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Analysis of Important conditions for supporting Logistics Cluster Integration

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Abstract

As a strategy for achieving regional competitiveness, the interest in the cluster approach has become relevant. Organizations in similar processes industries are creating synergies to access for more sophisticated services and customers increasing competitiveness and regional prosperity.
The purpose of this research is to identify the influence of agglomeration and the readiness to create synergies in some of logistics activities such as transportation services to become more competitive. The Northeastern region in Mexico, which is very active on international trade operations, have a critical mass of transportation services. The data was gathered from transportation firms' executives and secondary data sources. The first part of the research is a comparison of the evolution in different regions where these groups of firms have been stablished and their impact in competitiveness according to the occupied personnel, wages and total investment.
On the second part, the multivariate linear regression technique was applied, to test the impact of the agglomeration and synergies in the specified region to affect competitiveness.
As a result, the statistical significance of geographical allocation of the agglomeration and their intent to create synergies was display to contrast the hypothesis associated to the capabilities of the transportation logistics firms to become a cluster in the selected region.

Keywords
Geographical location, agglomeration, logistics clusters, Competitiveness, regional growth, prosperity.

1. Introduction

In supply chains, the elements of the logistics system have taken high relevance to compete and for some organizations is considered a key competence.
Based on the global competitiveness measured by the GCI (Global Competitiveness Index), a specific index to measure logistics competitiveness has been known as LPI (Logistics Performance Index), defined by WEF. The LPI index measures 6 specific dimensions of the supply chain such as "transparency and efficiency of customs", "infrastructure and transport quality", "international shipping", "logistics competence and quality of the service", "tracking and tracing" and "opportunity shipments". In the 2017-2018 LPI report, the countries of Eastern Europe, Asia-Pacific and North America represented the top 10 ranked and Germany was the first of the list.
Mexico is located on 54th position of the index, being the dimensions of *quality of transport infrastructure*, *logistics competence and quality of service*, and *transparency and efficiency of customs* the greatest opportunity areas to improve its position in the ranking (WEF, 2018).
Germany has highly developed logistics clusters, which helps it logistics competitiveness through synergies between different actors in the supply chain.

This study focuses on the truck carriers of goods, as part of logistics chains, in the region of Nuevo León (NL) in Northeast Mexico. The study pretends to analyze whether the factor of geographical location of the agglomeration and the factor of synergies in transport are existent in the logistics companies in the region to be integrated as part of a logistics cluster for competitiveness.

Transport of goods, impacts the following two dimensions of LPI: *infrastructure and quality of transport* and *logistics competence and quality of service*, two of the three most representative inefficiencies measured by this index (WEF, 2018). Simultaneously, this sector needs to develop strategies that allow companies to increase service levels to remain competitive in the specific region.

2. Theoretical background

The first concentrations that could evolve later as clusters, throughout history have known by different names and have become a subject of study for administrative economic sciences. Marshall identified clusters under the name of geographical agglomerations, because at the beginning of the twentieth century the regional economies of certain geographic areas were more developed than other economic activity sectors; characterizing those regions by a representative product or service that had outstanding value attributes.

According to Marshall, an industrial district refers to a group of specialized specific sectors in a defined geographic area, benefiting themselves from the advantages developed by large companies, generating innovation, skilled labor and confidence among the responsible companies (Marshall, 1890), (Marshall A., 1919).
For Lazzaretti (2006), an industrial district differs from a cluster because the approach of the first is towards to a local meso-economy with microeconomic orientation to productivity and welfare of the members and business in the geographical area; and the second focuses on a global competitiveness scheme, seeking to generate competitive advantages in productive linkages to serve larger scale markets.
Meanwhile Porter mentions that a cluster is represented by companies interconnected in a dense geographic concentration, including institutions such as universities, private firms and government agencies (M. Porter, 1998).

In a cluster, the companies that compose it, create alliances and share their strengths to achieve high value opportunities and high value markets complementing each other (McCormick, 2005), forming common value propositions to serve more scaled chains.
In addition, clusters are also stimulating development and economic growth of the geographical area and its competitiveness (Nallari & Griffith, 2013) and stimulating themselves from collective learning and shared knowledge (Rivera, Sheffi & Welsch, 2014).
The exchanges of best practices, strategies and innovation, raises the level of the cluster's participants, creating learning communities with shared visions for achieving equal regional goals.

In particular, clusters in developed countries tend to be larger in the number of integrated companies, are more reliable, they share more knowledge, have greater competitiveness and the collaboration and innovation that they generate is much higher than the clusters in under development countries (Ketels, Lindqvist, & Sölvell, 2006).

