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Effect of the Sustainable Supply Chain on Business Performance–The Maquiladora Experience

JORGE LUIS GARCÍA ALCARAZ[1], ROBERTO DÍAZ REZA[2], EMILIO JIMÉNEZ MACÍAS[3] (Member, IEEE), RITA PUIG I. VIDAL[4], FRANCISCO JAVIER FLOR MONTALVO[5], AND AGUSTÍN SÁNCHEZ-TOLEDO LEDESMA[5]

[1]Department of Industrial Engineering and Manufacturing, Autonomous University of Ciudad Juarez, Ciudad Juárez 32310, Mexico
[2]Department of Electrical Engineering and Computer Sciences, Autonomous University of Ciudad Juarez, Ciudad Juárez 32310, Mexico
[3]Electrical Engineering Department, University of La Rioja, Logroño, 26004 La Rioja, Spain
[4]Departament d'Informatica i Enginyeria Industrial, University of Lleida, Igualada, 08700 Barcelona, Spain
[5]ESIT—Escuela Superior de Ingeniería y Tecnología, Universidad Internacional de La Rioja, Logroño, 26004 La Rioja, Spain

Corresponding author: Jorge Luis García Alcaraz (jorge.garcia@uacj.mx)

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ABSTRACT Mexican maquiladoras have a complex and intensive supply chain because they import raw materials from other countries and export their final products. This paper reports a structural equation model with three independent variables associated with supply chain sustainability (*Inbound sustainability*, *Internal sustainability,* and *Outbound sustainability*) and two variables related to external entities integration (*Supplier integration* and *Customer integration*). Those variables are related to three dependent variables as sustainability indicators (*Business performance, Social performance*, and *Environmental performance*). Variables are related by ten hypotheses that are validated using the partial least squares technique integrated into WarpPLS v.7® software, and information comes from 187 responses to a questionnaire applied to managers and engineers laboring at the Mexican maquiladora industry. The research objective is to know the relationship among variables to increase performance based on sustainable activities. Findings indicate that, given the nature of maquiladora industry, *Supplier integration* does not moderate the relationship between *Inbound sustainability* and *Internal sustainability*. In addition, *Customer integration* does not moderate the relationship between *Internal sustainability* and *Outbound sustainability*. However, the *Business performance* has a high effect from *Social performance, Environmental performance, Internal sustainability and Outbound sustainability.*

INDEX TERMS Supply chain, business performance, social performance, supplier integration, customer integration.

I. INTRODUCTION

Supply chains (SC) are responsible for more than 50 percent of companies' environmental footprint. Therefore, managers usually seek to create sustainable supply chains (SSC) to improve the business performance [1] because nowadays, the greening concern in customers is growing [2]. Hence, to ensure that logistics activities do not harm the environment, an analysis of the whole SC is required, including procurement, production process and distribution.

To reach that goal, a strategy among SC partners must implement an SSC and have a shared commitment concerning environmental and social sustainability, economic efficiency and accountability, control mechanisms, and coordination for sustainable objectives [1].

An SSC is required because customers' and society's needs have changed, and currently, there is a deep concern regarding environmental protection, and therefore, customers tend to adopt sustainability as a lifestyle [3]. As a response, manufacturers must consider aspects associated with suppliers at the SC beginning (*Supplier integration*) and customers at the end (*Customer integration*), focusing not only on

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their production process. Then, it is vital to properly select sustainable suppliers and monitor their *Social, Economic,* and *Environmental performance* [4] because manufacturers' *Internal sustainability* depends on them.

Specifically, suppliers play an essential role in implementing SSC initiatives because they are the first partner in an SC [5], representing the *Inbound sustainability* for manufacturers. That is why adequate procedures to measure the *Supplier integration* for environmental support initiatives must be applied [6].

Supplier integration enables the information exchange, generating a reliable and collaborative environment with manufacturers and their *Internal sustainability* initiatives [7], where sales forecasts, production plans, monitoring and tracking orders, delivery tracking, and inventory level are shared [8]. The manufacturer should be concerned about *Supplier integration*, moving from compliance to commitment [9], evaluating the suppliers' performance through formal audits, training their employees and generating joint plans regarding sustainability, known as *Inbound sustainability* [10].

Likewise, as manufacturers are integrated with customers and suppliers simultaneously, they can efficiently implement joint environmental programs to increase the overall SC performance [11]. Regarding *Customer integration* with manufacturers in sustainable initiatives, surveys should be made to detect their preferences and integrate their opinions to design new products that help comply with corporate social responsibility [3], [12]. Researches indicate that the green activities by manufacturers have influenced the purchasing attitudes of US customers [13] and that they are willing to pay for green products [14]. This capacity to increment sales and win production orders due to green and sustainable concepts is known as *Outbound sustainability*.

In addition, Guo *et al.* [15] indicate that Chinese manufacturers can improve their business performance through the customer's cooperation. In the same way, Ahmad and Zhang [16] model customer purchasing intention based on the green qualities of a product, social responsibility, and the companies' involvement in China.

As can be seen, several cases studies regarding the impact of suppliers and customers on the sustainability process in various countries are reported. However, customers' and suppliers' integration in a sustainable production process would be useless if the company's performance is only measured from an economic point of view, ignoring environmental and social sustainability. D'Eusanio *et al.* [17] state that companies also want to be socially accepted and then need to initially evaluate their performance in workers. Additionally, Shea *et al.* [18] mention that occupational health and industrial safety indicators give workers greater confidence in their job performance.

There have been initiatives to analyze *Inbound sustainability*, *Internal sustainability*, and *Outbound sustainability*, and how *Suppliers integration* and *Customers integration* support the sustainable manufacturer's initiatives. For example, Ni and Sun [10] propose a model that analyzes these five variables and relates them to company performance in China; however, their work only focuses on associating SC sustainability with economic aspects. However, sustainability has at least three pillars to be analyzed in an SC, which refer to traditional *Economic sustainability*, *Environmental sustainability* and *Social sustainability*, as indicated by Sarkar *et al.* [19] in Bangladesh.

A. RESEARCH CONTEXT

Unfortunately, none of the previous studies has been applied in the Mexican manufacturing sector. There is no recent research regarding SSC in the maquiladora industry, where there are currently 5,138 companies under this taxonomy. A maquiladora is a subsidiary company representing a foreign investment established in national territory and having its headquarters in other countries [20]. Currently, 498 (9.69%) maquiladoras are established in Chihuahua state, and, specifically, 326 (3.34%) are in Ciudad Juarez. Furthermore, the manufacturing sector to which the maquiladora industry belongs in Mexico contributes 17.1% of gross domestic product and generates 2,689,209 jobs nationwide, 477,489 in Chihuahua state 316,619 in Ciudad Juárez [21].

