CRITICAL SUCCESS FACTORS OF WORLD CLASS MANUFACTURING IN THE MEXICAN AUTOMOTIVE INDUSTRY: AN ANALYSIS THROUGH STRUCTURAL EQUATION MODELS
FACTORES CRÍTICOS DE ÉXITO DEL WORLD CLASS MANUFACTURING EN LA INDUSTRIA AUTOMOTRIZ MEXICANA: UN ANÁLISIS A TRAVÉS DE MODELOS DE ECUACIONES ESTRUCTURALES

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	ABSTRACT
	World Class Manufacturing (WCM) is an innovative system for comprehensive management of manufacturing operations, characterized by the economic monetization of manufacturing activities and the determination of holistic impact on the organization. *WCM* enables prioritization of actions based on the economic needs of manufacturing operations, thus directing appropriate resources directly to these needs. This research aims to characterize the critical success factors of *WCM* and the achievement of objectives in organizations within the automotive sector in Mexico. The study was conducted in Mexico's automotive sector, identified as the country's most important manufacturing industry, representing nearly 4% of the National GDP and 20.5% of the manufacturing GDP. Through literature review and interviews with *WCM* system experts, six Critical Success Factors (CSFs) were identified, evaluated through 30 constructs. A data collection instrument was applied, subjected to reliability and validity tests through a pilot study. Empirical verification and validation of the instrument were conducted through exploratory factor analysis, confirmatory factor analysis, reliability analysis, and structural equation modeling in a sample of 201 valid surveys directed at experienced *WCM* professionals. The results indicate that managerial commitment, comprehensive competencies, leadership type, employee involvement, and organizational culture type directly influence the increased benefits of organizations implementing *WCM*. By understanding the various factors affecting *WCM* implementation, organizations can develop actions to mitigate risks and strategically plan the necessary short-, medium-, and long-term outcomes and resources.

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Factores críticos de éxito del World Class Manufacturing en la industria automotriz mexicana: An analysis through structural equation modeling

	RESUMEN
Palabras clave: World Class Manufacturing, factores críticos de éxito, implementación de costos, sistema estratégico de gestión, despliegue de costos.	*World Class Manufacturing* (WCM) es un sistema innovador de gestión integral de operaciones de manufactura, caracterizado en la monetización económica de las actividades de manufactura y la determinación del impacto holístico en la organización. WCM permite priorizar acciones basadas en las necesidades económicas de las operaciones de manufactura y así focalizar los recursos directamente a estas necesidades. El objetivo de este trabajo es caracterizar los factores críticos de éxito del WCM en organizaciones del sector automotriz en México a través de modelos de ecuaciones estructurales. La investigación se llevó a cabo en el sector automotriz de México por caracterizarse esta como la industria más importante de las manufacturas del país. A través de la revisión de literatura y entrevistas con expertos del WCM se identificaron seis CSF, evaluándose por medio de 30 constructos. Se aplicó un instrumento de recolección de datos el cual fue sometido a pruebas de confiabilidad y validez durante una fase piloto de evaluación. Se realizó la verificación y validación del instrumento mediante análisis factorial exploratorio, y modelo de ecuaciones estructurales en una muestra de 201 encuestas a profesionales experimentados en WCM. Los resultados indican que el compromiso gerencial, las competencias integrales, el tipo de liderazgo, el involucramiento y la cultura organizacional influyen directamente en los beneficios de organizaciones que implementan el WCM. Conociendo los CSF del WCM, las organizaciones pueden desarrollar acciones para mitigar los riesgos y poder planificar estratégicamente los resultados y recursos necesarios a corto, mediano y largo plazo.

Introduction

Changes in consumer behaviors resulting from globalization have motivated companies to engage in competition on a global scale, which has had a direct impact on the production and distribution of products and services (Gonçalves, da Silva, Ferreira, Tecilla, & dos Santos, 2016). Those organizations that still cling to inflexible mass production systems and traditional practices will not be able to keep pace with global changes and demands (Monge and Cruz, 2015; Flynn, Schroeder and Flynn, 1999; Lee and Paiva, 2018).

According to Avella and Vázquez (2005), the need to adopt a new business paradigm based on agility and the ability to adapt to change is manifesting itself in a new era of business. This business era is based on change as its main characteristic, revealing new trends in the management and organization of companies. In order to face the conditions of extreme turbulence and constant market change, the importance of greater flexibility in business management is perceived (Fortunato, 2009). Global competition has generated fundamental changes in the industrial competitive environment (De Felice, Petrillo and Monfreda, 2013).

Although the Manufacturing Management Systems also known as *XPS* of automotive companies seek to improve efficiency, quality, productivity and flexibility, they can be considered heterogeneous due to their differences in approach, prioritization of improvements and use of resources. According to Goes, Satolo, Ramos, Correa and Martins (2017), among the existing theories, the *World Class Manufacturing* (*WCM*) approach proves to be an effective transformation model to eliminate operational losses and support organizations in achieving high levels of performance.

There are several conditions, variables or critical factors that can affect the implementation of *WCM* in organizations. These factors may be internal or external to the organizations and have not been taken into account to mitigate them, either due to underestimation or lack of knowledge. Some factors may include human, cultural, technological, economic, geographic, political or social factors. One of the most important objectives for managers is quality and efficiency, which can be ensured by identifying and eliminating factors that result in poor performance. Therefore, it is essential to have a better understanding of the critical success factors (CSFs) and how to measure them (Belassi and Tukel, 1996).

In recent years, the automotive industry in Mexico has been characterized as the most important manufacturing industry in the country, boosting and energizing the country's growth and development. According to data from the National Institute of Statistics and Geography (INEGI), in the year 2023, the automotive industry will represent almost 4% of the national GDP and 20.5% of the manufacturing GDP. Due to the relevance of this sector and the benefits mentioned when implementing continuous improvement transformation models, it is common that manufacturing organizations in Mexico seek to adopt *WCM* as a strategy to improve their economic and productive performance, as well as to reduce the activities that do not add value in their processes.