Regarding logistics clusters and according to Sheffi (2013), it grows through positive feedback or mutual reinforcement, in the meantime, the greater the number of companies that are clustered in a specific geographic region to constitute the productive chains of logistics services, the greater the attractiveness of this cluster will be. It also generates knowledge sharing, collaboration, education and research and dense supplier base.

For a particular geographic location, logistics cluster represents a strong contribution to region growth, as it can provide jobs for both full-time employees of all organizational levels and employment of professionals and technicians from different chain operations, generating jobs indirectly also for companies whose business is information technology or logistics consultants, enabling an advanced logistics. Finally, horizontal integrations that occur from the cluster, share the benefits with industries that require such services (Porter, 2003) (Rivera, Sheffi & Welsch, 2014).

Transportation on a logistics clusters, is defined as multimodal freight operations, transportation of goods across different nodes (Bontekoning, Macharis, & Trip, 2004) as well as the distribution and delivery of goods at specific points. Transport can be local or international and may increase their competitiveness through integration into alliances and synergies with companies in the same industrial sector or through multimodal transport (Sheffi, 2012).

Authors such as Barney (1991) argue that competitiveness is generated according to the strategic exploitation of the capabilities and resources of the organization, creating value for the company, as described Gardetti (2004), cited by Aigner and Lloret (2013).

For other authors like Scheel and Parada (2008) it is developed through the creation of innovation and technology, producing clusters where the presence of customers stimulate the development of the competitive advantages of suppliers, so suppliers will evolve in creating value by creating "extended value systems" with strong technological base. The Aigner and Lloret authors (2013) suggest that the competitiveness of an organization is strongly associated with financial performance, because to the magnitude that profits are above average, the firm is considered a competitive company.

The definition of Porter on Competitiveness refers to *the ability to produce goods and services of superior quality with a lower price than competitors*. He also defines that the concept has its roots from productivity, but productivity cannot be considered in itself as a competitive advantage, claiming that the competitiveness of a region depends on the collective capacity of its industry to innovate and its way to compete (ME Porter, 1990).

For purposes of this study, logistics competitiveness is defined as the ability to stimulate the capacities of associated firms into competitive advantages that allow creating value through the production of goods and services of superior quality, affecting on sales increases for associated companies and increasing kilometers traveled with load (Verduzco-Garza & Alarcon, 2017).

2.1 Synergies

A study by Rendon and Verduzco-Garza (2017) identifies the competitiveness capabilities of logistics clusters in the region North America, Asia - Pacific and Eastern Europe, which highlights factors such as connectivity, geographic location, innovation, relationships between partners, exchange of best practices, information sharing, logistics integration, performance, efficiency and sustainability of operations, repeatedly appear in two or more regions. Then the elements for the next study are selected.
Some of these aspects together can be reflected in the term *synergy* for strategic alliances between companies, involving collaboration among the members, creating value by themselves, developing their combined capabilities and exchange of information; creating direct partnerships that increase the performance of companies and trust between them (Reve & Sasson, 2015), (Ketels, Lindqvist, & Sölvell, 2006), (Rivera, Gligor, & Sheffi, 2016).

2.2 Geographic Location

Location decisions focused on establishing proximity between companies become more important according to their impact on supply chains both manufacturing and services, given its effect on knowledge spills (Alcácer & Chung, 2007) which has benefited organizations. Establishing industrial parks, the industrial districts first described by Marshall (1890) and subsequently defined by Becattini (2004) shows that from early time that groups of companies in a specific activity sector were already considered as a form of cooperation and friendly competition between organizations, and subsequently a way to compete among regions.

On the concept of *geographic location of the agglomeration* based on studies from Sheffi (2012) this idea refers to a high density of logistics companies concentrated in a defined region and where a global network of value creation activities are created. Moreover, given its proximity and connectivity enables companies to create efficiencies by sharing assets and responding to unexpected demand changes without affecting the reliability of deliveries and contributing to economic progress in a particular region.

3. Methodology

For the development of this research as a first step, the hypothesis assumptions and objectives was formulated. Once the problem was clearly stated, we continued with the next three phases: (1) Planning, (2) Execution and (3) Report and communication.