By importing raw materials and exporting their products, the maquiladoras in Ciudad Juarez have a very consolidated supply chain and do so through three international bridges that cross into the United States of America. For example, IMMEX [22] reports the following data for the year 2021 regarding border crossings:

- Bridge of Las Americas: 112,194 empty containers and 112,194 containers with goods in 179,983 truckloads crossed.
- Ysleta Zaragoza Bridge: 247,973 empty containers and 1,386,207 containers with goods in 668,950 truckloads crossed.
- Santa Teresa Bridge: 56,523 empty containers and 80,806 containers with goods in 154,147 truckloads crossed.

B. RESEARCH PROBLEM AND OBJECTIVE

Importing and exporting, the Mexican maquiladora has a high level of SC operations, and it is of academic and scientific interest. So, the research question is, how are SSC been implemented in the maquiladora industry? This paper responds to that question by combining the Ni and Sun [10] model from the Chinese manufacturing sector regarding SSC and Sarkar *et al.* [19] model regarding sustainability in ready-made garments from Bangladesh. Additionally, the model identifies the effect of integrating sustainable customers and suppliers on the Mexican maquiladora sector to gain an SSC.

We report a new structural equation model, where variables reported by Ni and Sun [10] are associated with suppliers (*Inbound sustainability*), the internal manufacturing process (*Internal sustainability*), and customers (*Outbound sustainability*) are related to the financial performance of the company (*Business performance*) and the moderator

variables used are *Customer integration* and *Supplier integration.* However, considering that other variables can affect *Business performance*, *Environmental performance* and *Social performance* are also integrated as a response, according to Sarkar *et al.* [19]. This article assumes that *Environmental performance* and *Social performance* are the only way that maquiladora companies use to achieve better *Business performance*, so it is the dependent variable in the model.

The first contribution in this paper is that it combines two recent structural equation models to integrate a new model that is better adapted to the Mexican maquiladora industry. A second contribution is that this study reports a sensitivity analysis for the model, analyzing high and low occurrence scenarios for variables analyzed and is based on conditional probabilities. Our findings will allow managers to have a reference metric and framework for the dependence between variables and thus focus their resources on obtaining the type of sustainability they desire or are a priority for the company they manage.

II. LITERATURE REVIEW AND HYPOTHESIS

A. INBOUND SUSTAINABILITY (IS)

Sustainability in the maquiladora industry is a commitment that integrates all SC members, starting with suppliers and finalizing with customers. Therefore, appropriate supplier evaluation methodologies must be followed, and multiple attributes must be integrated [23]. Managers in the maquiladora industry must hear suppliers' and customers' sustainable concerns before beginning their production process. However, government regulations also play an important role in sustainability, and companies need to fulfill all of them [24].

However, communication with all external parties (suppliers, government, society, and customers) must be the first step [25]. Depending on those government regulations, raw materials from suppliers, and requirements from customers and society, managers can determine the level of training concerning green practices and environmental and social aspects [26]. A low collaboration between manufacturer and supplier can result in efficiency [27], short-term relationships with an unstable production process [28]. Additionally, low communication with customers can generate low sales and high inventories [15].

B. BUSINESS PERFORMANCE (BP)

Traditionally, company performance is measured from an economic approach since it is accessible and straightforward. Therefore, companies estimate the average return on sales and investment, profits growth, and market share in recent years [29].

This BP also depends on managers' ability to reduce SC costs, and for that, it is necessary to have a close relationship with suppliers, customers, and society. Then, the starting point in an SC is the search for low prices on raw materials from suppliers, without complex production processes, high energy consumption, or generating high amounts of waste that can result in penalties due to non-compliance with environmental regulations [30]. But additionally, information regarding customers is necessary for understanding quality requirements in products to increase sales and share market [31], [32]. Based on those mentioned above, the following hypothesis is proposed:

H_1. *Inbound sustainability* obtained through suppliers, customers, and society is related to *Business performance* in the maquiladora industry.

C. INTERNAL SUSTAINABILITY (InS)

Companies seek international certifications, such as ISO 14001, to guarantee internal credibility for their environmental management programs, which helps gain recognition from customers and facilitates their access to markets [33]. However, quality, sustainability, and compliance with certain norms or standards are made in the production process and for that is why companies should focus on spreading a sustainable culture, integrating training programs in compliance with regulations, and creating awareness regarding their environmental production process impact.

Those sustainable programs must be focused on consuming the least possible energy to transform raw materials into finished products, generating the least possible amount of waste into the air and ground or affecting workers [34]. However, these processes are made more accessible when sustainable suppliers offer products easy to transport, store and process with friendly machinery [35], sustainable customer tendencies are analyzed [3], the government has clear environmental goals [32], and society is integrated [36]. Based on it, the following hypothesis is proposed.

H_2. *Inbound sustainability* obtained from suppliers, customers, government, and society is related to *Internal sustainability* in the maquiladora industry.

However, *BP* depends not only on suppliers and their raw materials, government and their environmental rules or customer and their environmental preferences. *BP* also depends on internal production processes and environmental management. In other words, part of a company's success in the markets and its income are based on quality and environmental certifications for its products and production processes [37]. Yadav *et al.* [38] indicate that sustainable production processes are later converted into better *BP*.

Likewise, companies must focus on obtaining raw materials at a low cost through their purchasing department [39], using energy adequately in their production processes, avoiding material waste, and complying with environmental regulations [27]. In that case, manufacturers will perform better business due to these activities' savings [40]. Based on the above, the following hypothesis is proposed.

H_3. *Internal sustainability* obtained in the production processes is related to *Business performance* in the maquiladora industry.

D. SUPPLIER INTEGRATION (SI)

SI involves coordinating and exchanging critical information with manufacturers regarding raw material, processes, capabilities, and technology constraints, enabling more effective planning and forecasting, product and process design, and transaction management [25]. However, manufacturers must involve suppliers in improving *EP* throughout the supply chain, not only on operational aspects, as they can help reduce emissions and monitor waste flows when providing environment-friendly raw materials [41].

Li *et al.* [42] state that sustainable programs within a company begin with *SI* since some actions and decisions are made based on raw materials and information they provide. Hence, a supplier-manufacturer teamwork approach must be very close [27]. Based on it, the following hypothesis is proposed.

H_4. *Supplier integration* has a moderating effect on the relationship between *Inbound sustainability* and *Internal sustainability* in the maquiladora industry.

E. OUTBOUND SUSTAINABILITY (OS)

OS refers to offering customers sustainable products or services, measured by the manufacturer's production orders quantity, contributing to the environment's well-being. That is, manufacturers obtain more sales orders due to their environment-friendly products and processes [10]. However, customers are not the only ones who approve of the company's environmental efforts; the social acceptance due to ecological products and pro-environment programs should also be measured [43].

For this reason, if manufacturers intend to cover their market niche with a pro-environment attitude, they must make adjustments in their production process to meet those expectations [44], which leads to the following hypothesis.

H_5. *Outbound sustainability* is related to *Internal sustainability* in the maquiladora industry.

