An approach to assess the competitiveness in Logistics Centers through the analysis of its effectiveness

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1. INTRODUCTION

From a business point of view, the decision to locate the distribution center of a firm in a given logistics center can condition its performance, since the movement and storage of products is increasingly important in the current industrial landscape, as a part of the firm's supply chain, being a key element of its competitiveness (Porter, 2000).

There have been proposed some methodologies for the location selection's problem (e.g Chen, 2001; Kayikci, 2010; Kampf et al., 2011) by using different approaches (e.g. Analytic Hierarchy Process, Topsis, Artificial Neural Network). The location selection's problem usually considers some common criteria (e.g. accessibility, security, costs, environmental impact, proximity to customers, proximity to suppliers, possibility of expansion, quality of service, infrastructure conditions and human resource). However, the effectiveness has not usually been considered in the decision making process. Understanding the effectiveness of a logistics center allows its sustainable development, from the point of view of a company analyzing possible locations for its distribution center, the study of this aspect should be considered in order to identify the most competitive alternative.

The main objective of this paper is to identify the determining factors that affect the effectiveness of a logistics center, and propose a model based on the analytic hierarchy process (AHP), for the assessment of its competitiveness.

2. ANTECEDENTS

2.1. Concept of Logistics Center

There is no consensus in the literature when defining the concept of logistics center. Several authors gather a compilation of the different terms used (Meiduté, 2005; Rimiene and Grunday, 2007). The most common terms are Logistics Park, Logistics Platform, Freight Village, Logistics Center, although there are other terms (e.g dry port, distribution terminal).

This paper adopts the definition given by The European Logistics Platforms Association (Europlatforms, 2017) which considers:

"A Logistics Center is a center in a defined area within which all activities relating to transport, logistics and the distribution of goods – both for national and international transit, are carried out by various operators on a commercial basis. The operators can either be owners or tenants of buildings and facilities (warehouses, distribution centres, storage areas, offices, truck services, etc.), which have been built here".

According to Europlatforms, a Logistics Center should preferably be served by a multiplicity of transport modes and be managed in a single and neutral legal body.

2.2. Effectiveness and competitiveness in logistics centers

Moreno-Jiménez (2006) considers the effectiveness implies "doing the right thing", that is, identifying the relevant aspects and using them appropriately to solve the problem, which implies long-term strategic planning. Therefore, the effectiveness will mean the sustainable development of the logistics center as a whole, giving a level of service according to the demand of the users and the general requirements of the logistics activity.

On the other hand, as regards the concept of competitiveness, Porter (2000) considers it is

determined by the productivity, defined as the value of the product generated by a unit of labor or capital. A logistics infrastructure is considered competitive when its positioning is superior compared to other alternatives. To achieve sustainable growth and a competitive market position, a number of factors should be analyzed, which encompass a global and strategic vision of the logistics center.

2.3. The analytic hierarchy process (AHP)

AHP is a multicriteria methodology used in decision-making processes. It is included in the group of so-called 'discrete', since it considers the number of alternatives is discrete and each of them can be explicitly treated. This tool allows the consideration of multiple scenarios, actors, factors and criteria (tangible and intangible). It builds an absolute scale, associated with the priorities of the elements being compared, based on a four-step process: (i) modeling, (ii) valuation, (iii) prioritization and (iv) synthesis (Saaty, 1980; 1994). The AHP approach requires the translation of perceptions into numerical scales. One of the most used mechanisms is the Saaty's scale through pairwise comparisons (Saaty, 1980).

The priorities of the model (w_i=1,…,n) can be obtained by means of different methods. In this paper it is applied the eigenvector problem

$$Aw = \lambda_{\max} w \qquad \sum_{i=1}^{n} w_i = 1 \tag{1}$$

where $A=(a_{ij})$ is the reciprocal pairwise comparison matrix, λ_{max} is the principal eigenvalue of A and w is the vector of priorities. The measure of inconsistency in judgements have been obtained by means of the *Consistency Index- CI* (Saaty, 1980), expressed as

$$CI = \frac{\lambda_{\max} - n}{n-1} \tag{2}$$

where λ_{max} is the principal eigenvalue of the judgements matrix, and n its order. When the reciprocal comparison matrix is consistent $\lambda_{max} = n$, and $CI=0$. Saaty proposed the *Consistency Ratio- CR* as a way of normalize the measurement, that is given by

$$CR = \frac{CI}{RI(n)} \tag{3}$$

where $RI(n)$ is the Random Consistency Index for matrices of order n, obtained by means of the simulation of 100,000 reciprocal matrices randomly generated (Aguarón and Moreno-Jiménez, 2003).