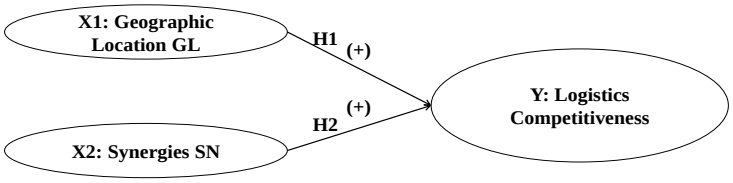
For research procedure, the different stages of the methodology were executed, by using bibliographic techniques, literature search and then a field study using a online survey questionnaire form.

During the planning phase, depth analysis of the literature was conducted in electronic high impact databases about clusters, logistics clusters, competitiveness, logistics competitiveness and on each of the above factors.
The general hypothesis to be tested and the graphical model of the hypothesis were defined. Later, the questionnaire to measure variables was developed and validated and sample size determined according to a finite population.

In the implementation phase, in the first stage was a descriptive analysis from secondary database sources to support the location coefficient LQ (Location Quotient) which measures the performance of a region in a specific activity sector in this case logistics activity. A comparison for two different years for both the region under study is the state of NL was performed.
For the second stage of implementation, a correlational analysis was executed. Data were collected from the questionnaire, going on modeling a mathematical data analysis using statistical techniques and specialized software IBM SPSS version 23. For the reporting and communication phase, the expected results are to meet objectives, test the hypothesis and prepare the drafting of the findings to communicate the conclusions and contributions.

The hypothesis for the development of this study aims to test whether truck carrier firms present the capabilities (factors) such as synergy (SN) and geographical location of the agglomeration (GL) jointly, to increase the competitiveness of the activity sector and form a cluster. The hypothesis is presented in the graphical model proposed in the
Fig. 1.

Fig. 1: Graphic Pattern



Source: Prepared by the author

To select the population of organizations focused on trucking service that would be surveyed for this research, were considered only companies that met the following elements:

- Companies in the NL region whose main product or service is the land movement of goods and services using trucking.
- Logistics companies in general with own transport fleet.

To prepare the questionnaire the support on references from other studies in the world and interaction with experts in the field was necessary, considering trucking firms as a subject of study with its own fleet in NL region.

The questionnaire was previously validated in a pilot test and its reliability was quantitatively confirmed by calculating Cronbach Alpha's coefficient (Cronbach, 1953) in all cases it was higher than 0.70. The table 1 shows the statistical reliability calculation summary of this coefficient for the measurement of each of the constructs. In addition, a validation with experts on the questions was made to obtain a qualitative opinion on the correct measurement of variables and make sure that the questionnaire were well targeted.

Table 1: Reliability statistics

Name	Variable	Cronbach Alpha	Cronbach Alpha based on standardized items
Synergies	SN	0.913	0.915
Geographic Location	GL	0.91	0.907

Source: Prepared by the author

After that, the size of a random sample was determined and those companies' representative responsible for answer the questionnaire. Must be either entrepreneurs or executives transportation, working in logistics or related area of the organization as being a decision maker, with full knowledge of transport operations in the organization, as well as access to transport measurement indicators.

To determine the size of the sample population were considered trucking companies listed in secondary data sources from the region of NL.
38 surveys were completed, and used to continue with the analysis.

4. Part 1 - Geographic Location descriptive comparision

One of the most common indexes to measure the geographical location of the agglomeration corresponds to the location coefficient named (LQ) for its acronym that refers to location quotient. According to Miller et al.(1991). The index had been used since the forties for geography and regional economies.

This index measures the ratio of employment generated by an industrial sector in a specific region and total employment generated in the same specific region. If the LQ is greater than 1, then it means that the average growth of employment in the sector of specific activity in a particular region grows faster than the region itself (Rivera, Sheffi & Welsch, 2014).
The formula for calculating the LQ shown below in the Equation :

Where:

LQ: Location Quotient
E_{ig}: Employment in the industrial sector *i* in the region g
E_{in}: Employment in the sector *i* in the country n
E_{Tg}: Total employment in the region *g*
E_{Tn}: Total employment in the country *n*

$$LQ = \frac{E_{ig}/E_{in}}{E_{Tg}/E_{Tn}} \quad (1)$$

Equation 1- Calculation of LQ
Source: (Rivera, Sheffi & Welsch, 2014)

This location index provides the geographic location of the agglomeration of firms in a specific sector of activity in a specific region. It will be used for measurement in the region of NL, Mexico.