F. CUSTOMER INTEGRATION (CI)

CI refers to close collaboration and information-sharing activities with key customers that provide strategic insights about market expectations and opportunities [45]. *CI* encompasses the information flow, services, and materials shared with manufacturers, engaging key customers to understand their requirements, and aligning organizational functions to create value [46].

However, *CI* covers activities ranging from idea generation to production management and product delivery [47], enabling a more efficient and effective response to the client, and it significantly affects the generated product quality performance [48]. The *CI* generates sustainable ideas that allow manufacturers to modify their production processes and cover a niche of pro-environmental customers, for which the following hypothesis is proposed.

H_6: *Customer integration* has a moderating effect on the relationship between *Outbound sustainability* and *Internal sustainability* in the maquiladora industry.

The critical points in SSC management practices are to fulfill the commitment to environmental improvement through collaboration between intra- and inter-organizational members and generating products with clean technologies [49]. In that case, if the manufacturer gains more orders by applying environmental activities, it turns into sales to specific market sectors with pro-environmental customers, resulting in higher profits that let to invest in more sustainable products [50] and a greater social acceptance in the company's context [51].

In addition, the quality programs and certifications that companies have implemented must be disclosed to society, so that general persons and customers will know them and, in this way, all partners are aware of the environmental progress that has been achieved [52]. Thus, the following hypothesis is proposed.

H_7: *Outbound sustainability* is related to *Business performance* in the maquiladora industry.

G. ENVIRONMENTAL PERFORMANCE (EP)

EP is the measurable result of companies' operations to obtain a policy that meets the objectives and ecological goals [53]. The activities must reduce the emissions of harmful substances into the air, subsoil, water, which harm human beings. This process helps to have environmental certifications that give societal prestige and recognition. However, activities focused on reducing reprocessing and recycling materials must be done, using less energy and preferably from renewable sources [54].

Likewise, reducing environmental accidents generates a fine reputation by complying with environmental and health regulations and avoiding government penalties, converting into higher sales and low production costs [55]. In other words, those company *EP* activities affect its financial income, and then the following hypothesis is proposed.

H_8: *Environmental performance* is related to *Business performance* in maquiladora companies.

H. SOCIAL PERFORMANCE (SP)

SP is the metric that indicates the responsibility level with employees and the society where a company is located [56]. To achieve high *SP* levels, companies must ensure health and safety for employees, providing them with appropriate equipment to develop their activities and focusing outside its walls, in the community where it is established [57]. Another way to increase *SP* is to avoid the discharge of harmful chemicals into the air, land, and water, reduce materials waste that affects the general population, and focus on renewable energy sources to increase their environmental commitment [58]. Thus, the following hypothesis is proposed.

H_9: *Environmental performance* is related to *Social performance* in maquiladora companies.

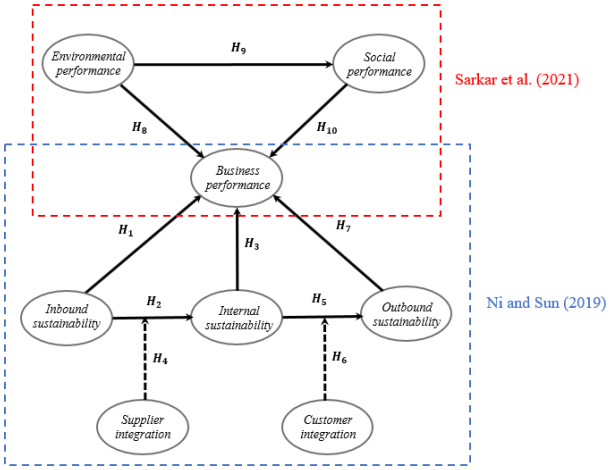

FIGURE 1. Proposed hypotheses.

Companies hope to obtain *SP* because of their sustainable efforts. In that case, there is energy consumption reduction in their production processes, with workers more motivated and efficient, generating less waste and parts reworking, since they see the organizational and healthy concerns for them [59], which generates an increase in financial profits of these companies [60]. Thus, the following hypothesis is proposed.

H_{10}: *Social performance* is related to *Business performance* in maquiladora companies.

Fig. 1 graphically illustrates the proposed hypotheses.

III. METHODOLOGY

A. QUESTIONNAIRE DESIGN

A questionnaire is designed and contains two previous pieces of research. The first is regarding SSC obtained from Ni and Sun [10] and contains *IS*, *InS*, *OS*, *SI* and *CI*, while the second section comes from Sarkar *et al.* [19] and integrates the *EP, BP* and *SP*.

The first version of the questionnaire is sent to three academics and eight managers laboring in maquiladora companies for a peer-review process. After two rounds with the peers, a final questionnaire was defined, consisting of three sections. However, some other items were added in latent variables according to the Mexican context and managers' and academics' experience in the maquiladora industry. After the judges' validation, a final questionnaire divided into three sections is obtained.,

The first section refers to demographic data associated with gender and years of experience in the job position. The second section integrates the controlled variables regarding SSC and contains *IS* (5 items), *InS* (6 items), *SI* (4 items), *OS* (4 items), and *CI* (4 items), while the third section refers to *BP* (7 items), *EP* (5 items) and *SP* (5 items). See the final questionnaire with full items description at a repository by García-Alcaraz and Díaz Reza [61].

All the items are answered on a five-point Likert scale, where one indicates that the activity is not done or that the benefit is not obtained. In contrast, five indicates that the activity is always done or the benefit is always obtained. The final questionnaire is uploaded to a virtual platform because companies have restricted access conditions due to the COVID-19 pandemic. The questionnaire is completely anonymous, and each item is conditioned to be answered to avoid missing value issues.

B. QUESTIONNAIRE APPLICATION

An email is sent to managers, engineers, and possible responders with at least two years of experience in their current job position associated with SC in the Mexican maquiladora industry. The email contains an invitation to participate in this research and a link to the questionnaire. They are given a 15-day period to reply.

If not getting a response, a second invitation is sent, providing another 15 days to respond. In case of no response, that case is ignored. The survey was applied from May to August 2020. The sample size calculation is according to the gamma-exponential method proposed by Kock [62] and based on the minimum significant regression parameter (β value).

C. INFORMATION COLLECTION AND FILTERING

On September 1, 2020, a database from the platform containing the questionnaire was downloaded in Excel format, which is then read in the SPSS v.25® software to make a debugging process that consists of the following activities [63]:

1. The items are standardized to identify extreme values. Standardized items with absolute values higher than four are considered extreme values and replaced by the median.
2. The standard deviation of every case in sections two and three of the questionnaire is obtained to identify non-committed respondents. Values less than 0.5 in the standard deviation are discarded from the analysis.

D. VARIABLE VALIDATION

All latent variables are validated before integrating them into the structural equation model (SEM) that appears in Figure 1. The indexes used for variables validation appear in Table 1, where the minimum or maximum acceptable value and the type of validation it represents are indicated. It is important to mention that Cronbach's alpha coefficient is obtained in an iteratively way. It is observed that the value increases when eliminating certain items in latent variables [64], increasing internal validity. Also, some items in latent variables were eliminated if the full collinearity variance inflation factor is greater than 3.3 because it also indicates that the common method bias (CMB) problem is absent [65], [66].

