Genoveva Vargas-Solar
EDITOR

CRITICAL FACTORS IN INDUSTRY 4.0

A Multidisciplinary Perspective

El Colegio de Chihuahua
Institución Pública de Investigación y Posgrado

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Calle Partido Díaz 4723
Colonia Progresista, C.P.32310,
Ciudad Juárez, Chihuahua, México
Tel. 52 6566390397

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Coordinación editorial: E. Liliana Chaparro Vielma
Corrección: Carolina Caballero Covarrubias
Cubierta y diagramación: Karla María Rascón González

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Prologue

This book is a compilation of works that present different perspectives associated with Industry 4.0 in the organizational environment in Mexico and the world. Research on the maquiladora industry—the main economic activity in Ciudad Juárez—predominates, nonetheless, *Critical Factors in Industry 4.0: a Multidisciplinary Perspective* also addresses topics on Small and Medium Enterprises (SMEs) and in particular research associated with the future perspective of human capital, focusing on labor contexts, social responsibility, technology transfer, systems for competitiveness, human resources development, among other concepts associated with Smart Manufacturing, Industrial Internet of Things (IoT) and Industry 4.0.

Critical Factors in Industry 4.0: a Multidisciplinary Perspective consists of 21 chapters of research findings of the influence the maquiladora industry has on the citizens of Ciudad Juárez. Although the topics of the contributions are varied, they can be grouped into generic classifications such as: Human Capital, Industry 4.0, Organizational Productivity and Competitiveness.

The significance of the human factor within the maquiladora industry is presented throughout the first chapters. These chapters propose practices such as the development of a career and life plan in order to improve the employee's potential and meet organizational objectives more efficiently. The book shows an analysis of the influence of emotional intelligence and leadership on employee turnover, as well as the precariousness of employment in terms of instability, social protection and low salaries suffered by workers to-

day. Finally, under the same Industrial topic, the authors expose how poor management decisions affect job motivation, role stress and job satisfaction.

The chapters: "Design of a rotating prototype for arm enhancement on an exoskeleton", "Intelligent Humidifier for Humidity Control in a Smart City using IoT and Type-2 Fuzzy Logic", "Essential factor in the survival of high-tech SMEs: Relational capital in the Machining Industry of the Juárez", "Chihuahua, Future determination of programmed obsolescence and how to determine future paradigm shifts in Generation Z technology consumption factors using an innovative metaheuristics", "Side Effects of the 4.0 Industry on Generation Y: A review of technological changes from an automotive labor perspective at Continental in Ciudad Juárez", "Automatic recognition for models of detection of arachnid bites in images through the use of Deep Learning", are associated with the welfare of the working age population and their expectations in their jobs regarding professional satisfaction and performance relationship in Industry 4.0. In these chapters, a solution based on AmI and Implementation of a Convolutional Neural Network for the detection of avian pests in citrus crops using smart drone propose the practice of Corporate Social Responsibility (CSR) and Lean Manufacturing (SM) philosophies as opportunities to increase market competitiveness. This group of authors focus on an analysis of the results of applying CSR in Small and Medium Enterprises, taking into consideration the large number of this type of companies in Mexico. On the other hand, in reference to Lean Manufacturing, or LEM, the purpose of the research is to show the advantages it provides to companies so that it is conceived not only as a tool, but also as an important business advantage.

The book closes with chapters associated with applications to improve the life of the population in a Smart City. The story of The history of a goldsmith-type manufacturing style that has perished addresses two aspects that are fundamental to the survival and growth of the companies: technological development and innovation in the maquiladora industry. In the first case, the Innovation Capacity Index is taken as a basis, an evaluation of this system is proposed in order to determine an adequate method to classify the level, innovation and development in the industry. On the other hand, on the subject of service quality, the authors present the case study of an organization under the paradigm of a Smart City with the purpose of making the company aware of the type of service it is providing and what are the possible improvements to it.

More than a compendium of knowledge, this book offers an original, dynamic and precise tour that allows the reader to access the social, environmental and economic issues derived from administrative actions. *Critical Factors in Industry 4.0: a Multidisciplinary Perspective* shows the Ciudad Juarez-El Paso border as a strategic place for business activity, exhibiting a place conducive to socioeconomic, political and tourism growth where

various stakeholders do their best to contribute to the economy of both the region and the country.

