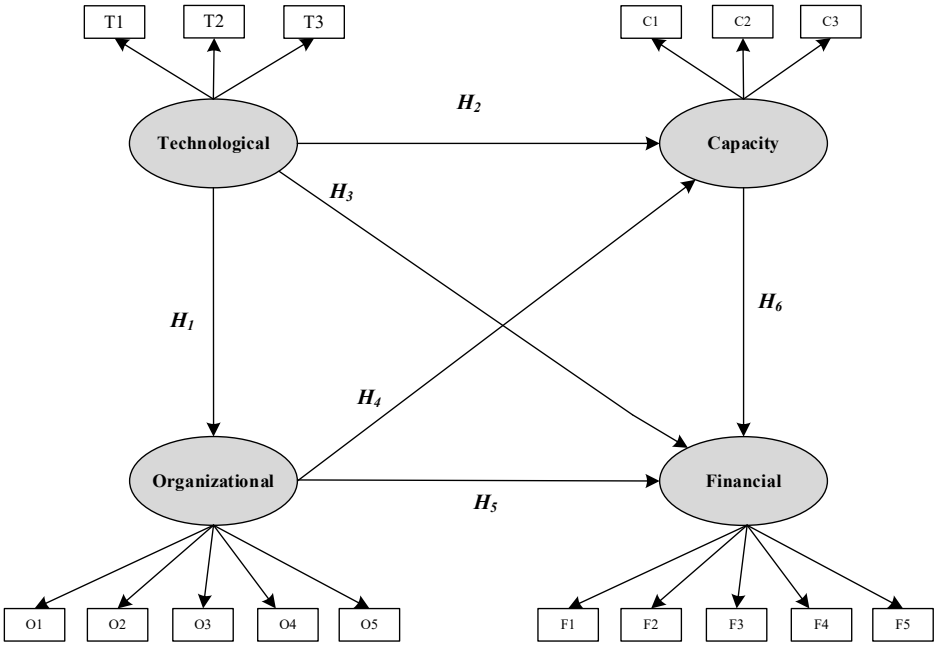

Figure 1. Model and hypotheses proposals.

3. Methods

In this research, a five-phase methodology was carried out, 1) design and elaboration of a questionnaire based on the information found in the literature and manufacturing companies in Mexico; (2) implementation of the questionnaire;

(3) creation of a database for the recording and purification of information; 4) statistical validation of the questionnaire and descriptive analysis of the sample that participated in the study and 5) modeling of structural equations from the proposed model in Figure 1. Each of the phases is detailed below.

3.1 Phase 1. Literature review and design of the questionnaire

To validate and quantify the relationships proposed in Figure 1 on PD, a literature review is realized in various databases (i.e., Science Direct, Springer, Emerald Insight, Taylor & Francis) to identify relevant information about the activities and aspects considered in other research when developing suppliers. Keywords such as "supplier development", "procedure supplier development", "success factors in supplier's development" were used, looking for activities that certainly to a greater or lesser extent suppliers perform aspects of the process, quality, capacity, technology, organizational, financial, service and time activities. Also were considered contributions from experts in the field and who work in the manufacturing industry to suggest, from their logistics and supply expertise, activities, and practical elements to include them and that are also supported according to the literature.

3.2 Phase 2. Management and application of the questionnaire

For the application of the questionnaire, the maquiladora sector in Ciudad Juarez, Mexico, was selected for the economic contribution and activity in the acquisition of raw materials. In October 2020 alone, a total of 33,125 million dollars referred to raw materials, this represented 14% of the national total and of which $32,518 million were imported inputs, and 607 million dollars were domestic inputs. Hence the motivation to identify and evaluate aspects to develop suppliers in this sector (AMAC, 2020). The questionnaire was applied to staff with previous knowledge about suppliers, purchasing, logistics, warehouse, planning, etc. and with a certain hierarchical level within the company, such as technicians, supervisors, engineers, and managers. For this, it was considered a stratified sample so that people who comply with it would be able to answer and at the same time recommend others from the same department. The questionnaire is managed with an e-mail to invite them to this collaboration. Then the questionnaire was created on the Microsoft Forms platform to share electronically through the link and thus facilitate the answer to it. This option has the advantage of being more visual, fast, and easily accessible since they have at hand a computer or cell phone to answer in a time less than 5 minutes.

3.3 Phase 3. Registration and Debugging of Data

When applying the questionnaire, the information obtained was recorded and organized in a database using the SPSS 24® software; the columns represented the observable items or variables, while the lines represented each questionnaire answered. The data purification is considered as follows:

-The standard deviation of each questionnaire to identify the people who did not show interest or objectivity when answering. If the deviation obtained is less than 0.5, then the questionnaire with all its information is discarded in the study.

