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Application of structural equation modelling to analyse the impacts of logistics services on risk perception, agility and customer service level

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ABSTRACT

Logistics services of manufacturing enterprises help to improve transport, delivery of materials and finished products. This paper presents a causal model to identify the influence that has the availability of logistics services on the risk perception, on agility and on customer service level of manufacturing companies. A questionnaire was developed, validated and applied to 225 employees of different industrial sectors. Information is integrated in a structural equation model for test seven hypotheses using partial least squares to calculate the regression coefficient between variables using 95 % confidence level. The results mainly indicated that the availability of logistics services have a positive and direct effect on risk in demand and in supplier's risk; but in addition, agility and transportation also have effects over them. All these variables have direct or indirect contributions on customer service level and can explain 45 % of its variability. On the other hand, it is also identified that transportation performance has a direct effect on agility 0.42 standard deviation units. Findings in this paper demonstrate quantitatively through a statistical analysis the importance of infrastructure for logistic services available in the regions, the role of transportation and its impact on risk in suppliers and agility, and how customer services can be improved increasing supply chain agility and diminishing the risk in demand.

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1. Introduction

Amid economic globalisation and the increasing complexity of economic relationships, companies currently require certain methodologies and techniques to improve and defend their positions within a global market [1]. Nowadays, the abilities to respond to challenges such as the continuous and rapid changes in customer demands, and remain competitive are critical success elements for modern organizations. Supply Chain (SC) is a network of companies interconnected by different kinds of flows: financial, materials, and information between suppliers to customers. Therefore, these organizations depend on their modernisation and globalisation to increase their competitiveness [2]. In this manner, they focus on mastering changing markets by being

competitive in on-time product delivery at low costs and high quality with short cycle times. That is, they still seek high levels of customer service.

The goal of SC is to manage the selection of material resources, suppliers, manufacturing process, delivery of products to the end user in such a way that products will move through the network of business activities in the small period and with least input. However, the achievement of this goal requires of assessing the connection between logistics services and suppliers in order to detect potential flaws that may compromise supply chain performance (SCP). Moreover, it can be said that under current conditions, practically there is no company in the world that can be operating in a complete secure environment. Risks have become the main concern in logistics and business processes [3]. From this perspective, SC risk is viewed as a number of unreliable and uncertain resources creating interruption, whereas uncertainty can be explained as matching risk between supply and demand in SC processes [4], and it tends to affect SCP. The stability of the SC depend of capacity of disruption classification to implement corrective actions in time [5], that improvement their results. Risk in demand is perhaps the most serious risk. It arises from volatile demand or inaccurate forecasts. In addition, the greater the risk in SC is, the poorer its performance becomes (inventory costs, lead time, agility, flexibility, and customer service). Hence, communication and the integration of suppliers with manufacturing companies are critical to make appropriate changes in costumers' needs and achieve high levels of customer service [6]. Similarly, to integrate all processes in a SC offer different opportunities of businesses, nevertheless this may imply many challenges, such as the establishment of key risk management objectives [1]. The key element, however, in on the flexibility and agility of all processes, and a modest idea of current state involves even a resilient focus on cooperative and integrative activities under the endowment of a better monitoring and connection through infrastructures of communication and information technologies (IT) [7].

First, flexibility is becomes an important instrument of competitiveness in global market and according Christopher [8] it constantly increases the number of organizations that choose it as mechanism of competitiveness [7]. Similarly, recent decade tendencies show that customers are demanding for wider variety of goods proposed and further possibilities for individual satisfaction of needs [9]. These challenges force organizations to become more flexible, adapt not only to global market in regard to prices and term, but to adapt to the changing demand in the market also. The most common direction of the research in this field is to evaluate flexibility of process in coordination within SC, especially in practical level. Flexibility is contextualized as the ability that have the companies to adjust to changes of market to produce diversity of products, high levels of production volume, or specific designs [10]. SC flexibility implies to produce different and new sophisticated non-standard products corresponding particular needs of consumers; to produce the orders for different volumes, i.e. management of output volumes; to use alternative methods by transferring all instruments needed for future work to the adequate location; to be adapted to the changes while transferring is being made; to supply the available products to the consumer. SC flexibility is the ability to satisfy consumers' needs and expressed as the possibility to supply different products, production quantities, and variety of new products and availability of products to consumer as response to market demand, with the purpose of acquire or preserve competitiveness. Often SC agility is described as ability to respond to short-term changes of demand or supply. In the other hand, the concept of agility was originated in the manufacturing sector in the early decade of 1990. It is defined as "the ability of a company to rapidly adjust tactics and operations within their SC and respond or adapt to changes, opportunities, and threats in their environment"[6]. Additionally, SC agility is as ability of a firm for handling the changes of volume and variety of products to satisfy the customer demand [11] , and was tightly associated with the effectiveness of strategic SC management in the competition among supply chains, rather than entities. The agility has two dimensions, alertness to change and response capability, at three levels: strategic, tactic and operational. Constantino *et al*. [12] defined it as a network of diverse companies integrated by materials, information, and financials flow, and focused on add value to improvement the flexibility and SCP. On the one hand, improving agility demands the contribution of information, communication, and coordination through information systems,