Jack Welch mentions that "Management is about managing in the short term, while developing long term plans". Thus, this work intends to show specific solutions in the organizational area of Industry 4.0 without overlooking the long term, leaving evidence in the theoretical contribution that may be of vital importance to future generations. The process of information gathering, review, joint work, and document correction results in a work that methodologically can be replicable to other areas of knowledge. This information will undoubtedly be of great help for management specialists. As Henry Mintzberg (internationally renowned management expert) once said, "Organizational management focused on Industry 4.0 is, above all, a practice where art, science and innovation of technology meet".

I hope that whether by reference, recommendation or simple coincidence, the reader may find this research useful, enjoy it, and that it may inspire them to find a solution to the problems that Industry 4.0 present these days.

Dr. Alberto Ochoa
Compiler

CHAPTER 7

Model of Logistics Factors and their Impact on the Competitiveness of Small and Medium Enterprises within the Industry 4.0 Paradigm

Idalí Bailón[1], Roberto Romero[1], Favela Marie*[1]

[1] *Department of Industrial and Manufacturing Engineering, Institute of Engineering and Technology, Autonomous University of Ciudad Juárez, Ciudad Juárez, Chih., México*

* *Corresponding Author: marie.favela@uacj.mx*

Abstract. The creation of new actions that promote the competitiveness of Small and Medium sized Enterprises (SME) is due to SME expansion. In Mexico, according to data provided by the National Institute of Geography and Statistics (INEGI), there are about 4 million 15 thousand business units, of which the 99.8% are SME that generate 52% of the Gross Domestic Product (GDP) and 72% of the jobs in the country. This means that choosing a right logistics and supply chain strategy requires using a creative process to develop an appropriate corporate strategy, using logistical factors that help to increase the SMEs competitiveness within the Industry 4.0 paradigm. The purpose of this research is to assess the impact of every logistical factor on the SME competitiveness in the plastics injection field. The methodology applied in

this research consists of first carrying out a literature review of many databases in order to identify the logistical factors, then, each one of these factors will be operationalized and thus, an instrument with 33 items will be produced. This instrument was validated according to content and criterion. To conclude, a first order factor model will be used to know the effect of each one of the logistical factors. The results of the theory review were 7 factors: transportation, distribution, inventory management, production, customer service, storage and supplying and purchases. In the validation stage, the Kendall Index and Cronbach's alfa were 0.366 and 0.907 respectively, which are acceptable ratings. Likewise, the factorial model presents acceptable adjustment indexes, being the customer service factor the most meaningful with a standardized weight of 0.906.
Keywords: Competitiveness, logistical factors, Multivariate Analysis

Introduction

Competitiveness is the result of the transformation of competencies, which offer a difference with respect to others and, in turn, turn them into attributes valued by demand (Bilancio, 1999). At present, the high competitiveness among companies has led various experts to propose models to raise it, but these models are particularly aimed at large companies because of their economic importance (Contreras, 2003), forgetting the small and medium-sized enterprises (SMEs) and their specific needs. In Mexico, according to data from the National Institute of Statistics and Geography, there are approximately 4.15 million business units, of which 99.8% are SMEs that generate 52% of the Gross Domestic Product (GDP) and 72% of employment in the country (PROMEXICO, 2014; Saavedra & Tapia, 2012; Soto, 2009), in this way, it is appropriate to support SMEs to raise their competitiveness levels that are in decline (Lopez, Ahumada, Perusquia and Zarate, 2010). Therefore, it is necessary to create actions that promote the competitiveness between SMEs. According to Ballou (2004), the creation of strategies begins with a clear understanding of the objectives that the company intends to achieve such as profit, survival, social, return on investment and market share or growth. This implies that the selection of an adequate logistics and supply chain strategy requires the use of a creative process, which allows the development of an adequate corporate strategy (David, 2003), which according to Ballou (2004); Zevallos (2006); Christopher (2003), innovative approaches in logistics and supply chain strategy can represent a competitive advantage by increasing flexibility, quality standards and efficiency (Tjahjono, Esplugues, Ares and Pelaez, 2017). Furthermore, it should not be forgotten that a competitive advantage is the consequence of having identified and ex-

ploited what another could not (Bilancio, 1999). An innovative process of logistics which have been in used since remote times, such as in the military, to be later adopted by companies as an efficient measure of competitiveness and to increase the profitability of the business (López et al, 2010).

Description of the problem.

Markets have become highly competitive and due to their rapid growth, they are constantly changing, going from simple to complex, from stable to dynamic (Gebauer, Gustafsson, & Witell, 2011). According to the importance that SMEs represent in the growth of a country (Ochoa, Jacobo, Leyva, & López, 2014), it is necessary to adopt strategies to contrast the demands of survival in the market (López-Mielgo, Montes-Peón, & Vázquez-Ordás, 2012). One strategy to follow when there are short product life cycles, or development of new product lines, or changing supply chains and new technologies, is logistics, which has become an essential instrument for the competitive success of companies (Christopher, 2003).

