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A MULTICRITERIA DECISION AID FOR EVALUATING THE COMPETITIVENESS OF TOURIST DESTINATIONS IN THE NORTHWEST OF MEXICO[1]

UNA AYUDA DE DECISIÓN MULTICRITERIO PARA EVALUAR LA COMPETITIVIDAD DE LOS DESTINOS TURÍSTICOS EN EL NOROESTE DE MÉXICO

Abstract
This work deals with the problem of comparing the competitiveness of tourist destinations as a multicriteria ranking problem. Comparing tourist destinations is a complex problem because they present wide heterogeneity between them. The Crounch-Ritchie model is used as the main approach for analyzing tourist the competitiveness of tourist destinations. Thereby, we structure the problem as a multicriteria ranking problem for comparing and ranking the destinations with highest competitiveness as the preference direction. For this project, we use the main tourist destinations in the Northwest of Mexico as case study. The ranking of tourist destination is based in their competitiveness, however with the multicriteria analysis proposed, it is possible to use any particular group of the attributes to choose a coherent family of criteria. This process is performed in two steps, the first one uses the ELECTRE III method to construct a valued outranking relation and the second one, a multi-objective evolutionary algorithm for exploiting those relations, and generate the ranking of destinations.

Keywords: MCDA, ELECTRE, destinations competitiveness.

Resumen
Este trabajo aborda el problema de la competitividad de los destinos turísticos como un problema de clasificación multicriterio. La comparación de los destinos turísticos es un problema complejo porque dichos destinos presentan una gran heterogeneidad entre ellos. El modelo de Crounch-Ritchie es utilizado como el enfoque principal para el análisis turístico de la competitividad de los destinos turísticos. De esta manera, el objeto de estudio del presente artículo se estructura como un problema de clasificación multicriterio para comparar y clasificar los destinos con mayor competitividad. Para tal objeto, se utilizan los principales destinos turísticos

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del noroeste de México como estudio de caso. El *ranking* de destino turístico se basa en su competitividad, sin embargo, con el análisis multicriterio propuesto es posible utilizar un grupo particular de atributos para elegir una familia coherente de criterios. Este proceso se realiza en dos etapas: la primera utiliza el método ELECTRE III para construir una relación valorada de superación, y la segunda usa un algoritmo evolutivo multiobjetivo para explotar esas relaciones y generar la clasificación de destinos.

Palabras clave: MCDA, ELECTRE, competitividad de los destinos turísticos.

1. Introduction

The global economy is changing at a rapid pace, and the tourism sector is not different in this regard. To make better decisions, both, the public and private sectors, need better tools to continually measure the competitiveness of tourism. Since improved competitiveness allows a company, or a country, to gain market share and generate profits in relation to its competitors. Another author mentions that the competitiveness of nations depends on the capacity of its industries to innovate, but only some companies are capable to do it with some consistency and coherence, improving their competitive advantage (Porter, 1991). In this regard, Krugman (1994) asserts that competitiveness is not so relevant at the national level, since countries are not competing among themselves, but instead is an internal issue rather than an external one. For this reason, competitiveness has been gaining more attention in media, in policy development, socioeconomic studies and business in general.

The concept of competitiveness often causes controversy, depending on the scope of its application, be it from a business perspective, or from public policy one. Since decision makers want to know current conditions and the policies to put in place in order to raise the competitiveness of their regions. However, there are several competing concepts of what competitiveness is, particularly in the context of tourism, but for our project we restrict to those definitions or concepts that can be properly measured, which are presented next.

In the tourism context, competitiveness is defined as the capacity of tourist destinations to attract travelers and investment (e.g. infrastructure and tourist equipment), which impacts the arrival of visitors, increases employment and the average expenditure of tourists. This last indicator, tracks the economic impact of tourism to local residents and providers of services.

The objective is to analyze the selected tourist destinations and make a comparison, from the best to the worse performing according to their preference. An important aspect of our project is the development of indicators under a multicriteria decision making approach, based on the ELECTRE III method. The final model will determine the ranking of the destinations according to their competitiveness based on the selected indicators and the preference of decision makers.

The use of decision support based on Multicriteria Decision Analysis (MCDA) is motivated by the fact that real world decision-making problems, have increased their complexity and cannot accurately be measured using only one-dimensional approaches. However, when using a more realistic approach there might be a risk of using too many indicators and this increasing the noise in the system, for this reason the analyst must include the key factors (not too many, and not too few). Nonetheless, the purpose and scope of MCDAS, is to support decision-making, while dealing with these types of complex problems.

Due to the importance of measuring the competitiveness of destinations tourist, it is convenient to have new techniques or methods that give participants new perspectives on this issue and to help them with the complexity of decision-making. This is the main motivation for developing this model, since it will allow decision makers not only to know the relative ranking, but also to develop better public policies, by participating from the start, in the definition and treatment of the problem. The policy-makers or experts who analyze the tourist destinations, will have a new tool to aid them in their decision-making process, composed of indicators in which they express their preferences.