Other indices associated with the validation process appear reported as supplementary information and can be consulted at García-Alcaraz and Díaz Reza [61]. Those values refer to T ratios confidence intervals for path coefficients, T ratios and confidence intervals for loadings and confirmatory

TABLE 1. Validation index.

Indice	Validation type	Best if
R-squared Adjusted R-squared	Parametric predictive validity	>0.02
Composite reliability Cronbach's alpha	Internal validity	> 0.7
Average variance extracted (AVE)	Convergent validity	> 0.5
Full collinearity variance inflation factor (FVIF)	Collinearity and common method bias	< 3.3
Q-squared	Non-parametric predictive validity	> 0.02

factor analysis, PLSc reliabilities (Dijkstra's rho) for internal and construct validity. Additional indices are reliability coefficients usually reported in others as the correlation matrix adjustment, correlations between latent variables with the square root of the AVEs and HTMT ratios (good if < 0.90, better if < 0.85) for convergent validity.

E. DESCRIPTIVE ANALYSIS

For the items remaining in the validated latent variables, the median is obtained as a measure of central tendency and the interquartile range (IR) as a measure of dispersion. These descriptive parameters are used, given that the information comes from opinions and is on an ordinal scale, representing assessments, hence the importance of respondents having sufficient experience in their job. High median values indicate that the activity or benefit is always performed or obtained, while low values indicate that the activity is not performed or the benefit is not obtained [67].

Likewise, high values in the IR indicate that there is no consensus among all respondents regarding the true mean value in a certain item, while small values indicate consensus or agreement among respondents since almost all of them have issued similar assessments.

F. STRUCTURAL EQUATION MODEL

The Partial Least Squares – Structural Equation Model (SEM) technique is chosen to test the proposed hypotheses in Fig. 1. It has been used in similar studies and allows latent variables to have different roles in the same model, as an independent and dependent. For example, Garcia-Alcaraz *et al.* [68] report an SEM to measure the impact of information and communication technologies (ICT) on supply chain agility performance, and Mardani *et al.* [69] use SEM-PLS for evaluating green and sustainable supply chain management. Also, PLS-SEM is user-friendly and recommended when there are small samples or no normal distribution, or data come from assessments on a Likert scale [70], as in our applied questionnaire.

Additionally, PLS-SEM maximizes the amount of variance explained, and it is composed of two models: the measurement model that represents the relationships between the observed data and all latent variables, and the structural model represents the relationships between the latent variables.

G. MODEL VALIDATION

Once the latent variables are validated, they are integrated into the SEM and executed in WarpPLS v.7® software based on partial least squares (PLS) algorithms. The following model efficiency rates are used with a 95% confidence level before its interpretation [71]: average path coefficient (APC) to validate the hypotheses, which must have $P < 0.05$, average R-squared (ARS), and average adjusted R-squared (AARS) for predictive validity and must have a $P < 0.05$; average Block VIF (AVIF) and average full Collinearity VIF (AFVIF) to measure collinearity, which, must be less than 3.3 and finally, the Tenenhaus GoF (GoF) index to measure the model-data fit, which, must be higher than 0.36.

H. EFFECTS ON SEM

Four effects are evaluated in the structural equations model. The first is the direct effects for testing the hypotheses proposed in Fig. 1, so a standardized β value is obtained and represents the changing intensity between two variables. A two-tailed hypothesis test is made to statistically test the significance in all estimated effects at a confidence level of 95%, where the null hypothesis is H_0: $\beta = 0$, versus the alternative hypothesis H_1: $\beta \neq 0$. Each β value is associated with a p-value; if it is proved that $\beta = 0$ is in a relationship, the conclusion is that there is no effect between those variables. However, if $\beta \neq 0$, it is concluded that there is a relationship between variables analyzed.

The second one is the indirect effects occurring through a mediating variable and can be of two segments or more. The third effect is the total effects represent the sum of direct and total effects. Finally, the moderating effects are obtained, which indicate how the relationship between two variables is affected by another, as is the case with *CI* and *SI* variables.

For each effect (direct, indirect, and total), an effect size (ES) is associated as a measure of variance explained by the independent variables in the dependent variable. The value of the R-square in a dependent variable represents the sum of all ESs on it.

I. SENSITIVITY ANALYSIS

One advantage regarding WarpPLS v.7® is that it performs calculations based on standardized values so that probabilities of occurrence of the variables at high levels (+) can be evaluated when $P(Z > 1)$ and low levels (−) when $P(Z < -1)$ [71]. Specifically, this paper reports a probability of joint occurrence of two variables in different combination scenarios, such as $P(Z_i > 1)$ and $P(Z_d > 1)$, $P(Z_i > 1)$ and $P(Z_d < -1)$, $P(Z_i < -1)$ and $P(Z_d > 1)$, and $P(Z_i < -1)$ and $P(Z_d < -1)$, as well as the conditional probability for $P(Z_d > 1)/P(Z_i > 1)$, $P(Z_d > 1)/P(Z_i < 1)$, $P(Z_d < -1)/P(Z_i > 1)$ and $P(Z_d < -1)/P(Z_i < -1)$, where Z_i represent an independent variable; Z_d a dependent variable; −1 indicates a low scenario for a variable and 1 a high scenario.

TABLE 2. Years of experience and job position.

Years of experience	Job position SCM	PRE	LME	Total
2 to <5	39	54	16	109 (58.28%)
5 to <10	14	13	8	35 (18.72%)
>= 10	23	11	9	43 (23.00%)
Total	76 (40.6%)	78 (41.7%)	33 (17.75)	187 (100%)

TABLE 3. Industrial sector and number of employees.

	<50	50 and <300	300 and <1000	1,000 and <5,000	5,000 and <10,000	>10,000	Total
Automotive	1	29	12	18	4	5	69(36.89%)
Electric/Electronic	0	14	32	14	2	1	63(33.69%)
Logistic	9	15	3	9	1	2	39(20.85%)
Machining	1	1	3	8	2	1	16(8.55%)
Total	11(5.88%)	59(31.55%)	50(26.73%)	49(26.20%)	9(4.81%)	9(4.81%)	187(100%)

IV. RESULTS

A. DESCRIPTIVE ANALYSIS OF THE SAMPLE

Four hundred eighty-six emails were sent to SC managers (SCM), Lean Manufacturing Engineers (LME) and Production Engineers (PRE) in 322 maquiladora companies because they are associated with SC operations. Only 196 completed questionnaires were obtained, giving a response rate of 40.32%; however, seven were eliminated because they did not meet the inclusion requirements, or uncommitted respondents were detected, leaving 187 for analysis and representing a valid rate of 38.47%.