The application of logistics increases the need for coordination and conjunction of processes and systems, which in turn allows the emergence of a final product or service perfected to market segments with constantly changing needs (Carranza et al, 2003). In order to position a company in such a way that it can be distinguished from its rivals, it is necessary to take full advantage of the value of its capabilities, as well as to implement strategies that make them competitive (Porter, 1982). Therefore, it is clear that the design and implementation of these growth and innovation strategies are what allow companies to achieve a better position (O & S, 2010; Rozmahel, Grochová, & Litzman, 2014) Nonetheless, the strategies adopted by SMEs are still not known with certainty because they are not documented (Ojeda, 2009), nor are the factors used for a better management of the company known, allowing it to take advantage of its resources in the best way and compete successfully in the market, overcoming the difficulties that currently arise and contributing to its growth (Bonitto, 2010).

Competitiveness

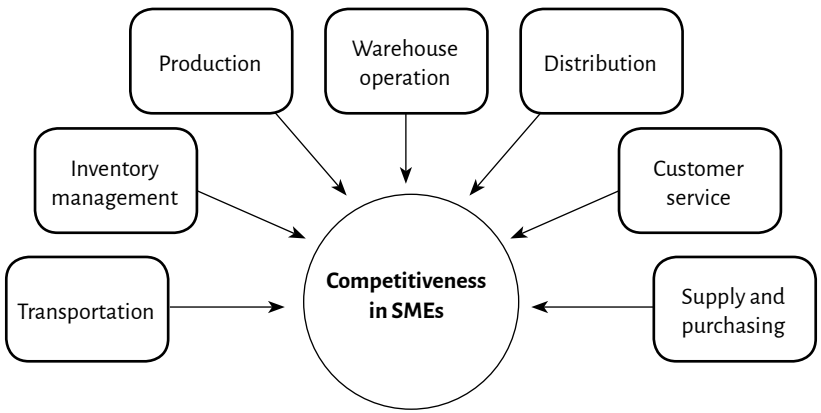
Competitiveness is conceived as a business phenomenon or organizational pattern of society, related to its behavior in the market in which it operates (Orozco-Rosas, Ahumada-Tello, & Zárate, 2010; Sanchez & Fajardo, 2008), maintaining and increasing its participation based on new strategies (Mora-riapira & Vera-colina, 2015). In most cases, competitiveness depends on productivity, profitability, competitive position, and participation in the domestic and foreign markets (Saavedra & Tapia, 2012). For Porter (1990),

competitiveness is "...the production of goods and services of higher quality and lower price than domestic and international competitors, which translate into increasing benefits for the inhabitants of a nation by maintaining and increasing real incomes".

Proposed ModelModel

According to the literature review, a logistics model is proposed for SMEs so that they can increase their competitiveness within the market (see Figure 2.1).

Figure 2.1 *Proposed model for increasing competitiveness in SMEs Each of these factors will explain the positive effects it has on increasing competitiveness in SMEs.*



Source: *Own elaboration.*

Generation of instrument as a survey

Survey designed is also of great importance since the way a question is written influences the answers obtained to the extent that the respondent may feel pressured to answer in a certain way (Alaminos & Castejon, 2015). The competitiveness of an organization linked to the management of Transportation for inventories associated with the distribution and storage of production is a decisive task of utmost importance (along with the proper characterization of a correct Customer Service Supply) to make the purchasing experience more efficient.

Formulation of the questions

The wording of the question should be carefully chosen as it may influence the responses of the interviewees. The more flexible the question is, the answers become more vague. Therefore, questions should not mislead the interviewee, should not be ambiguous, should not ask for information that the interviewee does not have or cannot recall

with certainty, or be too sensitive and cause the interviewee to avoid them or answer them in a misleading manner.

The order in which one question is asked in relation to the others is significant, given the cumulative nature of the information produced in the interview. Once a question has been asked, the interviewee will take it into account when assessing the following questions asked, thus, influencing the perception of its content. The *Likert scale*, according to Hernández, Fernández & Baptista (2006), consists of a set of items presented in the form of statements or judgments to which the participants are asked to react. That is, each statement is presented, and the subject is asked to express his/her reaction by choosing one of the five points or categories of the scale. Each point is assigned a numerical value. Thus, the participant obtains a score with respect to the statement and at the end his or her total score, adding up the scores obtained in relation to all the statements.