4.1 Geographic Location in NL: Two-Year comparison

For the Nuevo León region, a two-year comparison is shown using the iCluster tool for mapping clusters.
The National Institute of Statistics and Geography (INEGI) developed the tool based on census data of 2014. It combines Harvard's cluster methodology and Monterrey Institute of Technology and Higher Education (ITESM) methodology, adopted by the National Institute of Entrepreneurship (INADEM) for identifying strategic sectors and agglomeration in the country (Dirección General de Comunicación Social, 2017).
The
Fig**. 2**2 shows the iCluster map observing in Mexico the density and intensity of logistics activities in different states using the location quotient (LQ) indicator for 2009 displaying the geographical location of the agglomeration of that economic activity sector, where the states colored shaded darker colored represent greater intensity of logistic activities.

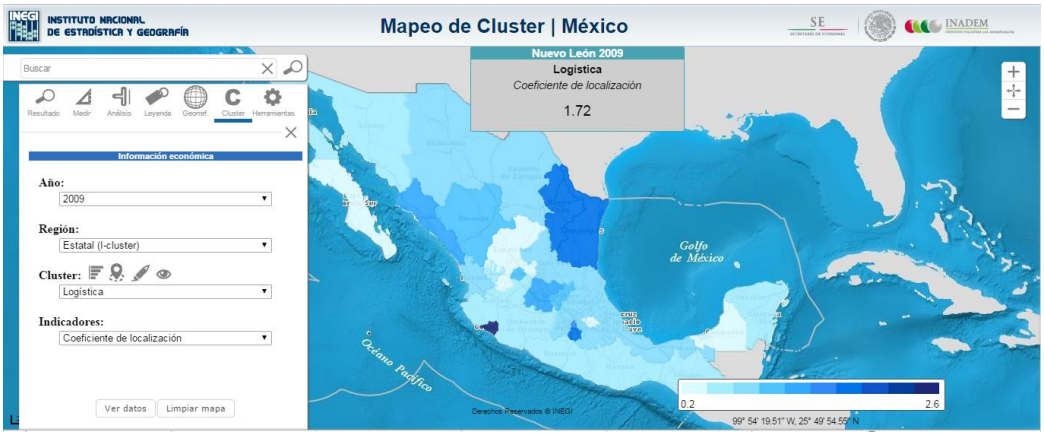


Fig. 2: ICluster activity Logistics Mexico Map 2009
Source: (INADEM INEGI & Ministry of Economy, 2017)

According to the above figure, the regions of greatest geographical location of agglomeration in logistics activity were the states of NL, Tamaulipas and Colima.

In 2014, Fig. 3 shows the geographic regions that have increased their logistics activities, where we perceive that Nuevo Leon has decreased its LQ, and new regions such as Mexico City stand out.

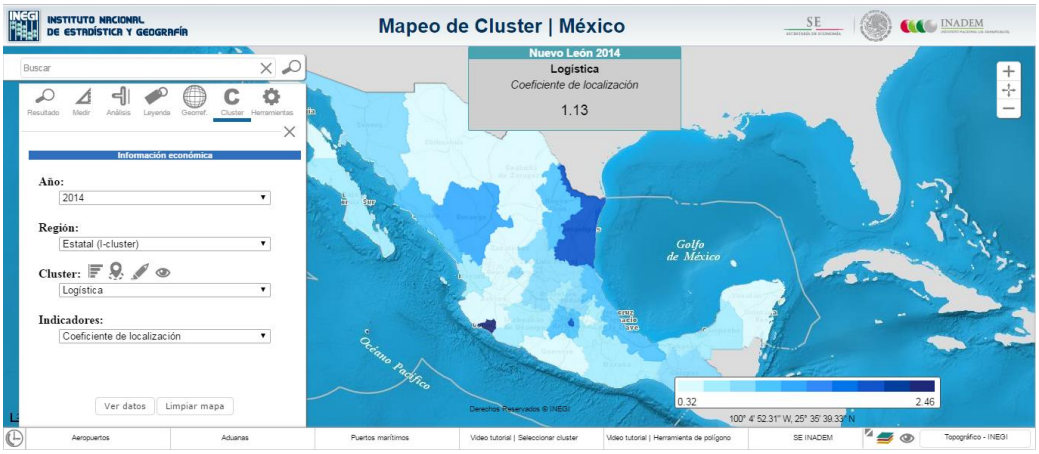


Fig. 3: ICluster activity Logistics Mexico Map 2014

Source: (INADEM INEGI & Ministry of Economy, 2017)

In addition, Table shows the comparison of the most representative indicators selected to see its evolution from 2009 to 2014 taking as an example the state of Nuevo Leon.