infrastructure, and availability of logistics services [7]. In this manner, transportation and logistics services by themselves are also important for competitiveness; thus, their impact must be assessed. Studies have evaluated different types of logistics services, such as road, railway, air, and maritime, including the analysis of costs in transport infrastructure, business services, and telecommunications. The availability and quality of these services have become important factors in the development of competitive strategies, although it has been proved that customer service is also crucial for the economic development of any region [13]. One critical components to effectiveness of logistics services is the support given by the information technology systems, since they is possible that have impacts on logistics operations. For instance, they facilitate cooperation and collaboration among SC partners and enable the automation of many logistics routine activities; these factors have been analyzed in different companies [14].

However, there is still a lack of empirical studies regarding the impact of availability services and transportation on SC agility in maquiladoras. Maquiladoras are, in fact, a type of company exports its finished products but imports raw materials and/or components from other countries. In Mexico, they share a highly competitive manufacturing platform with the United States of America and Canada [15]. Moreover, during the last 45 years, Mexican maquiladoras have become an important element to the economy of Mexico. The structure of this type of companies is that they belong to a global SC, so the requirements for improvement in the logistics and operations processes are high. Therefore, to contribute to the discussion of the impact of logistic services level on SC performance, this paper seeks to measure the influence of availability of logistics service on risk in supplier and risk in demand, agility and customer service level.

2. Methodology

2.1 Questionnaire and survey design

As methods, a questionnaire for gathering data was designed. It includes four major sections, and based on the research findings described by Bhatnagar and Sohal [7]. According activities and SC benefits in manufacturing industries operating in Asian countries like Singapore, Malaysia, Brunei, Indonesia, Philippines, and Thailand were listed. These activities include: evaluation of risk in demand, evaluation of risk in supplier, evaluation of logistics services, and transportation. Additionally, the most relevant benefits obtained from these activities respect to results of agility and customer service were also identified. The proposed questionnaire was adapted to identify similar elements in manufacturing industries of other countries including Mexico with the purpose of finding results about their performance and needs of improvement and development.

Selection and identification of the activities and elements of performance

Once a literature review was accomplished, the elements and the activities from logistics services, risk in supplier and risk in demand were identified. On the one hand, the elements of performance were determined and Table 1 shows the four elements surveyed. They were analysed as independent latent variables and include *Logistics services* (LSer), *Transportation* (Tran), perception of *Risk in demand* (DRisk), and *Risk in supplier* (SRisk). The same table also introduces the activities related to these elements and the literature that has addressed to them. However, these activities were adapted to the context of the research and validated for others authors since they come to an agreement on the importance of the same activities; the items related with the risk in suppliers (SRisk1, SRisk2, SRisk3, SRisk4) also are shown to evaluating contributions in SCP as well Bhatnagar and Sohal [7]. On the other hand, Table 2 introduces the benefits surveyed: agility (Agil) and customer service (CSer). The literature focusing on these benefits is also included in the table (brackets), i.e. customer service in terminus of complete orders, best rate of complete orders, and timely responds to customer needs. On the other hand, Table 2 also includes agility as an aspect of supply chain performance Finally, since some of the items of the

questionnaire to assess the availability of logistics services in the region, to considered it as regional elements to increases competitiveness of firms established in a given city or region.

In addition, the questionnaire contains one section about demographic data of participants, this helps identifying the industrial sector and other characteristics of the studied population and characteristic of the sample. Items were integrated in questionnaire, and a response validation was carried out to ensure their understanding. Hence, a preliminary test was administered to managers, supervisors, and academics, and it was responded in a Likert scale for subjective assessments, with a rating range from of 1 to 5; moreover, items of Table 1 and Table 2 defined the hypotheses proposed for the model shown in Figure 1, which are the corresponding items to latent variables from structural model (causal model). Some authors have relied on this scale in their studies of SC environments [26].