Based on the above statements, the need to identify the Critical Success Factors (CSFs) that affect the achievement of objectives during the implementation of *WCM in* manufacturing organizations in the automotive sector in Mexico is revealed. Through knowledge of the various factors that affect *WCM* implementation, organizations can develop actions to mitigate risks, thus enabling strategic planning of the results and resources needed in the short, medium and long term.

This article explains the steps necessary to develop and statistically validate an instrument to reliably evaluate the degree of implementation of the Critical Success

Factors (CSFs) during the execution of the *WCM* model in companies of the automotive sector in Mexico and a structural equation model identifies and correlates the factors and determines their significance with respect to the benefits.

World Class Manufacturing

World Class Manufacturing or *WCM* is a model focused on the management of manufacturing operations, based on applied methodologies and performance achieved by the best companies in the world. The model is based on the concepts of Total Quality (TQC), Total Productive Maintenance (TPM), Total Industrial Engineering(TIE) and Just in Time (JIT) (Midor, 2012; De Felice et al., 2013). The main objective of *WCM* is the continuous improvement in the manufacturing areas to guarantee the quality of the final product. Projects developed under the *WCM* methodology, aim at eliminating all forms of loss and waste with the ultimate goal of achieving zero accidents, zero waste, zero breakdowns and zero inventories (Fiat Chrysler Automobiles, 2014). Dudek (2016) and Netland (2014) state that *WCM* is an organization-specific production system, known as XPS, which has been implemented by organizations such as Fiat Chrysler Automobiles and initially by Fiat Corporation in 2005, as well as asserting that the current *WCM* model was developed by Professor Hajime Yamashina at Kyoto University in Japan. According to Fiat Chrysler Automobiles Corporation (2018) the *WCM* model is recognized as a common production system among the group of companies that are part of the *WCM Association*, with the objective of improving manufacturing performance by sharing knowledge and practices of excellence in manufacturing processes.

The *WCM Association* is a non-profit organization established for the purpose of improving the performance of manufacturing operations through the *WCM* model. In addition, it is responsible for developing and implementing the best manufacturing technologies, setting manufacturing standards, and increasing the competitiveness and economic benefits of members (Unilever, 2022). In 2021 the list of *WCM Association* member organizations included: Unilever, Iveco, CNH, FiatChrysler Automobiles, Royal Mail, Whirlpool Corporation, Semperit Corporation, ArcelorMittal, Elica Corporation, Ariston Thermo Group, CNH Industrial, Leonardo, Atlas Copco, Magneti Marelli, Iveco and Saint-Gobain.

According to De Felice et al., (2013), Yamashina (2013), Stellantis Corporation (2021), the *WCM* model covered by the *WCM Association* is composed of ten technical pillars and ten managerial pillars, which are usually illustrated inside a temple. The ten technical pillars are: 1) Safety, 2) Cost Deployment, 3) Focused Improvement, 4a) Autonomous Maintenance, 4b) Workplace Organization, 5) Professional Maintenance, 6) Quality Control, 7) Logistics and Customer Service, 8) Early Equipment Management, 9) Personnel Development and 10) Environmental and Energy Management. The ten management pillars are: 1) Management commitment, 2) Clarity of objectives, 3) Roadmap to *WCM*, 4) Allocation of highly qualified people, 5) Organizational commitment, 6) Organizational competence towards improvement, 7) Time and budget, 8) Level of detail, 9) Level of expansion and 10) Operator motivation.

Critical Success Factors

Critical Success Factors (CSFs) are characteristics, conditions or variables that, if properly maintained or managed, can have a significant impact on the success of a company in a type of industry (Villegas, 2012). According to (Näslund, 2013), apart from some slight variations, CSFs are similar in most quality improvement initiatives and appear to be relatively constant over time. An important finding is that CSFs tend to be

more related to how an organization addresses specific factors of the change effort than to the change methods themselves. Management commitment and involvement, as well as organizational culture, are often characterized as fundamentally critical.

Other factors such as type of leadership, human, conceptual and technical competencies that make up the integral competencies are known as key ingredients; that is, essential factors for the successful implementation of any continuous improvement transformation strategy (Mckinley, Manku-Scott, Hastings, French, and Baker, 1997). Therefore, they are commonly found or transferred to different improvement strategies. In fact, the main reason behind the transfer of concepts such as Six Sigma, Lean Manufacturing or other improvement strategies to other organizations is the success they have had in companies such as Motorola and Toyota (Snee and Hoerl, 2003).

According to Soti, Shankar and Kaushal (2010) CSFs were popularized by Rockart (1979). Specifically, CSFs are a series of essential factors for an organization, without which any improvement initiative has a low probability of success. The concept systematically highlights the key areas that management must carefully consider in order to achieve its performance objectives. By understanding the CSFs for implementing a system, an organization can successfully determine the difficulties that critically affect the process, mitigating or avoiding any risks that may contribute to its failure (Yaraghi and Langhe, 2011).

Due to the above, it is important to develop and validate a reliable instrument that allows the collection of data on the CSFs that affect *WCM* implementation in the specified study sector. This is in agreement with that mentioned by (Alkarney and Albraithen, 2018), who states that by understanding the CSFs for implementing a system, an organization can successfully determine the difficulties that critically affect the process, eliminating or avoiding any problems that may contribute to its failure.

Method

This study used a cross-sectional survey design to collect data on the critical success factors when implementing the *WCM* model with the objective of supporting the knowledge of organizations in the Mexican automotive sector. Following the classification proposed by Creswell and Plano-Clark (2007), Tashakkori and Teddlie (2010), and Vara (2012), the methodology was adopted with a mixed or quali-quantitative approach. This is because systematic, empirical and critical research processes were applied to support data collection and analysis, both qualitative and quantitative. Consequently, the methodology is considered qualitative as it is based on research and approaches of the *WCM* model proposed by Yamashina (2000, 2006, 2009 and 2013) and the *WCM* Association. In addition, it is considered quantitative by collecting data related to *WCM* experts from various Mexican organizations.

The survey design and validation process was developed in three stages, which are discussed below: A) Instrument design, which consists of construct and indicator definitions, B) Instrument administration, which includes data collection, and C) Statistical analysis for instrument validation, which consists of assumption checking, data analysis using factor analysis, and construct validation.