The final dataset with raw values can be consulted in Díaz Reza and García Alcaraz [72] as an SPSS file with SAV extension. Table 2 shows the respondents' distribution by years of experience in their position, and it is observed that SCM and PRE represent most respondents, 82.35%. Likewise, it is observed that most of the respondents had between two and five years of experience in their job position, concluding that they have enough experience, giving validity to the information obtained.

Table 3 shows the industrial sector to which the respondent belongs, and it is observed that most companies have between 300 and 5000 workers with 52.9%, while the most surveyed sectors were the automotive and electrical/electronic with 70.58%, which indicates that these companies have a properly established supply chain.

B. DESCRIPTIVE ANALYSIS OF THE ITEMS

Due to space restrictions, full details regarding the descriptive analysis are not given in the paper; however, readers can consult them as supplementary material at García-Alcaraz and Díaz Reza [61] in a scientific repository and items are sorted according to the median value. From the descriptive analysis, it is observed that for *IS*, the most important item regarding government is regulations on sustainability. Also, the client's voice should be heard before initiating a product design; however, supplier education and training should be conducted to improve delivery times and the production process. Additionally, manufacturers must assess the suppliers' sustainable performance and joint programs to improve procurement.

On the other hand, the essential item for *OS* is that the company sends sustainable products to the market, gaining social and governmental acceptance and finally, gaining orders from customers with an environmental style of life.

Regarding *InS*, the essential item is to avoid emitting pollutants, reduce its process levels, responsibly consume energy and water, and use environment-friendly materials and machinery. But also, manufacturers need to increase formal sustainability-oriented communication, training programs and workers' involvement. Those programs will let them get environmental certifications that can bring commercial benefits.

For *SI*, the most critical item is to have a joint decision-making process with suppliers for fast and on-time corrections if necessary. However, manufacturers must develop collaborative approaches with the most important suppliers regarding risk reduction and long-term agreements, and if required, manufacturers and suppliers must couple the inventory systems.

For *CI*, the manufacturers need to develop collaborative decisions with key customers and share information about processes and activities. Also, like *SI*, *CI* requires coupling information systems regarding inventories, forecasts, new designs and quality programs.

For *BP*, what is essential is reducing energy consumption and materials supplies costs; however, maquiladoras must reduce penalties due to emission of toxic wastes and substances to water or land that impact human health. However, here is important to mention that average profit and market share must be observed because they are very important in *BP*.

While for *EP*, the essential item is that the maquiladoras improve their environmental emissions level through less recycling, waste, and discharge of toxic products in all workstations. They also need to increase the use of renewable energy in the production process.

Finally, for *SP*, the critical item is that maquiladoras take care of their employees' safety, improve health, focus on a better standard of social life, develop economic activities and engage local employment.

C. LATENT VARIABLES VALIDATION

Table 4 shows the validation indexes for the evaluated and final model. According to the R-squared, Adjusted R-Squared, and Q-squared rates, it can be concluded that

TABLE 4. Latent variable validation.

	IS	OS	InS	SI	CI	BP	EP	SP
R-Squared		0.429	0.531			0.656		0.446
Adj R-sq		0.423	0.526			0.646		0.443
Composite reliability	0.891	0.88	0.844	0.898	0.884	0.865	0.912	0.912
Cronbach´s alpha	0.847	0.818	0.722	0.849	0.826	0.812	0.879	0.879
AVE	0.621	0.647	0.642	0.689	0.657	0.516	0.675	0.674
Full Collinearity VIF	2.884	2.493	3.144	3.158	3.026	2.23	2.76	2.323
Q-Squared		0.429	0.531			0.656		0.446

the dependent variables have sufficient parametric and non-parametric predictive validity since the values are higher than 0.02. Likewise, all the analyzed variables have internal validity since the Composite reliability, and Cronbach's alpha values are higher than 0.7 and show convergent validity since the average variance extracted is higher than 0.5 in all variables.

Finally, there are no collinearity problems within the analyzed variables, and there are no CMB problems since all VIF values are less than 3.3. There are additional validation indexes as supplementary material, and readers can see them at García-Alcaraz and Díaz Reza [61].

D. STRUCTURAL EQUATIONS MODEL

Given that all latent variables meet the evaluation requirements, they are integrated into the model for analysis, and the results and efficiency indexes are as follow. It is observed that, on average, the β indexes are statistically significant since the APC is higher than 0.02, and there is predictive validity as the ARS and AARS indexes are higher than 0.02 and have p-values lower than 0.05. In the same way, there are no collinearity problems since the AVIF, and AFVIF values are less than 3.3, and finally, according to the GoF, it is concluded that the data has an acceptable fit to the model.

- Average path coefficient (APC) = 0.320, P < 0.001
- Average R-squared (ARS) = 0.516, P < 0.001
- Average adjusted R-squared (AARS) = 0.510, P < 0.001
- Average block VIF (AVIF) = 2.085, acceptable if ≤ 5
- Average full collinearity VIF (AFVIF) = 3.498, acceptable if ≤ 5
- Tenenhaus GoF (GoF) = 0.606, large ≥ 0.36

Fig. 2 shows the evaluated model and observes that the minimum significant β value is 0.179 in the relationship between *SP*→*BP*. According to the gamma-exponential method, a sample size test is calculated and results in 180 responses required [62]; however, our sample size is enough with 187.

The red lines indicate a lack of enough statistical evidence at 95% to declare that those relationships exist because the P values are higher than 0.05, the maximum cut-off value allowed. Likewise, for the dependent variables, an R-squared value is indicated to measure the variance explained by the independent variables.

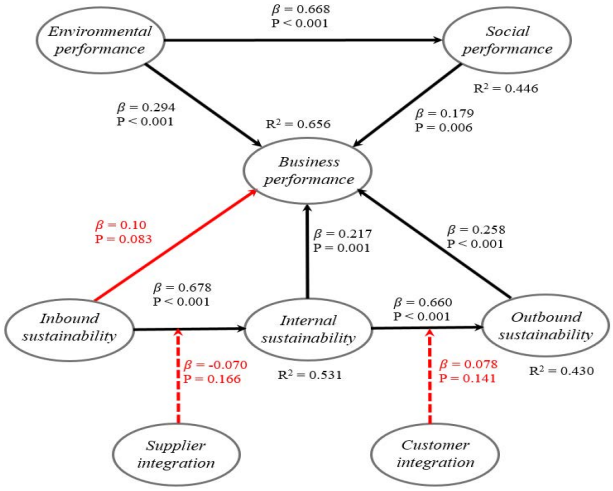

FIGURE 2. Evaluated model.

TABLE 5. Direct effects–hypothesis validation.