Table 1 Items of the construct of "Logistic activities"

Risk in Supplier (SRisk)	a	e	f	g	h	i	j
(SRisk1) My suppliers always deliver on-time orders.	x	x	x	x	x		x
(SRisk2) My suppliers always deliver complete and accurate orders.	x	x	x	x	x		
(SRisk3) My suppliers always deliver products according to quality standards.	x	x	x	x	x		
(SRisk4) My suppliers always remain in communication to reduce failures.	x	x	x	x	x		
Risk in Demand (DRisk)							
(DRisk1) Demand is always communicated in advance to the company by…	x					x	x
(DRisk2) Demand is transmitted by clients through real-time information systems…	x					x	
(DRisk3) Demand is visible in real time for both the company and its suppliers.	x					x	
(DRisk4) Demand for the finish product is stable and does not affect the demand…	x					x	
Logistics Services (LServ)							
(LServ1) Availability of air, road, maritime, financial, and legal services, and…	x			x			
(LServ2) Quality of air, road, maritime, financial, and legal services and…	x			x			
Transportation (Tran)							
(Tran1) Costs from raw materials and products transportation are low.	x						
(Tran2) Transportation units with satellite tracking systems have improved delivery	x						
(Tran3) Quality of transportation has improved in the last 3 years thanks to…	x						

a:[7]; b:[13]; c:[16]; d:[14]; e:[17]; f:[18]; g:[19]; h:[20]; i:[21]; j:[22]; k:[23]; l:[24]; m:[25]

Table 2 Items of the dimensions of the questionnaire correspond to benefits of performance

Agility (Agil)	a	b	c	d	h	i	k	l	m
(Agil1) Time for product development has improved in the last 3 years…	x	x	x			x	x		
(Agil2) Time management has improved in the last 3 years in relation…	x	x	x			x	x		
(Agil3) The company effectively responds to unexpected customer…	x	x	x			x	x		
(Agil4) Levels of product customisation have increased.	x	x	x			x	x		
(Agil5) The company meets the delivery capabilities required by the…	x	x	x			x	x		
Customer service (CSer)									
(CServ1) In general, the company has successfully completed orders in…	x			x	x		x	x	x
(CServ2) In comparison to other companies from the same industrial sector…	x			x	x		x	x	x
(CServ3) Company timely responds from customer needs.	x			x	x		x	x	x

a:[7]; b:[13]; c:[16]; d:[14]; e:[17]; f:[18]; g:[19]; h:[20]; i:[21]; j:[22]; k:[23]; l:[24]; m:[25]

2.2 Survey administration and data collection

The sample for this study was stratified, and it mean considered only the 326 (in 2017) maquiladoras established along the Ciudad Juarez. Then, a simple random sample of companies was selected as potential participants. The application of questionnaire was support by "University's APICS-UACJ chapter", and was done using three strategies to administer it; first, personal interviews were carried out; second, participants also had the opportunity to receive the document by their email, and finally, the questionnaire administration through an online specialized platform where the proper the link was sent to the respondent also by email.

2.3 Data capturing and validation

Information obtained was captured and analyzed by using software SPSS 21®. This was made to develop a descriptive analysis of the information about, gender, industrial sector, experiences of participants, etc. Missing values were detected and substituted by the median value of items, since data were obtained of an ordinal scale [26]. Also, outliers or non-typical values were identified to standardize every variable and internal consistency or reliability of every latent variable was assessed by using Cronbach's alpha and composite reliability indexes, considering a cutoff values of 0.7 for both [27]. However, some tests were additionally performed to improve reliability of the dimensions. Moreover, the average variance extracted (AVE) index was used as an indicator of both discriminant and convergent validity, using an acceptable value of 0.5 [28]. However, correlations among latent variables were also considered to assess convergent validity. Furthermore, full collinearity or the variance inflation factor (VIF) was employed to detect possible collinearity issues among latent variables. The rule of thumb of using a value of 3.3 as the maximum value was applied, although some authors suggest some higher than 10; Q^2 coefficient was used to assess nonparametric predictive validity (or relevance) with 0 as the minimum acceptable value.

2.4 Proposal and evaluation of structural equation model

This research seeks to analyse the impacts among the latent variables shown in Figure 1, which are measured by several items (Table 1 and Table 2). With structural equation modelling is possible to find a causal relationship between them and determine the contribution rate for each variable include in the model. The following paragraphs explain the justification for the formulation eighth hypothesis shown in the Figure 1, and graphically summarizes the proposed model. Transportation is a main part of the logistics processes and in the proper supply chains management. The main reason is because due to the fact that flows of products are globally shared and involves multiple companies. In this sense, the performance of the transportation is a key element for a good SCP. When failures or interruptions occur during the *Transportation* elements due to different causes that temporarily stops the passage of materials or products affecting the SCP [28], there will be a major perception of *Risk in Supplier*. The *Transportation* should encompass not only operations efficiency parameters, but also measures of service effectiveness to meet the goals of all parties, parties involved in the transportation logistics processes and the overall SCP. From this viewpoint, we propose three hypotheses to *Transportation* (Tran):

H1: The *Transportation* performance has a direct and positive effect on *Risk in Demand* (DRisk).
H2: The *Transportation* performance has a direct and positive effect on *Agility* (Agil).
H3: The *Transportation* performance has a direct and positive on *Risk in Supplier* (SRisk).