The Cronbach's Alpha coefficient, which is a static technique, analyses the internal consistency of the scale as a dimension of its reliability by calculating the correlation between scale items. This statistic can be considered as a correlation coefficient. One interpretation of their results indicates that if the different items of a scale are measuring a common reality, the responses to these items will have to present a high correlation between them, otherwise, the existence of a low correlation between some items shows some statements of the scale that are not reliable measures of the construct. The value of *Cronbach's Alpha* can range from 0 to 1. If it is 0, it means that the scores of the individual items are not correlated with those of all the others. On the contrary, a higher alpha value means a higher correlation between the different items, thus increasing the reliability of the scale, taken from Molina, (2008). *Cronbach's Alpha* below 0.5 shows an unacceptable level of reliability; if it were to take a value between 0.5 and 0.6 it could be considered a poor level. If it were to be between 0.6 and 0.7, it would be a weak level. Between 0.7 and 0.8, it would refer to an acceptable level; in the interval 0.8-0.9 it could be qualified as a good level, and if it took a value above 0.9 it would be excellent (Gallardo, Sánchez, & Corchuelo, 2012). *Cronbach's Alpha* is a standard measure of reliability defined as: Where: σ i 2 = the variance of the q-th item score, q=1..., k σ x 2 = total variance k = number of items

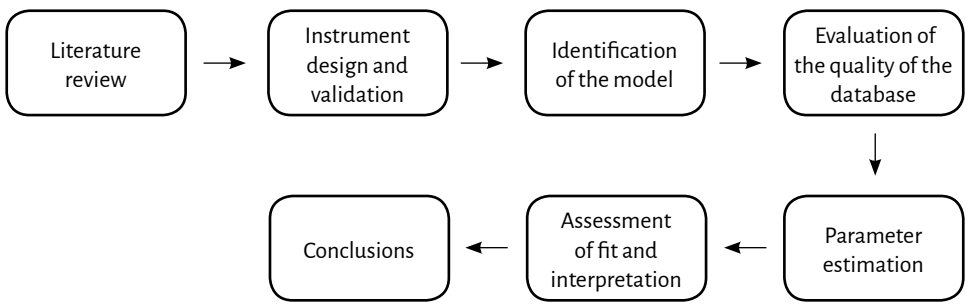
Factorial analysis, according to Pérez (2004), is a multivariate technique that aims to reduce the size of an excessively large data table due to the high number of variables it contains and to keep a few dummy variables that, although not observed, are a combination of the real ones and synthesize most of the information contained in their data. The factors should be enough to summarize most of the information contained in the original variables. Factor analysis can be exploratory or confirmatory.

Exploratory analysis is characterized by the fact that the number of factors is not perfectly known, and it is in the empirical application that this number is determined. In contrast, in confirmatory type analysis, the factors are fixed a priori, using hypothesis contrasts for their corroboration. According to Siegel & Castellan (1995), this coefficient is used when one wants to know the degree of association between k sets of ranks, so it is especially useful when experts are asked to assign ranks to the items, such as from 1 to 4. The minimum value assumed by the coefficient is 0 and the maximum 1, and its interpretation is the same as that of the Kappa coefficient. Nevertheless, it is necessary to review the rating given to each item since there may be a high degree of agreement in the aspects, an example of which is that the item is not appropriate (Escobar & Cuervo, 2008). Certainly, in this case, the item must be eliminated or modified completely until it fits the objectives of the measurement in an appropriate way.

According to Siegel et al (1995), a high value of the coefficient can be interpreted as a reflection that observers or judges are applying the same standards when assigning ranges to the items. This does not guarantee that the observed rankings are correct, as all judges may agree if they are all using the wrong criteria for ranking. According to Escobar & Cuervo (2008), Kendall's W concordance coefficient the hypotheses raised are H0: the ranks are independent, they don't match. H1: There is significant agreement between the ranges. Once the results are obtained, they are interpreted as follows: H0 is rejected when the observed value exceeds the critical value (with an alpha of 0.05) and when the significance level is lower than 0.05, the H0 is rejected, thus, it is concluded that there is significant agreement between the ranges assigned by the judges. Moreover, the strength of the concordance is interpreted, which increases when W approaches 1.

Proposal Methodology

Figure 3.1 *Proposed methodology for the development of the project.*



Source: *Own elaboration.*

The following sections present in detail what each of the above stages consists of.