-The lost values of each questionnaire consider that if the total of these is greater than 10% of the total values that make up the items of each variable, then the questionnaire is also discarded in the analysis. Otherwise, the values are replaced by the median.

-To eliminate the extreme values, the median was used to replace it because the information is proven from an ordinal scale.

3.4 Phase 4. Statistical Validation of the Questionnaire

The validation of the questionnaire was achieved first, with an analysis of data reliability from the registration, purification, and evaluation of the internal consistency of the items. For this, the Cronbach's alpha index (IAC) is calculated. This procedure provides information about the relationships between individual elements of a Likert scale. The correlation coefficients of the variables are also used, which are interspersed to calculate the estimates of reliability between inter-evaluators (Cronbach, 1951). (Table 1)

A reliability analysis allows determining the degree to which variables and items are related to the rest, knowing if they are located in the correct construct (Barbera, Naibert, Komperda, & Pentecost, 2021). After finding the reliability, the predictive and discriminant validity, as well as the collinearity, as well as the collinearity are evaluated using the WarpPLS 7® software. For such a case, discriminant validity refers to the correlation of factors, where values less than 1 mean the difference between two factors. In this case, the indices shown in Table 1 are considered, and their minimum and maximum values are suggested by (N. J. A. m. j. Kock, 2019; N. J. S. S. L. Kock, TX, USA, 2017).

According to the values obtained, these parameters define if the questionnaire is reliable to be applied in the research environment.

Table 1. Indices of validation of the questionnaire.

Index	Measure	Value suggest
R^2	Parametric predictive validity	≥ 0.02
Adjusted R^2	Adjusted parametric predictive validity	≥ 0.02
Composite Reliability	Internal consistency	≥ 0.70
Cronbach's Alpha	Internal consistency	≥ 0.70
Average Variance Extracted	Discriminant validity	≥ 0.50
Full Collin. VIF	Collinearity	≤ 3.30
Q^2	No parametric predictive validity	≥ 0.00 and similar to R

3.4 Phase 5. Structural Equations Modeling (SEM)

After validating the latent variables considering the values suggested in Table 2, we continue to integrate them into a model of structural equations to evaluate the relationships of the proposed model. Structural equation modeling is a multivariate statistical method that analyzes observable and non-observable variables in a causal and relational model based on a specific theory (Byrne, 2013). It allows validates a theoretical model to test and expand the theory from information obtained (Thakkar, 2020). The ability to simultaneously test direct and indirect effects or impacts between observable and non-observable variables is achieved (Kiraz, Canpolat, Özkurt, & Taşkın, 2020). For this case, the WarpPLS 7.0 software was used, which uses a partial least squares (PLS) method and accepts small sample sizes, complex models with numerous endogenous variables, exogenous and indicator variables or non-normal data distributions (Hair Jr, Hult, Ringle, & Sarstedt, 2016). Some model quality and adjustment indices are first estimated to interpret the results obtained in the model, such as those shown in Table 2.

Table 2. Indices to evaluate adjust and quality of the model.

Index	Acceptable value
Average path coefficient (APC)	P < 0.05
Average R-squared (ARS) and Average adjusted R-squared (AARS)	P < 0.05
Average block VIF (AVIF)	Acceptable if ≤ 5, ideally ≤ 3.3
Average full collinearity VIF (AFVIF)	Acceptable if ≤ 5, ideally ≤ 3.3
Tenenhaus GoF (GoF)	≥ 0.36

3.4.1 Effects of SEM

The main objective of SEM is to determine and validate the anticipated causal model or process (Thakkar, 2020), so three effects are calculated: direct, indirect and total. The arrows represent the direct effects in each of the hypotheses established in Figure 1; these effects are associated with a value of β as a regression coefficient and a p-value for statistical significance. To do this, they established as follows: the null hypothesis H_0: $\beta = 0$ against the alternative H_1: $\beta \neq 0$ with a 95% confidence level. Indirect effects are the effects of one variable on another because of an intermediate variable between them. Total effects are the sum of direct and indirect effects. In an SE model, the value of the variance of the latent dependent variables is also reported; this value is denoted by R^2 and is composed of the contribution of each of the independent latent variables; this percentage of variance is known as the size effect (SE).

4. Data Collection

For data collection, a questionnaire was used composed. It has three sections; the first contains questions related to demographic information (gender of the participant, a position where he works, experience and industrial sector, among others). The second presents information about peoples' experience in developing suppliers and consists of nine items (questions). The third section presents information on the indicators that companies consider when developing suppliers. This section comprises 40 items divided into nine sections (aspects) and the Likert scale because it assesses answers provided in a survey (Westland, 2019). The questionnaire was mainly applied to managers, engineers, supervisors and workers in the industry in purchasing, planning, logistics, and supply chain. It was mainly possible to collect 200 fully answered questionnaires to evaluate the causal model.