Logistics services, such as road, railway, air, and maritime, including the analysis of costs in transport infrastructure, business services, and telecommunications are important aspects to achieve competiveness and to improvement SCP [13]. These elements can be made up from an infrastructure perspective to improve of communication among companies. It required that companies and managers consider the ability to achieve effective communication with its suppliers and customers through the technologies used; this is the bottom line for promptly to reducing risk perception. It is also in line with the assertion that external integration with key

suppliers is conducive to agility [11]. In this sense, two hypothesis are proposed regarding *Logistic services* (LServ):

H4: The *Logistic services* have a direct and positive effect on *Risk in Demand*.
H5: The *Logistic services* have a direct and positive effect on *Risk in Supplier*.

Risk sometimes is understood as unreliable and ambiguous resources that creates SC interruptions, whereas uncertainty can be explained as matching the risk between supplier and demand in SC processes. The risk in: supplier, information flow, material flow and product flow, are focusing on a specific function or as a part of a SC, and do not span across the entire chain. Risks affecting suppliers and also affecting customers [22]; i.e. risk in demand, logistics risk, risk in supplier and risk in transportation [16]. Additionally, SC agility creates value within firms through the cost efficiency, which can be achieved through logistics activities to enhance profitability, sales turnover, and customer satisfaction [29, 30]. The manufacturers SC agility should seek for opportunities for operational collaboration and management practices and strategies to performance [31] with their potential partners, such a relational factor is a driving force of satisfaction and performance with their suppliers. From this perspective, three hypothesis are proposed:

H6: The *Risk in Supplier* has a direct and positive effect on *Agility* (Agil).
H7: The *Risk in Demand* has a direct and positive effect on *Customer service* (CServ).
H8: The *Agility* has a direct and positive effect on *Customer Service* (CServ).

In order to determine the model´s fit indicators, the proposed hypotheses in Fig. 1 had to be validated by considered the direct effects between latent variables (arrows directly connecting) and estimated P-value. *Agility* and *Customer Serv*ice are SCP elements, and they derive from the interaction between *Logistics services*, *Transportation* and *Risk in Supplier* and *Risk in Demand*. To test hypotheses shown in Fig. 1, we used structural equation modelling in WarpPLS 5.0 software. This is based on partial least squares (PLS) algorithms, and it is widely recommended for small-sized samples [32]. Therefore, execution conditions were made by the WarpPLS4 algorithm with bootstrapping as resampling method for better convergence coefficients. Likewise, the Adjusted R-squared (Adjusted R^2) and Average Path Coefficient (APC) were the indices used to validate the model. On the one hand, ARS determined the model efficiency and APC determine the predictive validity with maximum cutoff P -value lower than 0.05. Also, the index Average block Variance Inflation Factor (AVIF) was analyzed to measure collinearity among latent variables, the rule of thumb was 3.3 as the maximum value [33], while Q-squared (Q^2) coefficient was used to assess nonparametric predictive validity (or relevance) with 0 as the minimum acceptable value. In order to determine the model's fit, the proposed hypotheses had to be validated by considered the direct effects between latent variables (arrows directly connecting) and their estimated P-value. Afterwards, indirect effects between variables were measured (given between two latent variables through a third path or more), also total effects (sum of direct and indirect effects). The significance of every effect was measured using its P-value, and the equations to the null hypothesis: βi equal to 0, and the alternative hypothesis: βi different to 0. Every hypothesis were tested using a confidence level of 95 %, and it could be included in the final structural model. The β value represents the relationship between variables and indicates a unit change in the dependent variable [34].

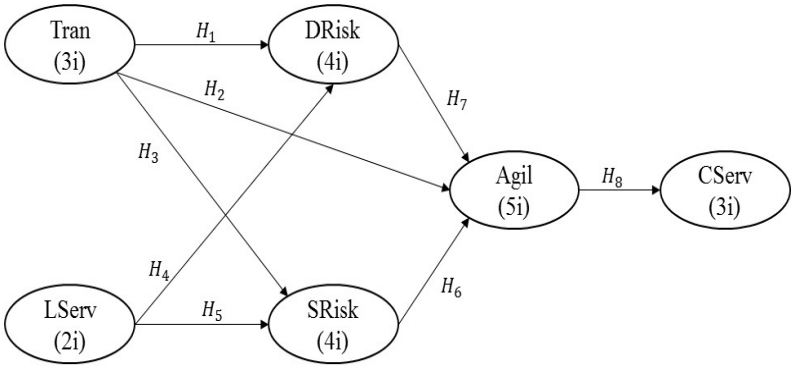

Fig. 1 Hypotheses from the relationship proposer in the model

3. Results and discussion

3.1 Sample description and analysis

After completing the process of data collection, it can to achieve the participation of 65 companies and 225 valid questionnaires were considered as a representative sample. Table 3 presents the results concerning the gender of respondents as well as the industrial sector of the surveyed companies. For instance, 156 participants were man and 58 were women. Also, 54 respondents worked in electronic sector, 39 in medical sector, and 67 in automotive sector. Please note that 11 participants did not specify their gender or job sector, this amount corresponding to 4.88 % of whole sample.