Literature review

For the present investigation, a bibliographic review was carried out in different databases, as well as scientific articles, with the objective of identifying the Logistics Management Models and each one of its logistic factors (Bibliographic review, Design of instruments and validation of the Model, specification of the Model, identification of the Model, evaluation of the quality and validation of the Model, Model specification, Model identification, quality evaluation, estimation of the Parameters associated with the proposed Model and Evaluation and interpretation of the correct fit of the Model). The interpretation of the conclusions contributes to increase the competitiveness of SMEs. SMEs. In this way, it is possible to identify the similar factors used in the reviewed models that have contributed to the increased competitiveness of SMEs to the increased competitiveness of SMEs in their current and Industry 4.0 context.

Instrument design and validation

Once the logistical factors or indicators for each of the constructs have been identified, the variables are put into operation and a table containing the construct used is drawn up with its definition and indicators. The questions are scored with the *Likert Scale* to measure the impact of each of the logistical factors on competitiveness in the SMEs. The *Likert Scale* is shown in Table 3.1.

Table 3.1 *Likert Scale used*

1. Strongly disagree	2. Somewhat disagree	3. Neither agree nor disagree	4. Somewhat agree	5. Strongly agree

Source: *Own elaboration.*

The instrument designed is scored by experts to find out how well the questions match each other.

The index used was Kendall's W, which is particularly useful when experts are asked to assign ranges to items, according to the author Escobar & Cuervo (2008). Having Kendall's W value, a sample is made for convenience to different SMEs of the plastic injection sector to know the criteria validity using *Cronbach's alpha* index. This way, it can be known whether the instrument carried out is suitable for measuring the impact of logistical factors on the competitiveness of SMEs. Strongly disagree 2. Somewhat disagree 3. Neither agree nor disagree 4. It is important to know the distinction of the relationship between the variables, since if they are not mentioned by the researcher, it is assumed

they are be equal to zero. The value of zero is given when there is a direct relationship between the expectation of results and academic performance, although the relationship between these two variables is measured by performance goals.

Identification of the model

When the correct theoretical model is known, the identification of the model continues. If all parameters are identified, then the model is also identified. To identify a model, the degrees of freedom are considered and they must be greater than or equal to zero.

Evaluation of the quality of the database

Once the model is identified, the evaluation continues. This stage examines all the variables to evaluate the quality of the database. Sample size is considered, and an adequate sample should have between 10 and 20 participants per parameter (Kline, 2005). Moreover, we must also consider the multicollinearity between variables, since correlation between variables is considered redundant, where values higher than 0.85 can mark potential problems in its correct implementation and proper interpretation. The existence of univariate and multivariate marginal scores (outliers) should also be examined. When an extreme score is presented for a variable, it is called "univariate cases", and multivariate cases arise when extreme scores are presented for more than one variable.

Parameter estimation

The above steps determine the values of the unknown parameters and their respective measurement error. Non-standardized and standardized coefficients of the parameters are estimated. Special programs are used to estimate the unknown parameters, such as LISREL (Linear structural relations), AMOS and EQS.

Assessment of fit and interpretation

Continuing with the steps, a goodness-of-fit diagnosis is made which refers to the accuracy of the assumptions of the model specified for the determination of whether it is correct and serves to approximate what is real. The most commonly used indicators are the chi-square statistic, the chi-square ratio over degrees of freedom (CMIN/DF), the change in chi-square between alternative models, the comparative fit index (CFI), the goodness-of-fit index (GFI), and the approximation mean square error (RMSEA). The resulting values range from 0 to 1, with 1 being the perfect fit.

Joint model fit

The overall model fit must be analyzed to ensure that it is an adequate representation of the full set of causal relationships. Each of the three types of fit quality measures are used.

Measures of absolute fit

The three most basic measures of absolute fit are the chi-square likelihood ratio (X 2), the goodness-of-fit index (GFI) and the square root of the mean squared residue (RMSR).

Incremental fitting measures

The model is evaluated in comparison with a null model. The null model is a single factor model without measurement error.

Parsimony adjustment measures

This type of measure provides a starting point for comparison between models of different complexity and objectives. One applicable measure for the evaluation of a single model is the measure of the standardized chi-square. A review of the three types of measures of joint fit reveals a consistent pattern of marginal evidence for the joint model as proposed.

Conclusions

After all the above steps have been completed, a conclusion is drawn regarding the achievement of the overall objective proposed in this project.

Results

This section presents the information and data obtained through the investigation of each of the stages already mentioned in the previous chapter. Starting with the review of literature and the operationalization of the variables, then the design and validation of the instrument, continuing with the application or data collection and finally with the application of the factorial model.