3. MODEL DEVELOPMENT

The proposed model consists of four levels: goal (G- to measure the effectiveness and competitiveness of a logistics center), 2 criteria (C), 8 subcriteria (SC), and 18 attributes (A). The assessment of the hierarchy has been carried out by a group of five experts (Administration representative, park manager, logistics operative, user company, logistics researcher) working in a context of group decision making (single decision based on consensus).

The elements of the model and the priorities obtained (with exception of the goal) are defined in Table 1 and Table 2. The group elicited 1 judgment for the pairwise comparison matrix that compared the relative importance of the actors versus the factors with respect to the goal; 12 judgments (6+6) when comparing the eight sub-criteria with respect to the criteria (two pairwise comparison matrices), 12 judgments (1+3+1+3+1+1+1+1) when comparing the attributes with respect to the sub-criteria (eight pairwise comparison matrices). All pairwise comparison matrices have acceptable inconsistencies (CR <0.10). The overall inconsistency of the model is acceptable (0.08).

Table 1. Model prioritization

C1. Actors										C2. Factors							
SC1		SC2			SC3		SC4			SC5		SC6		SC7		SC8	
w(A1)	w(A2)	w(A3)	w(A4)	w(A5)	w(A6)	w(A7)	w(A8)	w(A9)	w(A10)	w(A11)	w(A12)	w(A13)	w(A14)	w(A15)	w(A16)	w(A17)	w(A18)
0,068	0,068	0,018	0,003	0,003	0,058	0,019	0,009	0,001	0,002	0,033	0,298	0,246	0,049	0,019	0,058	0,024	0,024

Table 2. Elements of the proposed model

Elements	Description
C1. Actors	Entities and groups of people involved in the activity of the logistics center.
SC1. Property	Entity that owns the park.
A1. Public Property	The Logistics Center belongs to the Administration.
A2. Private Property	Company or group of companies.
SC2. Management	Independent, it guarantees a centralized control of operations and ensures the strategy of the initiative.
A3. Top management	Maintains the strategic mission of the logistics center, ensures the accomplishment of the requirements considered objectives of the park.
A4. Commercial management	It positions the logistics center in the market and analyzes its approach through the appropriate selection of located companies' typology.
A5. Technical –operational management	Management of the infrastructure technical aspects, which affect its daily operation. It cannot be neglected for giving a service of quality.
SC3. Direct users	The companies located in the logistics center which have chosen this location to carry out its activity.
A6. CEO	Organization working with the strategic alignment and acts according to this view.
A7. Economical-Technological commercial management	Departments analyzing the operational aspects of the supply chain management. They evaluate the tangible parameters and give advice on the adequacy of the operative to the mission of the company.
SC4. Indirect users	Logistic operators and transport infrastructure managers. Essential for the operation of the logistics center.
A8. Direct services	Logistic operators and transport infrastructure managers.
A9. Complementary services	Commercial, social, environmental support activities and technology and communication facilitation activities (shopping centers, financial institutions, restaurants, etc).
A10. Workers	Includes all types of activities in the logistics center.
C2. Factors	Aspects related to the effectiveness and competitiveness of the logistics center.
SC5. Technical-operational	The operational and structural aspects of the logistics center.
A11. Characteristics of the center	Surface for logistics activities, level of occupation, brand image, existence of synergies, etc.
A12. Technological-operational characteristics	Geostrategic position, infrastructures and capacity, extension of the influence area.
SC6. Economic	Establishment and maintenance costs in a logistics center, and expected profitability.
A13. Cost	Expected cost for the company for its location in a logistics center. This factor depends mainly on the property, and secondly on the management entity.
A14. Induced profitability	Expected profitability for the companies of the logistics center.
SC7. Social	Availability and quality of employment, with its effect in the logistics center and the region.
A15. Employment	The property factor, particularly the public property, ensures that the workforce is not a problem for the initiative, and even promotes regulations for that purpose.
A16. Innovation and knowledge	The advanced and innovative provision in new technologies is fundamental in the automation of the logistic processes, with a consecuence in a dynamization of the workforce, maximizing the use of resources.
SC8. Environmental	Beneficial effect of the supply chain management improvement to minimize the negative impact of logistics operations.
A17. Regulatory compliance	The environmental aspect must be considered from the design stage. The most modern environmental treatment solutions available with less unwanted effects are valued.
A18. Environmental improvements	Wastewater treatment for reuse, optimization of electrical use, existence of renewable energy for the maintenance of the logistics center and supply to users, use of efficient transport.