Table 4 presents the details of work seniority (expressed in years) and job position of respondents. First it can be observed that 46 participants have experiences level more than ten years in their current job positions, while the remainder (90 participants) reported between 4 and 10 years. Unfortunately, 20 individuals did not provide this information. Additionally, it can be observed the 54 held managerial positions, these participants represent 24 % of the complete sample size. Table 4 showed merely three participants worked as operation directors, while 11 did not report such information. It can be seen that both managers and planners have over two years of experience, and in some cases up to ten years, this indicates a good level of knowledge among respondents; and that the sample was composed mostly by individuals well informed about with SC.

Table 3 Gender of participants and industrial sector

Industrial Sector	Gender			Total
	Male	Female	Unspecified	
Automotive	45	21	1	67
Medical	24	12	3	39
Plastics	5	1	0	6
Metals	3	3	0	6
Electronic	43	9	2	54
Packing	2	0	1	3
Communications	0	1	1	2
Services	9	1	0	10
Others	19	9	2	30
Consumables	6	1	1	8
Total	156	58	11	225

Table 4 Positions and work experience of participants

Job	Years						Total
	0-1	2-3	4-5	6-10	>10	Unspecified	
Director	0	0	1	1	1	0	3
Manager	3	11	12	10	17	1	54
Engineer	4	2	4	6	2	0	18
Supervisor	4	16	5	6	8	1	40
Specialist	3	1	1	3	1	0	9
Technician	6	3	7	2	6	0	24
Operator	1	2	2	1	0	1	7
Planner	3	17	11	12	7	0	50
Unspecified	1	1	2	4	4	8	20
Total	25	53	45	45	46	11	225

3.2 Data reliability and validation

Table 5 presents the indexes of validation for latent variables in the model. From evaluation the reliability was considered the standardized loadings of every individual item of the questionnaire. According the values of Table 5, the information gathered is valid and can be used for its interpretation, are accepted since the values obtained are greater than 0.7, a recommended value to evaluate the internal consistency of the items in a construct (Cronbach Alpha Index: CAI), in addition, also the values showed an AVE higher than 0.5, these values confirm the discriminant and convergent validity presents in the questionnaire. The values for R-squared (R^2) are bigger than 0.15, which indicates predictive reliability, and Q-squared (Q^2) coefficients were similar to R^2 coefficients and upper than zero, hence indicating nonparametric predictive validity. On the other hand it can be seen that there is no evidence to declare collinearity among variables, because the results of the VIF are lower than the cutoff of 3.3 (maximum acceptable value for this research); all values in Table 5 are below to 2.

Table 5 Validation index of latent variables

Index	LServ	CServ	SRisk	DRisk	Agil	Tran
R^2 coefficients		0.451	0.158	0.164	0.282	
Adjusted R^2 coefficients (AR2)		0.446	0.150	0.157	0.276	
Composite reliability	0.941	0.857	0.888	0.888	0.909	0.848
CAI	0.874	0.750	0.831	0.831	0.874	0.730
Average variance extracted (AVE)	0.888	0.667	0.665	0.665	0.666	0.652
Full collinearity (VIF)	1.131	1.826	1.387	1.453	1.973	1.315
Q^2 coefficients		0.454	0.156	0.164	0.278	

3.3 Analysis and results: Structural equation model

The model validation and the fit indexes appear in Table 6. The whole model with the following values: APC = 0.305 with a P-value < 0.001, ARS = 0.264 with a P-value < 0.001, and an AVIF = 1.092, which was acceptable, since it was lower than 3.3. Finally, Tenenhaus GoF index for causal model achieved was 0.430, and this value is considered as large fit because is major to 0.36, for this index is recommended as minimum acceptable value 0.10. Note that the GoF index evaluates the goodness of fit of model about data provided. Therefore, it can be said that the adjustment of the data in relation to the proposed model is good, that because such relationships between variables happen in reality within companies as they are considered important for higher profits financial enterprises.