H_i	IV	DV	Effect size	Conclusion	β^a (p-value)	β^b (p-value)
H_1	*IS*	*BP*	0.053	Not supported	0.10 (P=0.083)	0.016
H_2	*IS*	*InS*	0.493	Supported	0.678 (P<0.001)	0.434
H_3	*InS*	*BP*	0.138	Supported	0.217 (P<0.001)	0.243
H_4	*SI*	*InS*	0.038	Not supported	-0.070 (P=0.166)	0.152*
H_5	*InS*	*OS*	0.458	Supported	0.660 (P<0.001)	0.393
H_6	*CI*	*OS*	-0.028	Not supported	0.078 (P=0.141)	0.131*
H_7	*OS*	*BP*	0.161	Supported	0.258 (P<0.001)	0.390
H_8	*EP*	*BP*	0.192	Supported	0.294(P<0.001)	0.799*
H_9	*EP*	*SP*	0.446	Supported	0.668(P<0.001)	0.579
H_{10}	*SP*	*BP*	0.112	Supported	0.179 (P=0.006)	0.353

β^a Indexes in our model
β^b Indexes in Ni and Sun [10] and model Sarkar, et al. [19] model.
* Indicates differences among models

E. DIRECT EFFECTS AND MODERATORS

The direct effects are used to test the proposed hypotheses in Fig. 1. Table 5 summarizes these effects based on values presented in Fig. 2, where latent variables involved in the relationship and the moderating variable, the β and the p-value for our model and the Ni and Sun [10] model, the effect size that the independent variable contributes to explain the dependent variable, and the conclusion about the hypothesis are illustrated.

It is observed that the two moderating effects are not statistically significant. *SI* does not moderate the relationship between *IS* and *InS*, and *CI* does not moderate the relationship between *InS* and *OS*. In the same way, the relationship between *IS* and *BP* was not significant. Thus, seven hypotheses are statistically supported, and three are not supported in our model, while in the Ni and Sun [10] model, six hypotheses are supported, and one is not supported.

Differences in β values between models are indicated with "*" symbol. Observe that SI and CI's moderating effects in our model were not significant statistically, but in the Ni and Sun [10], they were.

TABLE 6. Sum of indirect and total effects.

	IS	*InS*	*EP*	*OS*	*SP*
Sum of indirect effects					
BP	0.263 (P<0.001) ES = 0.140	0.171(P<0.001) ES=0.109	0.12(P=0.083) ES=0.078		
OS	0.447 (P<0.001) ES = 0.297				
Total effects					
BP	0.362 (P<0.001) ES = 0.193	0.388 (P<0.001) ES = 0.247	0.414 (P<0.001) ES = 0.270	0.258 (P<0.001) ES = 0.161	0.179(P=0.006) ES = 0.112
OS	0.447 (P<0.001) ES = 0.297	0.660 (P<0.001) ES = 0.458			
InS	0.678 (P<0.001) ES = 0.493				
SP			0.668 (P<0.001) ES = 0.446		

F. SUM OF INDIRECT AND TOTAL EFFECTS

Table 6 shows the sum of indirect and total effects between variables because their analysis is essential when there are no significant direct effects, such as the relationship between $IS \rightarrow BP$. In this case, a comparison of β values obtained in our model and the reported by Ni and Sun [10] is not made since they do not report the indirect and total effects. Observe that the indirect effect between $IS \rightarrow BP$ is 0.263 and is statistically significant, while the direct effect was not significant. In other words, suppliers and their raw materials as *IS* can affect *BP* only through the production and transformation process in *InS* as a mediator variable.

Concerning the sum of indirect effects, it is observed that there were 4, but only three of them are statistically significant ($IS \rightarrow BP$, $IS \rightarrow OS$, and $InS \rightarrow BP$) since the associated p-value is less than 0.05. However, the relationship between $EP \rightarrow BP$ is not. Nevertheless, all the total effects are statistically significant since the related p-values are less than 0.05 in all the relationships analyzed, indicating that the variables are directly or indirectly related.

G. SENSITIVITY ANALYSIS

Table 7 shows the sensitivity analysis with latent variables probabilities appearing in isolation at their high and low occurrence levels (" Probability " row and column). In addition, appear the probability that the variables appear jointly (&) in a combination of the possible scenarios levels and, finally, the conditional probabilities that the dependent variable occurs at a certain level since the independent variable has occurred at a certain level and is represented by "If". High levels are represented by "+" and low levels by "−".

Thus, for instance, *IS* at its highest level ($IS+$) has a probability of 0.166 and at its lowest level ($IS-$) is 0.134. However, the probability of $BP+$ occurring jointly with $IS+$ is only 0.070, but if $IS+$ has occurred, there is a conditional probability of a 0.419 that $BP+$ occurs. Furthermore, it is observed that $IS+$ will never be associated with $BP+$ since the probability is zero. However, if $IS-$ has occurred, there is a 0.440 probability of having $BP-$, which represents a risk for supply chain managers. This relationship demonstrates the importance of basing sustainability in the procurement process with the suppliers. The other relationships are interpreted similarly.

V. DISCUSSION OF RESULTS

A. FROM THE STRUCTURAL EQUATIONS MODEL

This paper has integrated two structural equation models into one that evaluates the Mexican maquiladora industry established in Ciudad Juarez and has ten hypotheses. The first seven hypotheses correspond to the sustainability model by Ni and Sun [10] and the other three by Sarkar *et al.* [19], where similarities and differences have been found.

The R^2 in a latent variable indicates the percentage of variance that explains each independent variable. For example, *BP* is explained in 65.6% but *IS* contributes in 5.3%, *InS* in 13.8%, *OS* in 16.1%, *EP* in 19.2%, and *SP* in 11.2%, so the most important variables for *BP* in the Mexican maquiladora industry are *OS* and *EP* because they have the biggest contribution according to the effect size and β value; however, more researches are required to know the *IS* role.

1) SIMILARITIES AND DIFFERENCES WITH NI AND SUN [10] MODEL

Regarding similarities with Ni and Sun [10] model, it is observed that the relationship $IS \rightarrow BP$ in H_1 was not statistically significant in the Chinese and Mexican context; however, companies that do not address the needs of society, their customers, and suppliers, will not be able to remain in the market, as indicated by Choi *et al.* [73]. Specifically, there is no direct and positive effect because the effect is indirect and is given troughs *InS* with $\beta = 0.263$.

For the relationship between $IS \rightarrow InS$ in H_2, $InS \rightarrow BP$ in H_3, $InS \rightarrow OS$ in H_5 and $OS \rightarrow BP$ in H_7, it is observed that they are statistically significant in both models, indicating that managers are focused on production processes and how they can generate a better financial income. However, the β value in the $IS \rightarrow InS$ relationship in H_2, although significant in both models, is very different and indicates that managers in China pay more attention to the *IS* variable associated with their external contexts, such as suppliers, customers and society. In Mexico, the β value for that relationship is lower, and this phenomenon may be because the maquiladora

TABLE 7. Sensitivity analysis.