Table 2: Evolution of economic indicators according to the geographical location of the logistics cluster in Nuevo Leon

Indicator	2009	2014
Location Quotient	1.72	1.13
Occupied Personel	37.356	23.567
Wages	4,663,872 Thousand pesos	2,347,603 Thousand pesos
Total Gross Production	31307896 Thousand pesos	22976149 Thousand pesos
Investment	1,157,030 Thousand pesos	715.685 Thousand pesos

Source:(INADEM INEGI & Ministry of Economy, 2017)

Nevertheless the decrements presented, NL indicators remains on the top of the regions with most geographical location of agglomeration in Mexico; but the logistics activity has been relocated in other states, especially the neighboring state of Tamaulipas, which has increased its LQ of 1.76 in 2009 to 1.9 in 2014.
These indicators allow us to see that, by decreasing the intensity of logistics activity in a region; economic indicators of competitiveness tend to be reduced disturbing the regional economy.

5. Part 2 - Synergies and Geographic Location Correlation Analysis

The information gathered using the questionnaire instrument was analyzed by using the linear regression statistical technique. The calculation was recorded on SPSS 23 program using the stepwise format and analyzing data obtained with 38 surveys.
For the first iteration of the model, the Pearson's coefficient of determination was very low, so the presence of multivariate outliers that could affect the study was revised.
This analysis was conducted in the same software program by measuring the Mahalanobis distance, which describes the distance between a data point and a center of mass, and is calculated for each observation in the data set giving each of observations reverse weight measurement distance being outliers, which receive lower weights (Muñoz & Uribe, 2013). 8 cases were identified and the sample was reduced to 30 observations. The
Table 1 shows the results obtained.

Table 1: Summary of models with N 30 by the method of successive steps

Model	R	R Square	R Square adjusted	Estimation Standard Error	N
1: GL	0.54	0.291	0.265	0.273	30
2: GL, SN	0.74	0.551	0.518	0.221	30

Source: Prepared by author

According to the ANOVA summary presented in the
Table **2**, the second model had a significance from the critical p-value of 0.000 and a critical value F of 16.591, which tells us that the model of two variables is significant.

Table 2: ANOVA

ANOVA						
Model		Sq Sum	df	Cuadratic Mean	F	Sig.
1: GL	Regression	0.852	1	0.852	11.472	0.002
	Residual	2.08	28	0.074		
	Total	2.932	29			
2: GL, SN	Regression	1.617	2	0.808	16.591	0
	Residual	1.315	27	0.049		
	Total	2.932	29			

Source: Prepared by author

The Shapiro-Wilk test was used, since it is most recommended for small samples to test for normality of the data set. The result of this test is that the null hypothesis indicates that the sample comes from a normally distributed population is not rejected.

Evaluating the relative importance of the coefficients obtained from the matrix of standardized regression coefficients, the importance of each variable in the equation is showed, where GL is greater but not very much than the independent variable SN effect. In this matrix, the calculated *t-student* variable values are observed: For the variable GL, the *t-student* result was 4.754 and the significance is 0.000; and for the variable SN, the *t-student* value was -3.961 and the significance of 0.000. These results conclude in the acceptance of the hypothesis of significance for these two variables.

After analyzing the obtained results, the demonstration of variable GL plus variable SN confirmed a significant model for the dependent variable *logistics competitiveness*. Therefore, we can accept hypothesis number 1 while hypothesis number 2 was not entirely acknowledged, since the variable SN even if it has a significant impact in the model is not positive in the dependent variable.

6. Conclusion and Future Research

Concerning the interpretation of the results it can be concluded that in the region of NL trucking firms have been affected positively on theirs competitiveness due to increase density in the geographical location (GL), as well as develop synergies through strategic partners (SN) has a negative effect given the profile conditions surveyed companies. This particular case analyzed in the sample collected that companies in the region where the analysis is performed, have very low trust, are not likely to share information and generate synergies to compete.

These two constructs as a whole explain and predict a part of the competitiveness dependent variable (R2> 55%).

Therefore, according to the results obtained, the conjoint of capabilities for the initial establishment of a logistics cluster in NL region were not totally acknowledged for the trucking companies, in order to increase competitiveness for the cluster members based on joint collaboration.

It is recommended to extend this study to other transport modes and for multimodal transport developed regions, such as Bajio region and Estado de Mexico so they can be compared on competitiveness. Finally, we recommend using the technique of Structural Equations (SEM) to implement an exploratory analysis of new variables in order to increase the explained variance by the proposed model, and the significance of new constructs to a greater understanding of the phenomenon behavior.

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Biography

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