Table 6 Efficiency indices structural model

Index	Value	Decision
Average path coefficient (APC)	0.305	P < 0.001
Average R^2 (ARS)	0.264	P < 0.001
Average adjusted R^2 (AARS)	0.257	P < 0.001
Average block VIF (AVIF)	1.092	Ideal <= 3.3
Average full collinearity VIF (AFVIF)	1.514	Ideal <= 3.3
Tenenhaus GoF (GoF)	0.430	Large >= 0.36

Direct effects: they are causal relations basics or relations of variation that involving two variables. The direct effects are those that directly influence of one variable over another [35]. Figure 2 illustrates the causal model and the effects findings in the relations proposed and evaluated. That is, every segment has a dependence β value and a P-value from the significance test. It can be observed that dependence among variables initially proposed is valid, since every P-value is lower than 0.01. For example, these values of P-value indicate that the parameter evaluated is different of zero and, consequently, β is significant. The aforementioned indexes hence demonstrated that the model was valid and could be interpreted. For instance, according to Figure 2, the relationship between the *Transportation* (*Tran*) and *Agility* (*Agil*) has a dependency measure of β = 0.42. This means that when the first latent variable increases its standard deviation by one unit, the standard deviation of the second latent variable also increases by 0.42 units. Since it is a high-dependency relationship, it can be concluded that the appropriate *Transportation* of materials and products is crucial to increase SC *Agility*. The biggest β parameter among variables is given between SC *Agility* and *Customer service* with β = 0.58 and a P-value < 0.001, these values indicate that exits a high dependence among both variables, and it means that while response giving the companies to improve and promote agility activities on SC, they will provide higher levels of service to their customers. All direct relationships can be similarly interpreted. Moreover, note in Figure 2 that all dependent latent variables show a R^2 value. This value indicates the percentage of their variance that can be explained by other independents latent variables. For example, the dependent variable *Agil* has a R^2 = 0.28, and this is the extracted variance by the *Transportation* (*Tran*) and perception of *Risk in Demand* (*DRisk*). There is the 28 % of variance extracted to *Agil* is explain only from *Tran* and *DRisk*. Likewise, dependent latent variable about the *Customer service* (*CServ*) has R^2 = 0.45, indicating that SC *Agility* (*Agil*) is 45 % responsible of its variance; it is the highest value in R^2. This means that with an increment of standard deviation by 1 unit in *Agil* and in *DRisk* is possible improvement CSer; which is important because the elements create up these variables.

Indirect effects: they are causal relationships that involve the presence of three or more variables. There is an indirect relationship among two variables when a third modulates the effect between the first two, i.e., when the effect between the first variable and the second passes through the third. The existence of an indirect effect among two variables does not cancel out the possibility that there is likewise a direct influence between them.

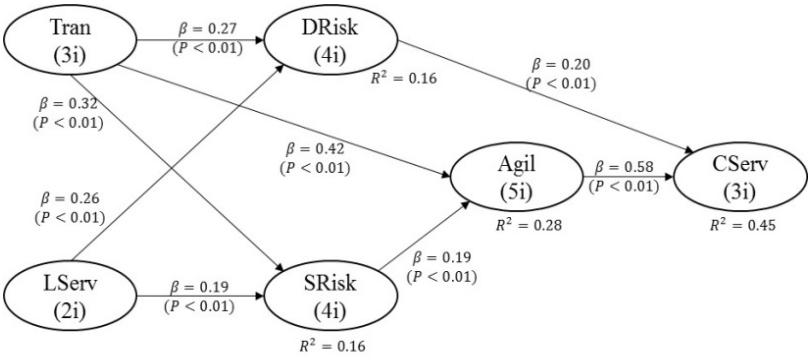

Fig. 2 Structural equation model final and significant relationships found

Indirect effects to one, two and three segments: For instance, based in the Figure 2, there are three indirect effects between latent variables *Logistics services* (*LServ*) and *Customer service* (*CServ*) given though *Risk in Supplier*, *Risk in Demand* and *Agility* (*SRisk*; *DRisk; Agil*) respectively. This indirect effect occurs through three segments.