Literature review

Based on the literature review in the different Science Direct, emerald and Springer Link databases and in several scientific articles reviewed, the models used by various companies to increase their competitiveness are: Model of the Ministry of Economy of Mexico, Supply Chain Operations Reference Council of North America (SCOR-model) (Lee et al., 2012) , and other models proposed by Hector Diaz, Rafael Garcia and Nestor Porcell

(2008), Carlos Alberto Gonzalez, Jose Luis Martinez, Claudia Malcon and Judith Cavazos, Andres Velasquez Contreras and the Directorate General of Policy for Small and Medium Enterprises of Spain: customer service, supply, purchasing, warehouse operation, inventory management, transportation, distribution and production.

Instrument design and validation

Once the research has been reviewed and the logistical factors for the constructions have been obtained, the instrument is made operational. These factors are presented in the matrix in Table 4.1

Table 4.1. *Construction Definition Transport indicators*

Construct	Definition	Indicators
Transportation	This is the type of transport to be used for the delivery of orders. (Kabashkin & Lučina, 2015).	Travel time (minutes), Private or rented, Maintenance cost, Frequency of use, Vehicle capacity (volume and weight) (Salazar, 2012).
Distribution	Having a strategic location that allows your customers to locate them, and to deliver your products to the points of sale in optimal conditions and at the right time, and that your suppliers can supply them in a timely manner (K, 2020, Taherdoost & Brard, 2019).	Numbers of commercial operations Reduction of sales and transport costs. Network of sellers and/or distributors. Location between customers and/or suppliers (Calderón & Cornetero, 2014).
Inventory Management	It is the determination of the points of rotation, the forms of classification and the reinventory model determined by the control methods (which determines the quantities to be ordered or produced (Salazar, 2012).	Product Quantity Goods Turnover Index (Ratio between sales and average inventory. Indicates the number of times the invested capital is recovered through sales). Goods Duration Index (Ratio of final inventory to average sales in the last period. Indicates how many times the inventory lasts) (Calderón et al, 2014).
Production	To have an efficient production process that allows it to produce the same products as the competition, but at a lower cost. To have highly qualified personnel that allows it to have a high productivity (K, 2020).	Human resources Machines and equipment Materials and inputs (K, 2020).
Customer service	To ensure that the customer receives a product and/or service at the right time and place, as well as to fulfill any promises made from the beginning of the interaction process (Chen & Tsou, 2012).	Level of compliance with customer deliveries (Chen & Tsou, 2012).

Construct	Definition	Indicators
Warehouse operation	Storage Decisions on the determination of space required design and layout of products inside (Roodbergen, Vis & Taylor, 2015).	Available stocks Expiry time Notification of stock for orders Own or rented storage capacity. (Calderón et al, 2014).
Supply and purchases	This is the quantity of product, as well as the time in which the supply will be made, considering the selection of suppliers, location, communication relationship and order processing (Roodbergen, Vis & Taylor, 2015)	Quotation Request. Supplier selection (cost, quality, delivery times). Reliability of suppliers Purchase order. Follow-up. Reception. Invoice management. Purchase of goods during the period (Calderón et al, 2014).

Source: *Own elaboration based in literature review.*

With the operationalization of the variables, it was possible to obtain an instrument composed of 38 items and at the end a question was added to qualify the level of competitiveness that the company considers to be qualified with a scale from 1 to 10. Each of the items is a unit of information to measure each of the constructions, the measurement instrument is presented in annex 1. To carry out the validity of each of the constructs based on their indicators, an evaluation by experts or content validity was carried out, which consisted of submitting the questionnaire to the assessment of 4 experts in the field, who judged each of the items on a Likert scale of 1 to 5, where 1 meant totally disagree and 5 meant totally agree with the question posed and its relationship with the impact on competitiveness. Thus, the following results were obtained, which are presented in Table 4.2.

Table 4.2 *Kendall's W estimate*

N	4
Kendall	0.366
Chi-squared	54.204
Df	37
Sig	0.034

Source: *Own elaboration.*

Kendall's W index obtained in the SPSS statistical program was 0.366 and a significant value of 0.034, proving an agreement among the experts.

Once the content validity was obtained, the instrument was applied in 9 small plastic injection companies in Ciudad Juárez, Chihuahua in order to measure the reliability of the instrument. After capturing the data gathered in the SPSS statistical program, the reliability analysis was performed using the *Cronbach alpha* index, obtaining a result of 0.880, as shown in Table 4.3.