This document is divided into seven sections. Section 2 describes the characteristics that identify to the tourist destinations in the Northwest of Mexico. The context of the analysis and the methodology for measuring competitiveness of destinations based on the Crouch-Ritchie model are described in section 3. In section 4, we present the Decision Support System used in this study. Section 5 shows the case study with the results, while a sensitivity analysis is presented in section 6. Finally, in section 7 we present the conclusions.

The results and the analysis of the competitiveness of the destinations, with the outranking method and the sensitivity analysis to strengthen our results. Finally, conclusions and future research are presented.

2. Analysis of touristic competitiveness models

The concept of competitiveness can be studied from different angles: through products, companies, branches of the economy or national and local economies, as well as in the short, medium or long term. Despite the extensive literature on competitiveness, today there is no clear consensus or definition for the discussion and, therefore, how to measure it (Benzaquen, Del Carpio, Zegarra & Valdivia, 2010; Gomezelj, 2006).

Authors like Duque (2005) suggest that competitiveness can be analyzed from three perspectives:

1. *The Entrepreneurial:* which has the capacity to produce and supply goods and services to local, regional or international markets, more efficiently and effectively than its competitors.

2. *The Industrial:* which consists of the ability of companies in a particular sector to achieve sustained success against companies competing abroad, without government protections.

3. *Regional:* covering the capacity to attract and incubate new ventures and provide the means for the growth of existing companies, which in turn translates into the possibility that their citizens must reach a high standard of living (Duque, 2005, p. 134).

The definitions offered by the literature provide a micro and macro connotation of what competitiveness is (Gomezelj, 2006; Crouch, 2010). From a macro-perspective, due to the fact that “competitiveness is of national concern and its objective is to improve the real income of the community” (Chen, 2008), and from the micro-perspective, because it is studied at the scale of a company, since it is here where any organization must provide products and services, which must meet the wishes of the modern consumer.

In this sense, Porter (1991) in this regard states the competitiveness of a nation depends on the ability of its industries to innovate and improve, so that certain companies are able to do so consistently, striving for improvements and increasingly enhance competitive advantage. And Krugman (1994) argues that competitiveness loses relevance at the national level, since the main countries are not competing with each other, so it is more of an internal matter of the nation than of an external aspect.

Duque (2005) defines competitiveness as the ability to compete, since in the international context competitiveness refers to the ability to compete in markets, being this the ability of a sector to successfully place its products in the international market, under free competition conditions.

Labarca (2008) stresses that the competitiveness of an industry can be measured in terms of the overall profitability of firms, the trade balance in industry, the balance between outgoing and incoming direct foreign investments and direct measures of cost and quality, considering that competitiveness in industry is an indicator of a country's economic strength.

To the interest to study competitiveness, we add the study of the competitiveness of tourist destinations, a result of the increase of the specific literature carried out by: Porter (1998); Crouch & Ritchie (1999); Dwyer, Mellor, Livaic, Edwards & Kim (2004); Ritchie & Crouch (2003); Dwyer & Kim (2003); Duque (2005); Gomezelj (2006); Díez (2012) and Crouch (2010), among others. In the sense that competitiveness has become a matter of economic importance for those countries where tourism has become an important generator of foreign exchange and which contributes to economic development.

Crouch and Ritchie (1999), as an effort in their research, have tried to develop models and general theories of competitiveness of the destinations that are not specific for certain destinations or attributes. These authors began to study the nature and structure of the destination's competitiveness (Crouch & Ritchie, 1995, 1999; Ritchie & Crouch, 2003). Its objective was to develop a conceptual model based on theories of the comparative advantage of Smith (1776) and Ricardo (1817), cited by Crouch (2010) And the competitive advantage (Porter, 1998), adapted to the distinctive features of the destination's competence.

In this sense, they propose a conceptual model of the competitiveness of the destination, in which it recognizes that the destination's competitiveness is based on the resource endowment of a destination (comparative advantage), as well as its capacity to deploy resources (competitive advantage). This model also highlights the impact of global macro-environmental forces (e.g. global economy, terrorism and cultural and demographic trends) and competitive micro-environmental circumstances that affect the functioning of the tourism system associated with destination. Target competitiveness factors are represented in the model grouped into five main groups.

In the development of the model, Crouch (2010) includes generic concepts that derive in a model that posits the competitiveness of the touristic destination, which is determined by five main components: qualifying qualifiers and amplifiers, destination politics, planning and development, destination management, attraction resources factors and conditioning and limiters factors. It is common to observe that the iteration of the visitor is based on the factors and resources of attraction, since it includes the primary elements of resources of the destination. And these are one of the fundamental reasons that potential visitors choose one destination over another (Crouch & Ritchie, 1999, p. 146).

In this way, these attraction factors and resources constitute the main elements of the destination resource and include physiography, culture and history, market relations, special activities, and the tourist superstructure. Physiography embraces the landscape and the climate; market links include linkages with residents of the tourism regions of origin; and the tourist superstructure consists mainly of accommodation facilities, food services, transportation services, and major attractions.