Table 7 also there is an indirect effect between the *Transportation* (*Tran*) and customer service (*CServ*), corresponding to indirect effect of two segments. Initially, the indirect effect of this relationship is given by only one segment: either perception of *Risk in Demand* (*DRisk*) or *Agility* (*Agil*); finally, the relationship between *Transportation (Tran*) and *Customer service (CServ)* occurs through two segments: *SRisk* and *Agil*. The result of this effect is the sum from both indirect effects (one and two segments); first, is multiplied the effect between *Tran* and *Agil* (0.420) with the effect between *Agil* and *CServ* (0.581), that is, (0.581 × 0.420 = 0.244); second, is multiplied the effect between *Tran* and *DRisk* (0.272) with the effect between *DRisk* with *CServ* (0.201), that is, (0.271 × 0.201 = 0.054); and with the values finding the result is 0.244 plus 0.054, obtained a value of 0.299 showed in Table 7. The indirect effects to three segments are calculus similarly, but it considering other variable; for example, the indirect effect of *Logistics services* (*LServ)* in *Customer service* (*CServ)* is given for perception of *Risk in Supplier (SRisk)* and the *Agility* (*Agil)*. The result of this is the multiplication of all effects: *LServ* on *SRisk*, *SRisk* on *Agil*, and *Agil* on *CServ* (0.188 × 0.194 × 0.581, respectively), and obtained a value of 0.0211 shows in Table 7 (marked). Additionally, Table 7 presents the indirect effects for every relationship between latent variables as well as their P-values for the significance assessment and also displays the results of indirect effects for two and three segments. These effects are calculated by multiplying each contribution of the variables involved in the chosen path. For example, the *Risk in Supplier (SRisk)* has an indirect effect of 0.113 to *Customer service (CServ)*, which is by an effect of *SRisk* to *Agil* with value of 0.194, and another effect of *Agil* to *CServ* with value of 0.581 (0.194 × 0.581 = 0.1127, approx. 0.113). The value for this effect indirect is marked whit gray and corresponding to indirect effect of two segments. Since the relationship has a value of 0.113, it is implied that when the *Risk in Supplier* (*SRisk*) increases its standard deviation by one unit, the standard deviation of *Customer service* (*CServ*) rises by 0.113 units. Thus, it is proved that the reduction of *Risk in Supplier* improves *Customer service* and thus satisfaction. Likewise, low perception of *Risk in Supplier* helps prevent production stoppages due to a lack of raw materials. Thus, greater *Agility* is achieved.

Sum of indirect effects: Figure 2 shows that *Risk in Supplier* (*SRisk*), perception on *Risk in Demand* (*DRisk*), and *Agility* (*Agil*) are responsible for this indirect relationship, which has sum total of 0.335 illustrates in Table 8. That is, they are the indirect effects among the *Transportation* (*Tran*) and *Customer service* (*CServ*). In two cases, the indirect effect of this relationship is given by only one segment: either *Risk in Demand* (*DRisk*) or *Agility* (*Agil*). However, in the third case, the relationship among *Transportation (Tran)* and *Customer service (CServ)* occurs through two segments: *SRisk* and *Agil*. In the end, value 0.335 is obtained of sum 0.036 and 0.299, corresponding to both indirect effect two and three segments of *Tran* on *CServ* of Table 8. This relationship indicates that when the *Transportation* increases its standard deviation by one unit, the standard deviation of *Customer service* also increases by 0.335 units. This reveals that the appropriate *Transportation* of materials and products is a crucial aspect to reduce *Risk in Demand* and in *Supplier*, and to increase *Customer service* level.

Total effects: Is the result of adding direct and indirect effects. Table 9 presents total effects for the relationships among the variables. For instance, the total effects between the *Logistics services (LServ*) and *Risk in Demand* (D*Risk*) is 0.259; which based on P-value was statistically significant. In other words, availability of *Logistics services* reduces the risk perception and helps achieve timely and complete deliveries of material and make appropriate deliveries to customers. Note that the highest total effect is of the agility occurred on *Customer service* (*CSer*) with 0.581. Similar interpretations can be provided for the remaining relationships in Table 9.

Table 7 Indirect effects to two and three segments between latent variables

Segments	With	Effect indirect of		
		LServ	SRisk	Tran
Two	CServ	0.052(P=0.133)	0.113(P=0.008)	0.299(P<0.001)
	Agil	0.036(P=0.219)		0.063(P=0.090)
Three	CServ	0.021(P=0.291)		0.036(P=0.171)

Table 8 Sum of indirect effects among variables

To	Indirect effects from the variable		
	LServ	SRisk	Tran
CServ	0.073 (P=0.059)	0.113 (P=0.008)	0.335 (P<0.001)
Agil	0.036 (P=0.219)		0.063 (P=0.090)

Table 9 Total effects from latent variables

To	Effects from				
	LServ	SRisk	DRisk	Agil	Tran
CServ	0.073	0.113	0.201	0.581	0.335
SRisk	0.188				0.323
DRisk	0.259				0.272
Agil	0.036	0.194			0.483

3.4 Contributions and industrial relevance

The results from this research confirm suspicions on the existence of direct impacts over dependent latent variables evaluated, and demonstrate that *Logistics services* and *Transportatio*n have effects on the risk perception. Note that we found a new impact from *Risk in Demand* (*DRisk*) on *Customer service* (*CServ*) with a β = 0.20 and a significance level < 0.01. This relationship mean that is important controlling the demand to accomplish with the requirements of customer, this is no doubt because that risks in demand forecasts are due mainly to the lack of connection and coordination among suppliers and manufacturers, and as a result a bad performance at the end of the chain. Results displays in Fig. 2 thus validated seven hypotheses as non-trivial, that is, statistically significant, and one as trivial (H_7), which can help identify strategies to improve *Customer service*, not only considering directly the agility, but other aspects such as risk, *Transportatio*n, and logistic services.