Instrument Design
The first step in the design of the instrument is to identify the constructs that will be used during the study. Consequently, a detailed review of the literature was carried out by consulting various databases, such as: Scielo, Emerald, Scopus, Proquest, Elsevier,

Springer, Ebsco, Nature, Jstor, Sage, Wiley, IEOM Society International, Academic Journals, CORE, Taylor And Francis Group, SPELL, Web Of Science, Semantic Scholar, Scientific Research Publishing. The review covered publications of the last fifteen years focused on the Critical Success Factors of the *WCM* model in Mexican automotive organizations. Keywords used for the search included *World Class Manufacturing*, Critical Success Factors, World Class, Yamashina, *World Class Association*, Total Quality Management, Lean Manufacturing, Total Productive Maintenance.

In the first phase of the instrument design, one hundred and twenty-seven (127) articles were examined to identify the Critical Success Factors (CSFs) with the highest number of mentions in the literature; in total, 9 CSFs were identified. The factors that accounted for more than 75% of the mentions were then selected to be used as the basis for the design of the data collection instrument. In a second phase of the instrument design, the 9 selected CSFs were reviewed with a panel of *WCM* experts (*WCM*) composed of seven members of the manufacturing sector, each with more than 7 years of work experience implementing *WCM*. Once the review with the panel of experts was completed, 6 Critical Success Factors (CSFs) that affect the successful implementation of the *WCM* were selected.

The selected constructs can be conceptually defined as follows. Integral competencies (IC) comprise technical, human and conceptual skills, fundamental for success in business management. Moreover, the different hierarchical levels of an organization demand varying combinations of these skills (Katz, 1974). The type of leadership (TL) involves characteristics, attitudes and practices that constructively influence the team and the work environment. It encompasses effective communication, empathy, trust, talent development, resilience, ethical leadership and collaboration (Castillo and Romero, 2021; Villarruel, 2021). According to Araneda (2016), positive leadership fosters a healthy work environment, increases team motivation and productivity, and helps retain talent. Managerial commitment (MC) is crucial for the success of organizational change and the promotion of employee involvement, as well as for cultivating an innovative culture (Avlonitis and Karayanni, 2000). In addition, its influence on the formulation of corporate sustainability strategies and the integration of environmentally responsible practices is highlighted (Bravo and Cassano, 2019). Employee Involvement (EI) refers to the active participation and collaboration of organizational members in decision-making processes and operational activities within the workplace. According to Vila, Laguillo and Faura (2020), staff participation can generate benefits in terms of organizational continuity and improve organizational efficiency and effectiveness. Organizational culture (OC) type encompasses shared values, beliefs, and practices that influence employee behavior (Akpa, Asikhia, and Nneji, 2021; Azeem, Ahmed, Haider, and Sajjad, (2021); Drozdowski, 2022). Their understanding and management are crucial for leaders seeking to create an effective work environment (Pujol-Cols, 2018). Benefits (B) relates to the positive results obtained by implementing improvement strategies in organizations, such as efficiency and waste reduction through Lean (Romero, 2020). These benefits are associated with positive actions or outcomes that favor both individuals and the organization (Maciel-Monteon, Limon-Romero, Gastelum-Acosta, Tlapa, Baez-Lopez, & Solano-Lamphar, 2020).

Operationalization of Variables

The six Critical Success Factors (CSFs) represent the latent variables that were studied through the survey. Since these variables cannot be measured directly, it was required to carry out their operationalization (Hernández, Fernández, & Baptista, 2010;

and Padua, 2018); that is, to transform subjective variables into directly observable objective variables (Condori, 2015; and Jöreskog, Olsson, & Wallentin, 2016). The final survey was developed from this operationalization process. To achieve this, it was necessary to work from the conceptual definitions of the constructs. Subsequently, a series of indicators were listed for each construction and then at least one element was provided to measure that indicator.

The operationalization processes of the latent variable Integral Competencies (IC) is explained below as an example. IQ can be described by three indicators, such as: *WCM* Technical Competencies, Human Competencies and Conceptual Competencies. Thus, the indicator labeled " *WCM* Technical Competencies" is measured through item CI-1; and "Human Competencies" is measured through items CI-2 and CI-3. On the other hand, items CI-4 and CI-5 measure the "Conceptual Competencies" indicator.

The instrument consists of 30 items distributed in 6 constructs. A Likert scale was used to collect the responses to each item, covering a range of perception in an interval of 5 units, from 1 = Never to 5 = Always. The choice of the five-point Likert scale in this specific study is widely accepted and considered appropriate for assessing latent variables through a series of interrelated items (Carpita and Manisera, 2012; Maciel-Monteon et al., 2020)

Content Validation

The survey was reviewed by the panel of seven *WCM*experts to verify content validity. The relevance and clarity of the questions, the clear meaning of slang commonly used in the industry, and the time required to complete the entire survey were evaluated. Subsequently, based on the experts' comments, the instrument was modified. Its final structure consisted of five sections: The first section provides a brief introduction to the objectives of the survey, the second section collects information on the professional data of the respondents. The third section evaluates the Critical Success Factors (CSFs) in *WCM* implementation, and the fourth section contains an analysis of *WCM* tools. The last section aims to learn about the benefits for companies implementing the *WCM* model.