5. Results and Discussion

5.1 Descriptive analysis of items

Descriptive inferences were made about the dispersion of the data obtained and interpreted according to the context under study. For this case, quartiles 25, 50 and 75 and the interquartile range were obtained to evaluate the consensus of the questions asked in the questionnaire and the repetitiveness in the answers given to quickly know the approximate average value obtained in each one. Table 3 shows in detail the results obtained in this analysis.

Table 3. Results of the descriptive analysis of items in the questionnaire.

Latent variable	Item	Quartile			Interquartile range
		25	50	75	
Capacity	Flexibility to achieve immediate product availability.	3.02	3.55		
	Agility to meet orders in a short time	3.13	3.64		
	Installed capacity	3.12	3.63		
Technological	Technological development	2.75	3.40	3.95	1.20
	TICs for sharing information	2.61	3.30	3.87	1.26
	Use of software to agility	2.71	3.38	3.93	1.22
Organizational	Financial health	2.77	3.42	3.97	1.20
	Experience on industry	2.85	3.44	3.97	1.12
	Position on industry	***2.53***	***3.24***	***3.82***	***1.29***
	Organizational culture	2.58	3.25	3.82	1.24
	Ethic and commitment	3.03	3.57		
Financial	Purchase price	3.07	3.59		
	Ordering costs	2.81	3.43	3.97	1.16
	Transportation costs	3.04	3.56		
	Inspection costs	2.79	3.42	3.96	1.17
	Diversity in payment methods	2.60	3.32	3.91	

5.3 Proposed Improvements

5.3.1 Latent variable validation

Validation of the latent variables is carried out to know the composite reliability of Cronbach's alpha and the extracted variance to evaluate the level of prediction. The convergence value is about to with concerning average variance extracted, and shown in detail in Table 4, where values higher than 0.3 are observed for R^2 and which are considered acceptable with good predictive value, values greater than 0.7 for reliability and higher than 0.5 for AVE is also observed, being in all cases acceptable.

Table 4. Validation of latent variables.

Index	Technological	Capacity	Organizational	Financial
R^2		0.338	0.317	0.373
Adjusted R^2		0.331	0.313	0.363
Composite Reliability	0.874	0.851	0.869	0.902
Cronbach's Alpha	0.781	0.735	0.811	0.863
Average Variance Extracted (AVE)	0.700	0.658	0.571	0.650
Full Collin. VIF	1.606	1.571	1.744	1.530
Q^2		0.340	0.314	0.376

5.3.2 Structural Equation Model

The model of structural equations in Figure 2 was obtained using WarpPLS. The results of Table 5 where the effects, the p-value and the size effect are summarized. The direct effects in all cases are significant at a level of 99% confidence, with the values of the relationships shown in Figure 2 being indicated by the β. For example, there is a direct and positive effect of the *Technological* performance on the *Organizational* performance with a value of 0.563 and a significance of 99% and an effect size of 0.317; all of this indicates that when there is a change in the first variable, a change in that proportion will be achieved positively, also explaining 37.1% of its variance. Similarly, can analyze all effects in Figure 2.

Table 5. General results of structural equations model.

Hypotheses	Direct Effect β	p-value	Size Effect	Indirect Effect β	p-value	Size Effect
Technological → Organizational	0.563	p <0.001	0.317			
Technological → Capacity	0.324	p <0.001	0.164	0.191	p <0.001	0.097
Technological → Financial	0.165	P =0.009	0.075	0.315	p <0.001	0.144
Organizational → Capacity	0.340	p <0.001	0.174			
Organizational → Financial	0.332	p <0.001	0.177	0.084	P =0.044	0.045
Capacity → Financial	0.248	p <0.001	0.121			