This research argues that to improve the agility in the supply chain in Mexican maquiladoras, it is necessary that transportation performance and risk management be effective. That is, reducing the risk in suppliers and demand by maintaining communication in real time, in addition to lower transportation costs and the satellite connection required to monitor deliveries of material.

This argument is supported by the hypotheses H2 and H6. The first because, there was a direct impact (β = 0.42) towards agility, and the second because, the *Risk in Supplier* presents an impact to *Agility* (β = 0.19). Both impacts explained the 28 % of the variance of the latter showed as $R^2 = 0.28$. In this sense, major transportation performance increased the agility in manufacturing industries of Ciudad Juarez, the participants sugared that is a key aspect to leads of products to customers.

Also was argument that *the Transportation* decrease the *Risk in Demand,* and *Risk in Suppliers*, which is supported by the hypothesis H1 and H3. Both represent two direct impact with values of β = 0.27 and β = 0.32 respectively , and this mean that in maquiladoras companies of Ciudad Juarez, the participants sugared that the *Transportation* performance in this region is good because is low the risk perception. There is, the communication and the integration of suppliers in manufacturing companies used information technologies to maintained communication and can be adjusted to demand changes or other aspect required.

On the other hand, in this research we also argued that the availability of *Logistics services* affected the perception of risk, both in demand and in suppliers. This implication is supported by hypotheses H4 and

H5, since the results found indicate direct impacts on *Risk in Demand* (β = 0.26) and *Risk in Suppliers* (β = 0.19), where the major impact is about *Risk in Demand*. This means that if *Logistic services* performance is good, i.e. availability of air, land, maritime, financial, legal services and information, the company's operations work best and is perceived less risk as: forecast, visibility, communication and stability. Additionally, there is an association of communication and integration with suppliers and the decrease of the risk perception since errors are diminished, on time deliveries of materials and the number of complete orders is improved. In addition, the findings are important and for instance, the *Risk in Supplier* has influence on agility, and this mean that when there is a major risk in suppliers to complete orders on time, and in exist exacts quantities, it is difficult to achieve agility. Therefore, the managers interested in achieving SC agility should seek opportunities for operational collaboration with their partners. As a relational factor is a driving force of satisfaction and performance for both manufacturers and their suppliers. Regarding hypothesis H_7, the results about this relationship not has important associations to contribute on improving the *Agility*. The improving agility demands the contribution of information, communication, and coordination through information systems, infrastructure, and availability of *Logistics services* and not for the decrease of *Risk in Demand*. The results found to hypothesis H_8 indicating a main contribution of agility on *Customer services*, where the communication and the integration of suppliers with manufacturing companies are critical to make appropriate changes in costumers' needs.

4. Conclusions

Results obtained in this research confirm that in order to assess the competitiveness of companies in terms of customer service, it is important to consider both availability of *Logistics services* and quality of *Transportation* In addition, the impact caused from both elements on *Customer services* occurs through a greater *Agility* and less risk in demand and risks from suppliers, and results show that costumer service is 45 % explained by agility and demand risk perceived. That is, to the higher levels of SC agility, the lower the risk perception and consequently, customer service is improved. Similarly, in order to achieve SC agility, managers must be able to provide logistics services and proper connectivity among SC members through a suitable transportation of materials.

Those findings indicate the importance of proper communication and coordination through information systems and logistics services, which are the starting point for production process. In fact, communication and integration with suppliers is a critical success factor for companies because facilitate operations along the SC, improve delivery time and operational cost. In addition, *Transportation* services and *Logistic services* must be aimed to reduce *Risk in Suppliers* and in *Deman*d, because this lets to increase *Agility* on SC, increasing its performance. Finally, findings indicate that *Customer services* in Ciudad Juarez are adequate in comparison with other regions of Mexico, and in fact, agility has a direct effect of 0.58 on *Customer service*.

Hypotheses here tested were validated using information from Mexican maquiladoras and in future research is planned to compare this industrial sector with others in Mexico and others countries. In addition, the use of information and communication technologies in SC as a latent variable is being considered to be integrated in the structural equation model for knows its role in diminish risk in supplier and in demand, and how it impact the SC integration. Undoubtedly variables assessed in this research are a point of reference to disclose the logistics processes on maquiladoras.

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