Instrument Administration

This study focuses on manufacturing organizations within the automotive sector in Mexico with experience in implementing the *WCM* model proposed by the *WCM Association*. The companies were identified through interviews with *WCM* experts and experienced WCM experts from founding companies of the *WCM Association*. The target survey participants were employees in middle to senior management positions; i.e., from supervisors at the lower end, to corporate leaders, engineers, managers, CEOs and corporate global vice presidents with *WCM*experience. The survey was administered using *Google Forms* and access was sent via an internet link. A total of 990 links were sent through different digital media such as: *Whatsapp*, email, *Facebook* and *LinkedIn*. The response rate was 22%, with 218 surveys completed with professionals from 11 different companies. The demographic characteristics of the sample were: Professionals of female gender 15.38% and male 77.78%; Type of organizations where the professionals work was Tier1 with 78.63% and Tier2 with 14.53%; Professionals with WCM experience between 1 to 3 years were 7.26%, between 3 to 5 years were 20.94%, between 5 to 7 years were 27.35%, between 7 to 10 years were 20.09% and between 10 to 15 years were 17.52%. The leadership roles of the professionals were Executive Leadership (global operations) with 3.85%, Executive Leadership (local operations) with 25.21%, Functional Area Leaders with 32.91%, Middle Level Leaders with 8.97%, Middle Level Supervisors with 20.94% and Others with 1.28%

Statistical Analysis for the Validation of the Instrument

To validate the instrument, the method used by De La Vega, Baez-Lopez, Limon-Romero, Tlapa, Flores, Rodríguez, and Maldonado-Macías (2020) was followed. The validation of the questionnaire comprises two fundamental tests: reliability and validity. Factor analysis was used to assess the reliability and validity of indirectly observable variables (Rodrigues, Jacinto, Antunes, Amaro, Matos, & Monteiro, 2023). Initially, four crucial aspects in survey validation were checked (Byrne, 2016): the presence of missing data, outliers, compliance with univariate and multivariate normality assumptions, and the presence of multicollinearity.

Factor Analysis

The EFA of the correlation matrix was used to establish the latent factors that explain the variability of the observed variables. A Promax rotation was performed and sample adequacy was assessed using the Kaiser Meyer Olkin index (KMO) and Bartlett's test of sphericity. Non-significant factor loadings were removed and a Confirmatory Factor Analysis (CFA) was performed using SPSS and SmartPLS.

Construct Validity

Convergent, discriminant, and nomological validity were assessed as recommended by Hair, Black, Babin, and Anderson (2014). Cronbach's alpha was estimated to evaluate the internal consistency of the instrument.

Results

In order to avoid missing data, only those surveys that were complete in *google forms* were included in the analysis. Subsequently, the database was checked for outliers, identifying observations with unique characteristics that clearly differed from the rest (Cohen, G. Cohen, P., West and Aiken, 2002). This procedure was carried out by applying the Mahalanobis distance. A total of 17 surveys identified as outliers were eliminated as they did not meet a conservative level of statistical significance, following Kline's recommendation, with *p < 0.001* (Kline, 2016). Thus, the subsequent calculations for the validation of the survey were performed considering only 201 responses. This measure was necessary to improve the normality of the database, since, by meeting this assumption, it was possible to use the maximum likelihood method to extract the factor (Schumacker and Lomax, 2015) following the same methodology used in this research study.

Verification of univariate normality was necessary as an essential, although not sufficient, condition for multivariate normality (De la Vega et al., 2020). To assess the normality of the variable data, it is proposed to rely on skewness and kurtosis; therefore, these two indices were used to measure the univariate normality of each variable in the instrument (De Carlo, 1997, cited by De la Vega et al., 2020). This resulted in absolute values of less than 1.96, corresponding to an error level of 0.05, for skewness and absolute values of less than 3 for kurtosis, as detailed in Table 1. These results corroborate Mardia's (1974) assertion that for a normal distribution, the measure of skewness should have a value of ±1.96 and the standardized kurtosis, a value equal to or less than 3.

Next, multivariate normality was evaluated using Mardia's test, which is based on the normalized value of multivariate kurtosis (Mardia, 1974). This procedure involves

comparing Mardia's coefficient for the data under study with a calculated value obtained using the formula *p x (p + 2),* where *p* represents the number of variables observed in the model (Khine, 2013). The verification of this assumption was carried out by contrasting the multivariate kurtosis value obtained through the statistical calculations of the virtual program *"WebPower - Statistical power analysis online"* with the value calculated by means of the proposed formula. With a total of 30 variables in the survey, the calculation yielded a value of 960, thus exceeding the multivariate kurtosis index obtained with *WebPower*. By meeting the condition that the calculated value is greater than the obtained value (931.404), the assumption of multivariate normality in the data set is also satisfied (De la Vega et al., 2020).

Ultimately, the presence of multicollinearity in the data was examined to rule out the possibility that two or more variables were highly correlated (Hair, Anderson, Tatham and Black, 1998). Two tests were used for this purpose: the first calculated bivariate correlations, since, according to Hair et al. (1998), any pair of variables with a correlation higher than 0.85 should be interpreted as evidence of possible problems. However, this analysis did not reveal such a situation, since the highest bivariate correlation was 0.83. The second test evaluated the variance inflation factors (VIF), which determine whether a variable could be redundant by presenting values greater than 10 (Hair et al., 1998). The VIF results in the study indicated a maximum value of 5.92 (see Table 1). Therefore, based on the two tests performed, it can be concluded that this data set does not present multicollinearity problems.

Table 1
Results of construct validity tests

Constructs / Variables		Asymmetry *(Skewness)*	Kurtosis *(Kurtosis)*	Inflation Factor *(VIF)*	Factor Loading *(Factor Loading)*	Eigenvalues *(Eigenvalues)*	Composite Reliability *(rho_c)*	Crombach's alpha *(Crombach Alpha)*
B	B1	-0.328	-0.867		0.924	4.272	0.958	0.958
	B2	-0.092	-0.938	5.203	0.923			
	B3	-0.233	-0.833	4.418	0.918			
	B4	-0.167	-0.927	5.418	0.931			
	B5	-0.270	-0.847	4.968	0.925			
TL	TL1	-0.113	-0.681	2.858	0.866	3.571	0.901	0.901
	TL2	-0.211	-0.562	2.874	0.854			
	TL3	-0.192	-0.922	2.558	0.813			
	TL4	-0.057	-0.808	2.511	0.839			
	TL5	-0.019	-0.739	3.073	0.852			
IE	IE1	-0.183	-0.700	3.166	0.858	3.745	0.917	0.917
	IE2	-0.046	-0.626	3.024	0.869			
	IE3	-0.469	-0.117	3.103	0.853			
	IE4	-0.180	-0.261	3.101	0.872			
	IE5	-0.194	-0.708	3.177	0.876			
GC	CG1	-0.319	-0.289	2.020	0.754	3.297	0.873	0.871
	CG2	-0.347	-0.485	2.550	0.821			
	CG3	-0.373	-0.411	2.116	0.795			
	CG4	-0.128	-0.629	2.473	0.835			
	CG5	-0.048	-0.682	2.647	0.851			
CO	CO1	-0.992	0.742	4.045	0.898	4.035	0.941	0.941
	CO2	-0.835	0.554	3.943	0.888			
	CO3	-0.804	0.526	3.946	0.901			
	CO4	-0.840	0.584	3.813	0.898			
	CO5	-1.028	0.863	4.363	0.906			
CI	CI1	-0.211	-0.870	5.925	0.930	4.272	0.958	0.958
	CI2	-0.289	-0.810	5.601	0.936			
	CI3	-0.174	-0.930	4.773	0.919			
	CI4	-0.254	-0.784	5.143	0.914			
	CI5	-0.300	-0.825	5.177	0.922			