Table 4.3 *Cronbach alpha estimation*

Cronbach's Alpha	N of Items
.880	38

Source: *Own elaboration.*

To increase the Cronbach's alpha index, items associated with the Model were identified and upon their elimination from the analysis, theCronbach's alpha index significantly improved. The 5 items eliminated are shown below in Table 4.4.

Table 4.4 *Items eliminated with low correlation*

	Corrected Item-Total correlation	Cronbach's Alpha if Item Deleted
Use transport efficiently.	0.019	0.881
Capacity (volume and / or weight) of transport.	0.259	0.882
Have a high level of product (raw material, in process and finished)	-0.496	0.898
Know the levels of inventories.	0.068	0.883
Have availability of finished products.	0.159	0.881

Source: *Own elaboration.*

With the items eliminated, the analysis is carried out again to know the new *Cronbach's alpha* index (see Table 4.5), obtaining an alpha of 0.907, thus, increasing the reliability of the instrument and leaving the instrument with only 33 items.

Table 4.5 Cronbach's alpha estimate with items eliminated

Cronbach's Alpha	N of Items
0.907	33

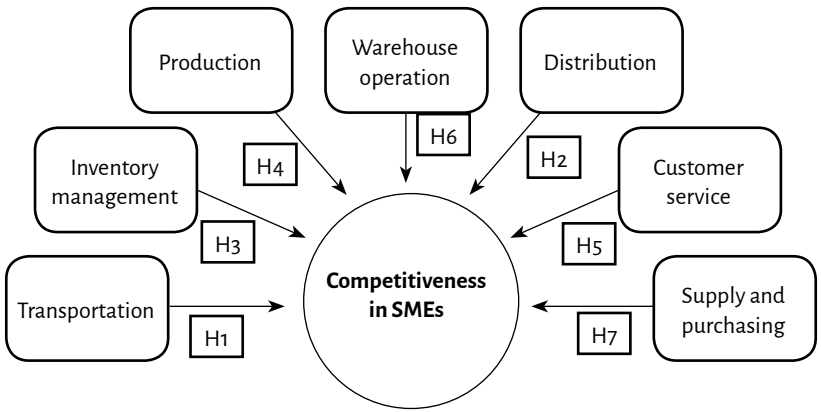
Source: *Own elaboration.*

Once the instrument was validated (survey), the complete study was performed on 20 plastic injection companies, located in Ciudad Juarez, Chihuahua.

Model specification

According to the theoretical foundation, a logistics model was designed for SMEs. The basic conceptual model is presented in Figure 4.1. The following hypotheses were proposed for this research: H1: The transport logistics factor contributes positively to the competitiveness of SMEs. H2: The distribution factor contributes positively to the competitiveness of SMEs. H3: The inventory management factor contributes positively to the competitiveness of SMEs. H4: The production factor contributes positively to the competitiveness of SMEs. H5: The customer service factor contributes positively to the competitiveness of SMEs. H6: The warehouse operation contributes positively to the competitiveness of SMEs. H7: The supply and purchase factor contribute positively to the competitiveness of SMEs.

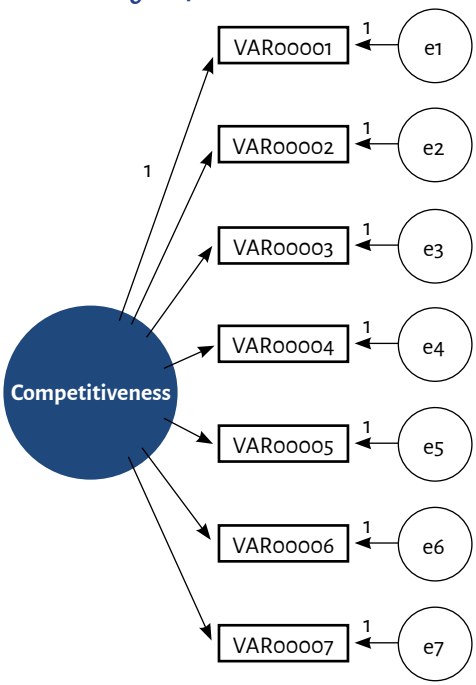
Figure 4.1 *Model based on the theory*



Source: *Own elaboration.*

The previous model (Figure 4.1) establishes that good management of each of the logistics factors present helps to increase the competitiveness of SMEs. Figure 4.2 shows the factorial model used for the elaboration of this project.

Figure 4.2 Factorial model



Source: Own elaboration.

The logistic factors are shown below with their respective codification (Table 4.6).