			IS		*InS*		*OS*		*EP*		*SP*	
	Level		+	-	+	-	+	-	+	-	+	-
		Probability	0.166	0.134	0.107	0.118	0.155	0.171	0.193	0.144	0.209	0.150
BP	+	0.166		&=0.070 If=0.419	&=0.000 If=0.000	&=0.064 If=0.600	&=0.000 If=0.000	&=0.064 If=0.414	&=0.005 If=0.031	&=0.096 If=0.500	&=0.005 If=0.0028	&=0.091 If=0.436	&=0.000 If=0.000
	-	0.155		&=0.001 If=0.032	&=0.060 If=0.440	&=0.00 If=0.00	&=0.064 If=0.545	&=0.00 If=0.00	&=0.064 If=0.375	&=0.005 If=0.028	&=0.080 If=0.556	&=0.005 If=0.026	&=0.080 If=0.536
SP	+	0.209		&=0.086 If=0.516	&=0.000 If=0.000	&=0.070 If=0.650	&=0.011 If=0.091	&=0.091 If=0.586	&=0.000 If=0.000	&=0.107 If=0.556	&=0.000 If=0.000		
	-	0.150		&=0.000 If=0.000	&=0.075 If=0.0560	&=0.005 If=0.050	&=0.080 If=0.0682	&=0.005 If=0.034	&=0.086 If=0.500	&=0.005 If=0.028	&=0.102 If=0.704		
EP	+	0.193		&=0.091 If=0.548	&=0.000 If=0.000	&=0.064 If=0.600	&=0.000 If=0.000	&=0.080 If=0.517	&=0.005 If=0.031				
	-	0.144		&=0.011 If=0.065	&=0.086 If=0.640	&=0.000 If=0.000	&=0.086 If=0.727	&=0.000 If=0.000	&=0.091 If=0.531				
InS	+	0.107		&=0.053 If=0.230	&=0.000 If=0.000								
	-	0.118		&=0.000 If=0.000	&=0.080 If=0.600								
OS	+	0.155				&=0.070 If=0.650	&=0.005 If=0.045						
	-	0.171				&=0.000 If=0.000	&=0.064 If=0.545						

industries are subsidiaries of other companies, and they have little contact with suppliers and customers, being dedicated only to assembly activities.

For the *IS*→*InS* relationship in H_2, the β value is 0.678 units (the highest in the model), indicating that suppliers, customers, society and government must be important partners in the environmental initiatives. Managers must focus on training and education, the unification of ecological efforts to obtain better use of water and energy to throw fewer pollutants into the atmosphere and facilitate reverse logistics programs that promote recycling products at the end of their useful life.

However, the relationship between *InS*→*BP* in H_3 is the most interesting since it has a $\beta = 0.217$, which was expected to be larger. This relationship indicates that environmental certifications, company personnel training, and programs focused on reducing water and energy use, low pollution emissions, and ecological materials support energy cost reduction and administrative penalties.

The *SI* moderating effect on *IS*→*InS* in H_4 and *CI* in the *InS*→*OS* in H_6 were statistically insignificant due to the maquiladora industry characteristics. The relationship *InS*→*OS* in H_5 is statistically significant with $\beta = 0.660$ units, indicating that activities developed by manufacturers into their production processes, such as environmental certifications, good use of resources, and energy, allow increasing the social acceptance image.

The *OS*→*BP* relationship in H_7 was statistically significant with $\beta = 0.258$ and indicates that gaining orders from customers concerned with the environment, complying with government environmental regulations, and having coverage with ecological products reduces costs associated with acquiring materials and energy consumption.

2) SIMILARITIES AND DIFFERENCES WITH SARKAR ET AL. [19] MODEL

Concerning the similarities of the proposed model with that of Sarkar *et al.* [19] in Bangladeshi ready-made garments and integrating three hypotheses (H_8-H_{10}), it is observed that all are statistically significant in both models, although differences in their values are observed. It indicates that managers in the manufacturing and garment industry are concerned about their decisions' social and environmental impact.

Regarding the *EP*→*BP* relationship in H_8, it was statistically significant with $\beta = 0.294$, indicating that reduction of pollutant discharges, waste and material recycling, environmental accidents reduction and the use of renewable energies support energy costs reduction, government administrative penalties, and increased income and investment, as declared by Sarkar *et al.* [19].

Likewise, the relationship *EP*→*SP* in H_9 was statistically significant with a $\beta = 0.668$, one of the highest in the model and indicates that reducing pollutants emissions, waste, and recycling processes favor the health and safety of employees. Furthermore, *SP*→*BP* in H_{10} has a $\beta = 0.179$, indicating that *SP* allows better use of resources such as energy and water to obtain higher market coverage and, therefore, higher financial profits. These findings are similar to Sarkar *et al.* [19].

B. FROM THE SENSITIVITY ANALYSIS

Even though many of the relationships between variables may seem obvious, this study reports the conditional and joint probabilities for its high- and low-level scenarios, even if they are unrelated. Sensitivity analysis shows that managers should strive for *IS*+ because there is a probability of 0.419. 0.516, 0.458 and 0.230 for occurring *BP*+, *SP*+, *EP*+ and *InS*+, respectively and indicating that maquiladora managers

will always gain some benefits. It is also verified that *IS*− does not allow obtaining *BP*+, *SP*+, *SP*+ *or InS*+, since the conditional probability is zero, indicating that low *IS* levels will never benefit maquiladora companies. Likewise, it is observed that if *IS*− occurs, then *BP*− can occur with a probability of 0.440, *SP*− at 0.560, *EP*− at 0.640, and *InS* - at 0.600, which is interpreted as a high risk in an SSC.

Also, if *InS*+ occurs, *BP*+, *SP*+, *EP*+ and *OS*+ can occur with a probability of 0.600, 0.650, 0.600 and 0.650, respectively and those are attractive probabilities for a manager since *InS* refers to internal activities under their control. Likewise, it can be seen that *InS*+ has no or almost no chance of generating *BP*−, *SP*−, *EP*−, or *OS*−, indicating that efforts to achieve high levels *of InS*+ will always be reflected in several benefits. However, if *InS*− occurs due to a lack of internal control, managers will have little or no chance of getting *BP*+, *SP*+, *EP*+, or *OS*+. On the other hand, there is a risk that when *InS*− occurs, there is a probability of 0.545, 0.682, 0.727 and 0.545 to obtain *BP*−, *SP*−, *EP*− and *OS*−, respectively and those scenarios are not favorable conditions for the maquiladora industry.

Additionally, if *OS*+ occurs, there is a probability of 0.414, 0.586 and 0.517 to obtain *BP*+, *SP*+ and *EP*+, respectively, indicating the importance of covering market niches with pro-environmental clients and having social and governmental acceptance of eco-products. In other words, *OS*+ always guarantees benefits, as there is little or no chance that it will be related to *BP*−, *SP*− and *EP*−. However, if *OS*− occurs, then unfavorable conditions can be obtained since there is a conditional probability of 0.375, 0.500 and 0.531 to obtain *BP*−, *SO*− and *EP*−, respectively and *OS*− is rarely associated with *BP*+, *SO*+, and *EP*+ since the probabilities are zero or almost zero.