Exploratory factor analysis (EFA) of the correlation matrix established the latent factors that explain the variability of the observed variables, and the results were used as an indicator of the validity of each construct analyzed. According to Brown (2015) instrument validity refers to the degree to which the instrument faithfully measures what it purports to measure. In the factor analysis, maximum likelihood estimation was used to extract the factor and Promax oblique rotation. Factor rotation is essential in EFA and is considered by many to be the most crucial tool in the interpretation of EFA (Lorenzo-Seva and Ferrando, 2019). In this study, a Promax rotation was chosen because, in addition to meeting distributional assumptions, it is less likely to generate inappropriate solutions or uncorrelated factors (Raykov and Marcoulides, 2008).

The first step in conducting an EFA involves assessing sample adequacy by calculating the Kaiser Meyer Olkin index (KMO). The KMO test provides a measure to determine whether the partial correlations between variables are small (Romero, 2020). Values above 0.7 are considered regular, meritorious if they are above 0.8 and very good if they are above 0.9 (Kaiser and Rice, 1974). Another method used to verify the feasibility of a factor analysis is Bartlett's test of sphericity. In this context, a factor analysis is feasible as long as the null hypothesis is rejected. This study reported a KMO value of 0.932 and a significant Bartlett's test of sphericity ($p <0.001$), confirming the applicability of factor analysis.

The second crucial step in an EFA is to eliminate non-significant factor loadings. Hair et al., 2014 suggest that the appropriate value of a factor loading is adjusted to the sample size. The study is based on 201 reliable surveys; therefore, factor loadings greater than 0.4 as recommended by Hatcher, 1994 were considered significant for the analysis. Factor rotation is essential in EFA and is considered by many to be the most important tool in interpreting the results (Hair et al., 2014).

After performing the EFA and applying the promax rotation, 6 constructs composed of a total of 30 variables with significant factor loadings were identified. Similarly, 78.15% of the total variance of the data was explained. It should be noted that the eigenvalues of all the components were greater than 1. To assess the reliability and consistency of our findings, we adopted a confirmatory approach. After performing the EFA, we conducted a Confirmatory Factor Analysis (CFA) using *SPSS ® and SmartPLS*. Multivariate normality and multicollinearity of the data were assessed, and outliers were checked. No problems related to the first two assumptions were detected and no additional surveys had to be eliminated from the analysis due to the presence of outliers. In summary, subsequent tests were carried out with 201 surveys. Table 2 shows the results of the factor structure of the 30 variables for the total sample.

Table 2
Factorial Structure of Constructs

Variables	Factors					
	1	2	3	4	5	6
CO1	0.807					
CO2	0.789					
CO3	0.811					
CO4	0.807					
CO5	0.821					
IE1		0.735				
IE2		0.755				
IE3		0.728				
IE4		0.760				
IE5		0.767				
B1			0.854			
B2			0.852			
B3			0.842			
B4			0.868			
B5			0.856			
CI1				0.866		
CI2				0.876		
CI3				0.844		
CI4				0.836		
CI5				0.851		
TL1					0.749	
TL2					0.729	
TL3					0.661	
TL4					0.704	
TL5					0.727	
CG1						0.569
CG2						0.674
CG3						0.633
CG4						0.698
CG5						0.725
Eigenvalues *(Eigenvalues)*	7.58	6.34	8.68	8.41	7.14	5.00
% Variance Explained	39.53	13.54	9.90	7.04	4.74	3.41
% Accumulated Variance	39.53	53.07	62.97	70.00	74.74	78.15

The validity of a measurement model is based on establishing acceptable levels of goodness-of-fit and finding specific evidence of construct validity. According to Hair et al., (2014) the use of three to four indices usually provides adequate evidence of model fit. Kline (2016) indicates that, when attempting to validate a measurement model, it is essential to estimate at least the following model fit indices: the static χ^2/df statistic, the root mean square error of approximation (RMSEA), the comparative fit index (CFI), the standardized root mean square residual (SRMR). From these perspectives, it is assumed that investigators should report at least one incremental and one absolute index, in addition to the χ^2 value and associated degrees of freedom. Therefore, estimation of the χ^2 value, the CFI or the Tucker-Lewis index (TLI) and the RMSEA will provide sufficient information to evaluate a model. Also, to compare models of different complexities, researchers can incorporate the normalized fit index (NFI).

The results of the confirmatory factor analysis (CFA) indicate an excellent fit, with an X^2/df of less than 2.0. In addition, the CFI and TLI values are greater than 0.9, the RMSEA value is less than 0.08 and the SRMR value falls below 0.05. These fit indices confirm the validity of the measurement model. The findings presented in Table 5 reveal that an NFI index of 0.922 indicates an acceptable level of complexity for the initial model. In addition, the R2 values for the main indicators CG, TL, IE, CO, CI and B range between 0.42 and 0.60. These results suggest that these six constructs can be used to evaluate the

critical success factors that influence the implementation of *WCM* in the automotive manufacturing industry in Mexico.

Convergent validity is commonly assessed using the Average Variance Extract (AVE) index. Generally, an AVE value greater than 0.5 indicates good convergent validity, confirming that a set of items are indicators of a specific construct Hair et al., (2014), by converging or sharing a high proportion of variance in common. In our study, Table 3 below presents the AVE values on the main diagonal of the matrix (in bold) for each construct or latent variable. It is important to note that all values are greater than 0.5.