4. CASE STUDY

The application of the model has been carried out through the comparison of three logistics centers in Spain (S): S1. Zaragoza Logistics Platform (PLAZA), S2. Coslada Transport Center, Madrid (CTC) and S3. Vitoria-Gasteiz Intermodal Transport and Logistics Center (CTV). The selected logistics centers are comparable in the decision-making process for a given company, since they offer a similar activity that satisfies its needs. The valuation of the three alternatives has been made by the group of experts based on their knowledge and expertise and the available information on these logistics centers.

From a global point of view, it can be seen that the final or total priorities of the alternatives are: w(S1) = 0.564; w(S2) = 0.143; w(S3) = 0.293. The ranking of alternatives shows that PLAZA (S1> S3> S2) is the preferred alternative in terms of effectiveness and competitiveness (Figure 1).

Figure 1. Final priorities of the analyzed alternatives

If analyzed the ranking of alternatives from the point of view of the Actors it can be seen (Figure 2a) PLAZA is the preferred alternative followed by CTC (S1> S2> S3). However, the same analysis from the point of view of the Factors (Figure 2b) shows there is a rank reversal of the alternatives, although PLAZA remains preferred over the other two alternatives (S1> S3> S2).

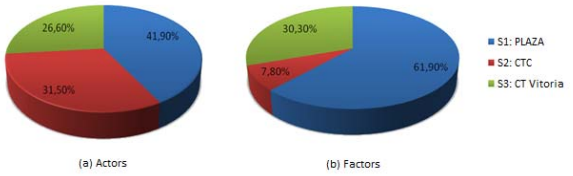

Figure 2. Preference of the alternatives with respect to the actors and factors of the model

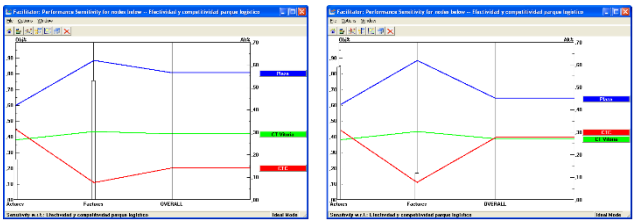

Figure 3. Sensitivity analysis of the global model

The sensitivity analysis of the model has been carried out by using the Expert Choice™ software. The Performance graph (Figure 3) provides information on the total priorities of the alternatives and their global behavior with respect to the criteria. It can be seen that the best alternative, S1, dominates the other two alternatives both in the actors and factors criteria (Figure 3a). By introducing changes in the weights of the criteria it can be produced a rank reversal of the best alternative at a global level. Carrying out a simulation (Figure 3b) it is necessary to increase the weight of the Actors criterion by 59% for CTC to be the preferred alternative over CT Vitoria, although the preferred alternative remains being PLAZA. In any case, this change is quite improbable due to the radical changes needed with regards to the initial values.

In short, the sensitivity analysis confirms that the ranking S1>S3> S2 is strongly robust and that PLAZA is the most effective and competitive alternative.

5. CONCLUSIONS

This paper proposes a model for the assessment of the effectiveness and competitiveness of a logistics center. A hierarchy of the factors involved has been obtained through the application of the AHP methodology with relative measures. The economic factor, particularly the company location costs in the logistics center (A13), together with the technological-operational characteristics of the logistics center (A12) are the main influential factors. The environmental factor has average relevance, consolidating the general trend of commitment to the environment and the use of efficient and sustainable resources.

The validation of the model has been carried out by means of the analysis of three logistics centers in Spain, under similar conditions of supply for a company, determining that PLAZA is the most competitive option. In the case of three comparable alternatives, the application of AHP with relative measurements is advisable. However, when the number is greater than 7±2 it is recommended to use AHP with absolute measurements, allowing to establish a recommendable level of competitiveness.

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