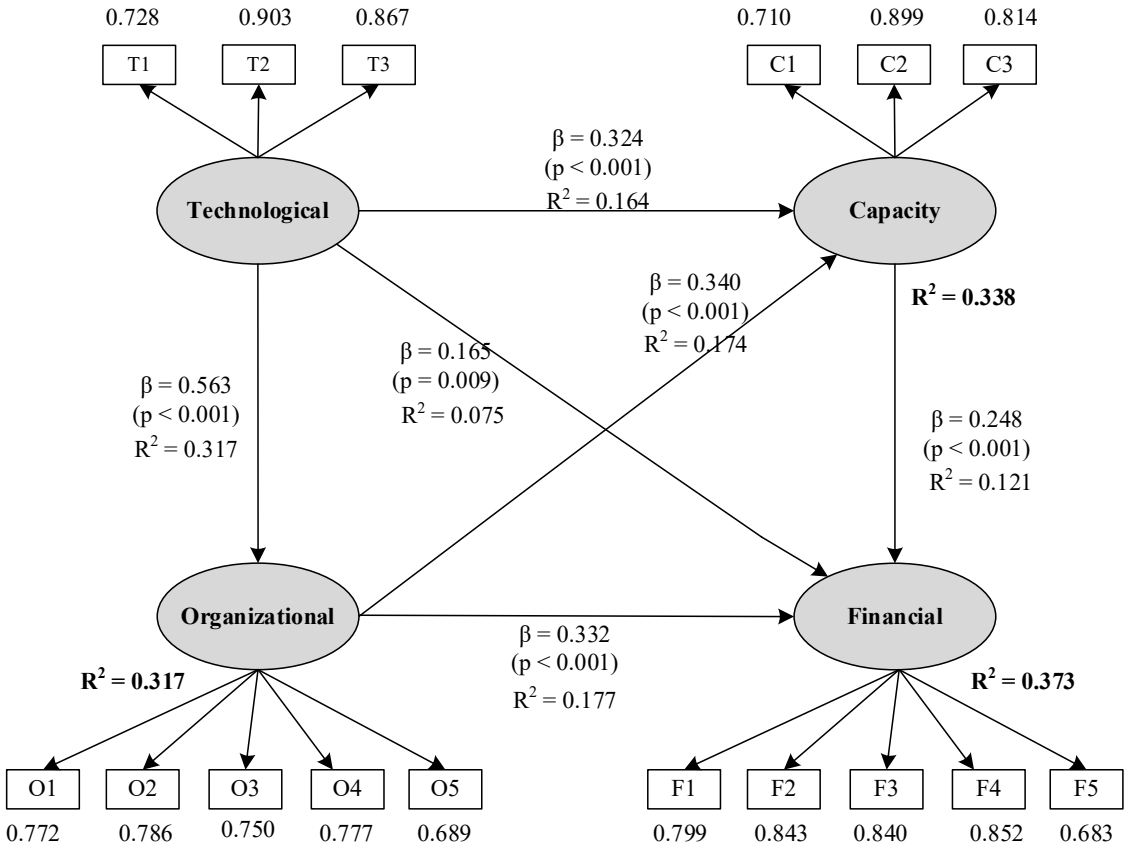

Figure 2. Structural Equation Model obtained and hypotheses validation.

5.4 Validation

The information shown in Table 6 indicates the statistical decisions made according to the analysis of the relationships in the model, so they are accepted as there is no statistical evidence that the information provided by the people who answered the questionnaire is different from what was suggested in the model. For example, in H_1, we have the statistical evidence to affirm with a 99% confidence level that there is a positive and direct relationship between technological performance and organizational performance with a value of 0.563. This means that for every standard deviation that the first changes, in that same proportion, the second will change. In the same way, each hypothesis is analyzed to evaluate whether it is accepted or rejected. It is observed that for all cases, the hypotheses are accepted because the inferences of the theory shown by the researcher about these relationships are supported by the information obtained from the companies; therefore, there is statistical evidence to prove that decisions to develop existing suppliers should consider complementary evaluations about both technological performances, of capacity and organization obtained in said suppliers.

Table 6. Decisions to Hypothesis.

Hypotheses	β Value	P-value	Conclusion
H1	0.563	<0.001	Accept
H2	0.324	<0.001	Accept
H3	0.165	=0.009	Accept
H4	0.340	<0.001	Accept
H5	0.332	<0.001	Accept
H6	0.248	<0.001	Accept

6. Conclusion

In the model of structural equations, it was found as the most important factor that technological performance is crucial to improve the rest of the aspects since it has direct and positive effects, and when it changes to a proportion of one standard deviation, everything will change positively in the proportion shown, 0.563, 0.332, 0.324 and 0.165 respectively. It means that all model aspects are key to obtaining greater economic benefits for companies and improving supply chain performance. In general, there is an acceptable level of interest in evaluating these performances in the suppliers that currently collaborate in the manufacturing companies in the region studied; however it is necessary to deepen the methods of monitoring suppliers methods since the incorporation of suppliers in supplier development programs in the manufacturing industry in Ciudad Juarez is scarce, it is required on the one hand to define a method of selection of suppliers and on the other, one of evaluation of the performance of the same. Companies adapt to their particularities to incorporate suppliers; a standardized procedure is not followed that includes most of the criteria or requirements that a supplier must meet as a long-term collaborator who works together for the same organizational objectives.

For future research, it is recommended to expand the study to achieve a larger sample size, include other complimentary items and incorporate the methodology used to develop the providers. These would allow us to investigate more about how it is currently carried out, and thus, we will propose new strategies to develop suppliers.

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