Table 3
Correlations between constructs, average extracted variance and squared correlations squared

	B	GC	CI	CO	IE	TL
B	**0.82**[a]	0.29	0.27	0.36	0.18	0.24
GC	*0.54*	**0.58**[a]	0.04**	0.12	0.01**	0.04**
CI	*0.52*	*0.20***	**0.82**[a]	0.16[a]	0.41	0.39
CO	*0.60*	*0.35*	*0.41*	**0.76**[a]	0.09	0.32
IE	*0.42*	*0.08***	*0.64*	*0.30*	**0.69**[a]	0.06
TL	*0.49*	*0.21***	*0.62*	*0.56*	*0.24*	**0.65**[a]

*Note:*The values of the main diagonal with the symbol (a) correspond to the Average Variance Extract (AVE). Values in *Italic type* represent correlations between constructs, significant at p level <= 0.001. Values with the symbol (**) have non-significant values since they have p-values > 0.001. The values above the main diagonal are the squared correlations.

As for the internal consistency of the instrument, it was evaluated by estimating Cronbach's alpha (Cronbach, 1951). This coefficient helps to determine whether the different items or questions of a scale are related. Its values range from 0 to 1, with values closer to 1 indicating greater internal consistency. In this context, George and Mallery (2016) suggest relying on values above 0.7, as lower values could be questionable. According to the results presented in Table 3, all latent variables demonstrate adequate convergent validity, since all Cronbach's alpha values are greater than 0.872. These results were obtained using the SPSS program.

Discriminant validity measures the extent to which a construct is truly different from others. High discriminant validity provides evidence that a construct is unique and captures phenomena different from the others (Martínez-García and Martínez-Caro, 2009). One way to calculate this indicator is to compare the AVE values for two constructs with the squared correlation. The AVE must be greater than the squared correlation to confirm that the two constructs are independent of each other. Table 3 shows that the constructs have an AVE value greater than the squared correlation in all cases. This supports the discriminant validity of the constructs or latent variables.

Finally, nomological validity confirms that correlations between constructs in a measurement theory make sense. The correlation matrix provides information to identify how the constructs are related to each other. The results of the nomological validity test performed in this research are summarized in Table 4, where all the correlations between the constructs are positive and significant except for 3 cases where they were not significant because the *p* was greater than or equal to 0.001: CG-CI, CG-IE and CG-TL.

TABLE 4
Results of the Initial Structural Equation Model (SEM) Proposed

| Trajectory Analysis	Parameter estimates	Standard errors	T-values	P-values	Results
B	1.178	0.142	8.310	0.000	Accepted
GC	0.464	0.090	5.185	0.000	Accepted
CI	1.206	0.142	8.505	0.000	Accepted
CO	0.838	0.109	7.711	0.000	Accepted
IE	0.544	0.078	6.984	0.000	Accepted
TL	0.790	0.114	6.941	0.000	Accepted
CG <-> B	0.399	0.072	5.538	0.000	Accepted
IQ <-> B	0.615	0.101	6.086	0.000	Accepted
IC <-> GC	*0.149*	*0.060*	*2.488*	*0.014*	*Rejected*
CO <-> B	0.597	0.090	6.659	0.000	Accepted
CO <-> CG	0.220	0.054	4.047	0.000	Accepted
CO <-> CI	0.408	0.082	4.951	0.000	Accepted
IE <-> B	0.337	0.067	5.007	0.000	Accepted
IE <-> CG	*0.042*	*0.040*	*1.065*	*0.288*	*Rejected*
IE <-> CI	0.520	0.077	6.791	0.000	Accepted
IE <-> CO	0.203	0.055	3.717	0.000	Accepted
TL <-> B	0.471	0.084	5.594	0.000	Accepted
TL <-> CG	*0.128*	*0.050*	*2.555*	*0.011*	*Rejected*
TL <-> CI	0.608	0.091	6.655	0.000	Accepted
TL <-> CO	0.457	0.075	6.088	0.000	Accepted
TL <-> IE	0.157	0.053	2.967	0.003	Accepted

Note. Values in *italic type* represent rejected results with P-values >=0.001.

In order to propose a final structural equation model that describes the relationships between the significant variables, the relationships between the variables CI - CG, IE - CG and TL - CG were eliminated, since they did not show statistical significance. Figure 1 represents the final proposed model that includes only the significant variables, while Table 5 presents their Fit Indices.

Table 5
Final Model Fit Indices for Model Measurement

Statistical Adequacy of Fit	Recommended Values for a Satisfactory Model Fit		References		Initial Model	Final Model
X^2/df	-	Good fit: X2/df < 2	-	Bollen, 1989	1.120	1.133
TLI	- -	Acceptable fit: TLI > 0.90 Good fit: TLI > 0.95	- -	Hair et al (2014) Schumacker, 2015	0.990	0.989
IFC	- -	Acceptable fit: CFI > 0.90 Good fit: CFI > 0.95	- -	Hair et al (2014) Schumacker, 2015	0.991	0.990
RMSEA	- -	Acceptable fit: RMSEA < 0.08 Good fit: RMSEA < 0.05	- -	Browne and Cudeck (1993) Hair et al (2014)	0.024	0.026
SRMR	- -	Acceptable fit: SRMR < 0.08 Good fit: SRMR < 0.05	-	Steiger (1990)	0.039	0.070
NFI	- -	Acceptable fit: NFI > 0.90 Good fit: NFI > 0.95	-	Mulaik, James, Van Alstine, Bennett, Lind, and Stilwell (1989)	0.922	0.921