Table 4.6. Logistic factors

Logistic factor	Codification
Transportation	VAR00001
Distribution	VAR00002
Inventory management	VAR00003
Production	VAR00004
Customer service	VAR00005
Warehouse operation	VAR00006
Supply and purchasing	VAR00007

Source: Own elaboration.

Model identification

Once the model has been specified, the values for each parameter are identified and the degrees of freedom of the model are calculated using AMOS version 22. (Table 4.7).

Table 4. 7 Computerization of degrees of freedom

	Value
Value Number of moments of the sample	28
Number of parameters to be estimated	14
Degrees of freedom	(28-14) = 14

Source: Own elaboration.

Evaluation of the quality of the database

According to Kline (2005), an adequate sample to carry out a factorial model must have 10 to 20 surveys per parameter. In the AMOS program, this gives us a value of 14 estimates, therefore a minimum sample of 140 companies is required, however in Ciudad Juarez there are only 28 plastic injection companies and only 20 surveys were obtained from them. Due to this small sample size, the bootstrapping method is used to generate and increase the sample size by replicating the original sample, estimating the standard errors of each sample.

Conclusions and Recommendations

Conclusions

Multivariate analysis is a tool that helps through its different and diverse techniques to understand and estimate the effect and relationships between multiple variables associated with the model proposed in this project. The general objective of this project has been achieved by measuring the effect of each of the logistic factors that affect the competitiveness of an SME in the plastic injection molding sector, as well as the relative importance of each one of them. Once the importance of each of the logistic factors is known, the SMEs will be able to take them into account in order to increase their competitiveness. The identified logistical factors that can be considered by SMEs to increase competitiveness are: Customer service, which is the logistic factor with the highest estimated value of 0.906, contributing to competitiveness if the customer receives a product with zero defects, in addition to a low cost, the SME has certifications, and the customer is given some guarantee or maintenance to the purchased product.

Supply and purchases, this logistic factor with an estimated weight of 0.880, contributes to competitiveness if it considers its suppliers to be highly reliable (quality of raw materials, on-time deliveries, etc.), the management of purchase order formats and the handling of low-cost agreements with suppliers. *Inventory management*, this logistic factor with an estimated weight of 0.732, contributes to competitiveness by knowing the number of transactions and/or sales made, the management of specific lot sizes, as well as the use of a security inventory.

Transportation, a logistic factor with an estimated weight of 0.601, contributes to competitiveness if one considers the type of transportation to be used by minimizing the cost and time occupied for your deliveries. *The storage factor* with an estimated weight of 0.559, contributes to competitiveness by knowing the number of finished products in stock, determining the use of a warehouse according to the needs of the product and knowing the times of exit of your product.

Production is another logistic factor with an estimated weight of 0.342, which contributes to competitiveness if you have highly trained personnel, making use of standard components and flexible systems in the processes, besides considering new technology for your process. *Distribution* is the last logistic factor that has an estimated weight of -0.080, although this factor was determined in the research as a factor that affects the competitiveness of the SMEs, the results obtained does not show a significant value. It can be understood that SMEs are not considering important the variables that explain this factor, so it can be acknowledged as an area of opportunity if they reduce transport costs, customer waiting time and have some distribution center contemplating its location among customers and suppliers to help this factor contribute to competitiveness.

The results obtained in this research will help the SMEs in Ciudad Juarez identify the relative importance of each of the logistics factors that contribute to their competitiveness, thus, allowing them to make a better decision on the factors that have a greater effect on their competitiveness.

Recommendations

Disruptive innovations are changing the landscape and business models of many industries. Since processes are increasingly digitalized and sensitive data increases exponentially, supply chains are also affected by the fourth industrial revolution. Thus, the concept of the 4.0 supply chain must be analyzed, identified and expanded as well as its corresponding dimensions and indicators that promote an increase in competitiveness from a strategic management perspective considering other future frameworks associated with the implementation of certain technologies, such as virtual and augmented realities, 3D-Printing and simulation, big data analytics, cloud technology, cybersecurity, the IoT, miniaturization of electronics, the use of collaborative robots, drones and nanotechnology particularly the warehouse, transport logistics, procurement

In future investigations, competitiveness can be presented as an observable variable that can be measured with different indicators, for example: productivity, quality, human resources, production, innovation, environment, etc.

It is recommended that the logistical factors that had less weight be increased in the number of variables that describe it and, in this way, their impact on competitiveness be increased.

On the other hand, the information collected can be used to create a structural model. Lastly, it is recommended that this model be replicated in other SME sectors in order to generalize it. Moreover, these systems evolve through the adaptation and reconfiguration of their structures, i.e. through the dynamics of the structure.

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