Also, if *EP*+ occurs, there is a conditional probability of 0.500 and 0.556 for obtaining *BP*+ and *SP*+. That is why *EP* is a pillar of maquiladora companies' social and commercial success. Additionally, *EP*+ is rarely associated with *BP*− and *SP*−. However, if *EP*− occurs, there is a risk that *BP*+ and *SP*+ will not be obtained since the probabilities are almost zero; there is a risk that *EP*− will generate BP− and SP− with a probability of 0.556 and 0.704, respectively.

Finally, it is observed that *SP*+ favors the *BP*+ occurrence at 0.436, and it is not associated with *BP*−. However, *SP*− can never generate *BP*+ because the probabilities are zero, and there is a risk with a probability of 0.536 that generates a *BP*+.

VI. CONCLUSION AND FUTURE RESEARCH

This research has been conducted in a specific sector of the Mexican manufacturing industry: the maquiladora industry, and several conclusions and recommendations can be stated regarding this industrial sector:

1. There are similarities and similarities between Mexican maquiladora with the Chinese manufacturing sector and the Bangladeshi garment industry sector regarding SSC.
2. Managers in China give greater importance to IS than Mexican managers, which indicates that they consider their customers, suppliers, society, and workers more.
3. Compared to Mexican managers, managers in China consider that they can win more customers with a pro-environmental approach due to their environmentally friendly production processes.
4. Mexican managers consider that *CI* does not affect *OS*, which indicates that integrating customer opinions does not allow them to win more production orders. These phenomena may be due to the maquiladora industry nature, where there is not a direct relationship with customers and suppliers, and they focus only on the assembly process, which is demonstrated by observing that in the maquiladora industry, the moderating effect of *SI* on the *IS*→*InS* relationship is not statistically significant, while in China it is.
5. Managers in the Mexican maquiladora industry should pay special attention to *IS* since it has a high indirect effect on *OS*. In other words, a good relationship with customers, society, suppliers and workers allows them to win more production orders.
6. Efforts should be made to create a deep environmental education in Mexican maquiladora companies since compared to the model of Sarkar *et al.* [19], the ratios of *EP*→*BP* and *SP*→*BP* are lower; however, they are more aware that *SP* gives support to *BP*.

In future research, we intend to study the food industry, which is abundant in the region and strongly focuses on compliance with quality and safety standards. Also, on this occasion, we use the Sarkar *et al.* [19] model where *BP* is the dependent variable; however, some managers in the maquiladora industry are interested in having *EP* as a response variable.

AVAILABILITY OF DATA AND MATERIALS

The dataset supporting the analysis and conclusions of this article is available at following link: https://doi.org/10.17632/strbt9sr4h.1 and a the survey used is at: https://doi.org/10.6084/m9.figshare.14462163.v1.

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JORGE LUIS GARCÍA ALCARAZ received the M.Sc. and Ph.D. degrees in industrial engineering, the Ph.D. degree in innovation in product engineering and industrial process, and the Ph.D. degree in sciences and industrial technologies. He was a Postdoctoral Researcher in production systems. He is currently a full-time Researcher with the Autonomous University of Ciudad Juarez. He is also the National Researcher in Mexico. He was the author/the coauthor of more than 150 papers, conferences and congress; the author/the coauthor/an editor of ten books; and an academic editor of some JCR journals. His research interests include manufacturing, production process modeling, and supply chain.

ROBERTO DÍAZ REZA received the bachelor's degree in industrial engineering, the master's degree in industrial engineering with a specialty in quality, the Ph.D. degree in innovation in product engineering and industrial processes, and the Ph.D. degree in advanced engineering sciences. He has published a book about total productive maintenance with Springer and he has published some articles in indexed journals related to lean manufacturing tools. Also, he has participated in some international congresses. His current research interest includes the industrial processes optimization using lean manufacturing tools.

EMILIO JIMÉNEZ MACÍAS (Member, IEEE) received the master's degree in industrial engineering (computer science, electronics, and automation specialty) from the University of Zaragoza and the Ph.D. degree in industrial automation from the University of La Rioja. He is currently a full-time Professor with the University of La Rioja, where he is the Director of the master on industrial engineering and leads the ''Modeling, Simulation and Optimization'' Group. He is also the Head of the Division of Systems Engineering and Automation, Department of Electrical Engineering. He has published more than 200 works (journal articles, conference papers, and books). He has participated in more than 40 research projects. He has advised 18 Ph.D. thesis. He has elaborated more than 70 patents. He has received several awards for his main research works. He has published 95 articles in journals indexed in Journal Citation Report (JCR). His research interests include modeling and simulation, factory automation, production, and logistic systems, applied mathematics, renewable energy, and environmental impact. He was the President of the Federation of European Simulation Societies (EUROSIM), the Discrete Event and Hybrid Systems Technical Committee (TC 1.3), and the Modeling and Control of Environmental Systems Technical Committee (TC 8.3.) of International Federation of Automatic Control (IFAC).

RITA PUIG I. VIDAL received the Chemical Engineering degree, the Ph.D. degree in chemical engineering, and the degree in chemical sciences from Universitat Ramon Lllull, Barcelona, Spain, in 1988, 1993, 1994, respectively, and the master's degree in environmental management from the Universitat Politècnica de Catalunya (UPC), in 2003. She worked as a Lecturer and a Researcher with UPC, from 1993 to 2018. She was the Vice-Director of the Igualada Engineering School, UPC, from 2001 to 2004, and the Director for six years (from 2004 to 2010). In UPC, she founded the GIR-Environment Research Group specialized in process optimization and sustainability assessment. In September 2018, she changed from UPC to the University of Lleida (UdL). She is currently a Full Professor with the Department of Computer Science and Industrial Engineering, UdL, and member of DBA-UdL Consolidated Research Group (Center of Biotechnological Agrifood and Chemical Developments).

FRANCISCO JAVIER FLOR MONTALVO received the Ph.D. degree in innovation in product engineering and industrial process from the University of La Rioja, Spain and the many master's degrees. He is currently a Researcher with the International University of La Rioja, Spain, where he develops his work in environmental study of products and processes through life cycle analysis (LCA), LEAN production and process optimization and technological processes, and product developments. He has several JCR index paper published and many contributions in congress and research projects. He has developed an intense professional activity occupying executive positions in numerous companies and creating companies in different technical and productive sectors.

AGUSTÍN SÁNCHEZ-TOLEDO LEDESMA received the Executive M.B.A. degree from the IE Business School, the master's degree in environmental and quality management and occupational risk prevention, and the Ph.D. degree in renewable energy and electrical engineering. He is currently a Professor with the Universidad Internacional de La Rioja. He is also the Director of the observatory of the occupational risk prevention and the international prevention congress. He is also a National Researcher in Spain. He is the author/the coauthor of more than 100 papers, conferences, and congress. He is the author/the coauthor/an editor of ten books and academic. His main research interests include business management and health and safety.