Figure 1
Final Proposed Structural Equation Model (SEM)
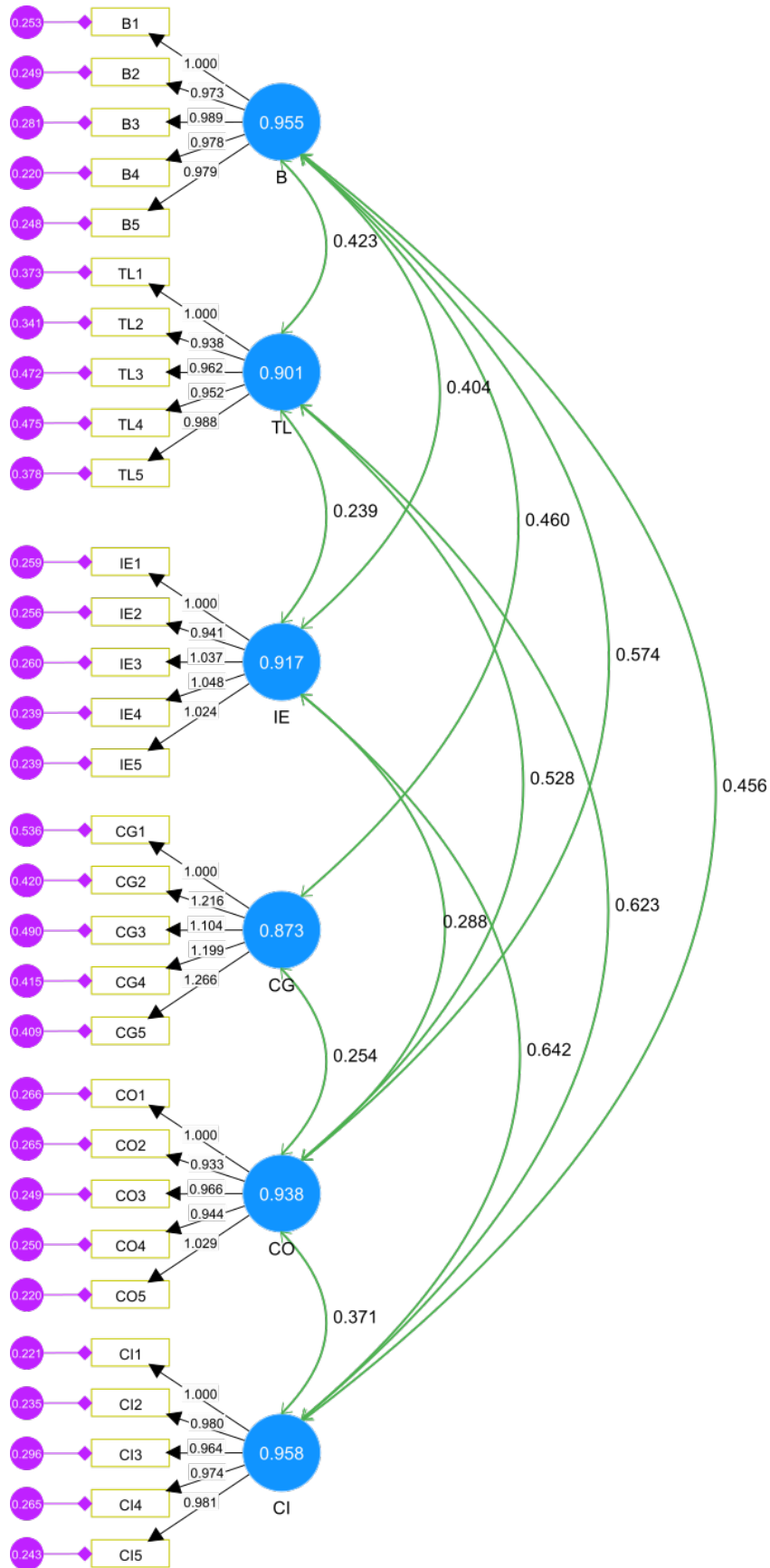
Discussion and Conclusions

The purpose of this research was to determine the critical success factors (CSFs) in the implementation of the *WCM* model in the automotive sector in Mexico, through the creation and evaluation of a data collection instrument (survey). The design of the instrument included the process of operationalization of variables, which allows direct measurement of unobservable variables through measurable indicators, as is the case of CSFs (Padua, 2018). Construct validity was assessed using the EFA, confirming that the items measured truly reflect the theoretical latent variables they were intended to measure. Finally, the study evaluated the three types of construct validity (convergent, discriminant and nomological), and each yielded a statistically satisfactory result.

During the validation of the instrument, the responses obtained were analyzed, making it possible to evaluate the perceived level of implementation of CSFs in the implementation of the *WCM* model in the sector studied. Table 6 presents the overall mean and standard deviation for each factor used to investigate the level of CSF implementation perceived by respondents.

Table 6

Critical Success Factor Ratings

Construct	Variable	Media	Standard Deviation (SD)	Average Mean	Average SD	Range
Integral competencies (IC)	CI-1	3.23	1.20	3.237	1.182	6
	CI-2	3.20	1.17			
	CI-3	3.23	1.20			
	CI-4	3.28	1.16			
	CI-5	3.24	1.18			
Type of leadership (TL)	TL-1	3.25	1.08	3.317	1.074	4
	TL-2	3.28	1.02			
	TL-3	3.39	1.10			
	TL-4	3.35	1.09			
	TL-5	3.31	1.08			
Management Commitment (GC)	CG-1	3.62	0.90	3.583	0.900	2
	GC-2	3.52	0.86			
	GC-3	3.61	0.92			
	GC-4	3.53	0.92			
	GC-5	3.63	0.90			
Employee Involvement (EI)	IE-1	3.38	1.00	3.320	1.043	3
	AR-2	3.31	1.06			
	AR-3	3.37	1.03			
	AR-4	3.28	1.04			
	AR-5	3.26	1.08			
The type of organizational culture (OC)	CO-1	3.80	1.05	3.745	1.026	1
	CO-2	3.75	1.00			
	CO-3	3.69	1.02			
	CO-4	3.70	1.00			
	CO-5	3.80	1.06			
Benefits (B)	B-1	3.28	1.20	3.245	1.190	5
	B-2	3.18	1.18			
	B-3	3.26	1.19			
	B-4	3.26	1.19			
	B-5	3.23	1.19			

The average values range from 3.245 to 4.745, with an average standard deviation of 1.07, indicating a good level of *WCM* model implementation. The information revealed

that the CSFs Organizational Culture Type (OC) and Managerial Commitment (MC), with values of 3.745 (±1.026) and 3.583 (±0.9) respectively, were considered the most relevant factors in the implementation of the *WCM* model. In third and fourth place were the employee involvement factor (EI) and the leadership type (TL), with values of 3.32 (±1.043) and 3.317 (±1.074) respectively. Finally, respondents perceived CSF Benefits (B) and comprehensive competencies (CI) to have the least influence during *WCM* model implementation, with values of 3.245 (±1.19) and 3.237 (±1.182) respectively. It is important to note that the six factors were considered by the respondents as "always" and "almost always", that is, as elements usually present in the implementation of this type of improvement projects.

The research results revealed that Organizational Culture (OC) emerges as the most prominent Critical Success Factor (CSF) compared to the other factors analyzed. Organizational culture has proven to be a fundamental element for the successful implementation of continuous improvement processes (Akpa et al., 2021). Characteristics such as cohesion, shared values, and adaptability stand out in organizations that have achieved successful implementation in previous studies Quinn and Cameron (2019). The advantage of a strong CO is reflected in goal alignment, proactive behaviors, and reduced resistance to change (Paais and Pattiruhu, 2020). These findings support the importance of Organizational Culture in the context of *WCM* implementation in the Mexican automotive sector.

Management Commitment (MC) stands out as a very important CSF, according to the ranking derived from the factor analysis, being an essential component for the success of *WCM* implementation. Distinctive features of effective managerial engagement include appropriate resource allocation, active leadership, and consistent involvement in project phases (Bravo and Cassano, 2019). Previous studies have shown that top management commitment creates an environment conducive to the adoption of transformational practices, generating an organizational culture aligned with the principles of the model (Vega, Fuentealba, & Patiño, 2016). Observed benefits range from improved operational efficiency to a boost in employee motivation and engagement (Flores and Cervantez, 2018). These results underline the relevance of Management Commitment in the success of *WCM* initiatives in the Mexican automotive sector.

According to the respondents the next relevant factor of the research was Employee Involvement (EI), being one of the essential components to achieve success in *WCM* implementation. The active participation of employees in continuous improvement processes, the generation of innovative ideas and organizational adaptability to operational changes are elements that create an environment conducive to innovation and organizational flexibility, thus supporting the success of transformation models (Tuuli and Rowlinson, 2009). Other key features of effective engagement encompass open communication, encouragement of active participation, and promotion of feedback between employees and management (Pujol-Cols, 2018). These aspects not only strengthen internal collaboration, but also contribute to building a dynamic organizational culture that is receptive to continuous improvement (Vila et al., 2020). According to Gonzalez, Pozo, Grob and Quijada (2021) positive interaction between employees and management not only benefits the implementation of efficient processes, but also enhances the organization's ability to adapt and thrive in a dynamic environment. The benefits range from increased creativity and identification of improvement opportunities to a strengthened sense of employee ownership and commitment.

In the context of the implementation of the *WCM* model in automotive organizations in Mexico, the Leadership Type (TL) emerges as one of the most outstanding CSFs. The literature on leadership reveals its breadth and complexity,

generating considerable interest and recognizing its fundamental role in organizations (Jiménez, 2010). The emotional intelligence approach highlights the relevance of understanding and managing emotions to achieve effective leadership results (Goleman, Boyatzis and Mckee, 2002). Previous studies have identified diverse leadership styles, including visionary and personal, particularly evident in female leaders, highlighting their ability to lead change (Changúan, Parrales, Higuera, & Cadena, 2020). In addition, the importance of styles that balance well-being and organizational objectives is highlighted (Campos, Morcillo, Rubio and Celemín, 2020). Authentic leadership, characterized by faithfulness and transparency, has gained attention and is associated with virtuous organizations (Villafuerte and Lupano, 2020). Leadership, shared by leaders and followers, is presented as essential in continuous improvement initiatives, as it influences the success of such initiatives (Kuei, Madu and Lin, 2001). According to Eckes (2001) improvement initiatives fail due to weak project leadership and management skills, so commitment, effective communication, project participation, selection and evaluation ensure the achievement of goals and objectives.

Integral competencies (IC) stands out as the CSF with the lowest weighting in the implementation of the *WCM* model according to the respondents. Organizational competencies, fundamental to success, evolve over time and require commitment to continuous learning (Khandii, 2021). Previous studies underline the essentiality of technical, conceptual and human competencies for successful leadership (Robbins and Coulter, 2004 and Koontz, Weihrich and Cannice, 2014). While conceptual competencies involve strategic thinking, human competencies focus on interpersonal skills crucial to assessing, guiding and leading teams (Vitaza, 2020). Effective communication, adaptability and commitment are key to human competencies, fundamental for a healthy work environment and achievement of objectives (Van-der-Hofstadt-Román and Gómez-Gras, 2006). IQ, enriched by skills in strategic management, teamwork, effective communication and decision making, is presented as a fundamental pillar for successful, competitive and transformational leadership (Cavagnaro and Carvajal, 2020; Araneda-Guirriman, Neumann-González, Pedraja-Rejas, and Rodríguez-Ponce, 2016).

This research study succeeded in meeting the objective of examining the relationship between the Critical Success Factors of *WCM* and the achievement of the objectives, as well as its effective implementation in the analyzed sector. However, there are two fundamental limitations to this work. First, the survey focused exclusively on the automobile manufacturing sector of the Mexican manufacturing industry. Nevertheless, it is considered that the instrument could be applied in other industrial sectors in different countries with conditions similar to those in Mexico. However, it is recommended that the validity of the instrument be verified and adjusted if necessary before using it in sectors other than those for which it was originally designed and validated. Second, the Critical Success Factors considered for the development of the instrument were derived from a comprehensive literature review and evaluation by *WCM* experts in the automotive sector. Therefore, it is likely that there are Critical Success Factors that influence other sectors with different levels of maturity in manufacturing processes and technology if different industrial areas are analyzed.

As future research possibilities, the authors are interested in exploring the structural relationships between WCM implementation and the benefits obtained by developing them in other industrial sectors. The survey developed in this study can be used in other manufacturing industries with similar characteristics; therefore, the authors will seek to apply and validate the instrument in other manufacturing sectors

manufacturing sectors in the nation with the objective of supporting, through the WCM model, the strengthening of industrial competitiveness.

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