Competitively tourism in Crouch's studies (Crouch, 2010) determines that managing the competitiveness of destination has become a topic of interest, due to theories, models and processes that can help guide the approach in this challenge, and which offer the possibility of positioning with clarity and endurance a complex management task. And to extend their analysis, Crouch, in collaboration with Ritchie (Ritchie & Crouch, 2003), defines it as the relative capacity of a destination to meet the needs of visitors in the various aspects of the tourist experience.

Finally, in relation to this model proposed by Crouch and Ritchie, investigations were developed by Crouch (1995); Dwyer & Kim (2003); Sánchez & Fajardo (2004); Dwyer et al. (2004); Duque, (2005); Gomezelj (2006); Gándara, Chim-Miki, Domareski & Biz (2013), among others. Therefore, the literature in relation to the model proposed by the authors in analysis will be favored through further in-depth research on specific factors or categories that allow to measure the competitiveness of destinations.

3. Tourism in the Northwest of Mexico

In our study, we assume the Northwest region of Mexico is composed by the states of Baja California (Bc), Baja California Sur (Bcs), Sinaloa (Sin) and Sonora (Son). This region has a total population of 9.222.337 (INEGI, 2012), 34.2 per cent of the region´s population belong to the State of Baja California, 6.9 per cent to Baja California Sur, 30 percent to Sinaloa and the 28.9 percent to Sonora, and together this region represents only 8.2 percent of the national population.

Tourism is one of the sectors with the largest economic contribution to these states. According to the Ministry of Tourism (SECTUR in spanish), most of the economic output for the region is concentrated in 14 destinations: Ahome, Culiacán, El Fuerte, Mazatlán, Ensenada, Mexicali, Playas de Rosarito, Tecate, Tijuana, Los Cabos, La Paz, Loreto, San Carlos and Hermosillo. These destinations are aggregated at the municipality level.

According to statistics obtained by the program for monitoring and evaluating tourist activity provided by SECTUR (2014), for the Northwest of Mexico, there was an average occupation of 21.523 rooms, which represented 49.2 percent of potential occupation.

Given the relative importance of tourism, we consider that is only natural that competitiveness assessments have taken more relevance in recent years. Serving as reference to show the relative position for each destination. In this context, new indicators have been incorporated, for measuring competitiveness, an integrated way, since they were designed to show the differences among the tourist destinations in terms of products and services. We also incorporate new concepts and methodologies that have been adopted from other disciplines to this research topic, but recognizing the particular structure of the problem. All these aspects combined has led to the development public policies with the purpose of improving the development of these destinations, and that require information that is up to date.

In the same way, our proposed methodology combines criteria and indicators that allow decision makers to rank tourist destinations in the Northwest of Mexico, and at the same time it is designed to serve as a measurement of their competitiveness. For this reason, we consider that these metrics are useful for the planning and development of these destinations, at the local, regional, national and international level, because competitiveness (the main topic of this study) includes the possibility of promoting the economic development of tourist destinations and of their productive structure.

4. Contextual framework

In this work, we want to analyze the competitiveness of 14 destinations in the Northwest of Mexico. The information used for the analysis was obtained from the National Institute of Statistics, Geography and Information in Mexico (INEGI), the Ministry of Tourism (SECTUR), the Mexican Institute for Competitiveness (IMCO), the Government of Baja California, Baja California Sur, Sinaloa and Sonora, the National Water Commission (CNA), the National Institute of Anthropology and History (INAH) and the National Institute for Federalism and Municipal Development (INAFED).

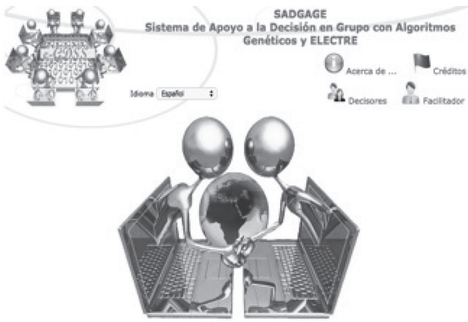
Our analysis is based in the Crouch-Ritchie model, which is a multicriteria method aimed at evaluating tourist destinations. But our approach also develops a Multicriteria Decision Support System (MCDS), which has improvements over traditional comparison methods, and is a line of research that has been gaining importance, and now occupies an important place in the multicriteria analysis (Pardalos, Siskos & Zopounidis, 1995; Belton & Hodgkin, 1999; Marakas, 1998; Sauter, 1997).

For its part, the Crouch-Ritchie model identifies 36 attributes to determine the competitiveness of the destination. However, we found there are 45 attributes that we consider relevant for our analysis, that are already available (INEGI, 2012). These attributes are grouped into five main groups of factors for the model; these factors were the ones used as criteria in the ordering method.

5. Analysis of the competitiveness destination using a Decision Support System

The described problem was treated with a Group Decision Support System SADGAGE (Leyva & Álvarez, 2013), this system SADGAGE was designed on the basis of a methodology for the multicriteria ranking problem, which uses the method ELECTRE III (Roy, 1990) to model the preferences and a multi-objective evolutionary algorithm based on NSGA-II (Leyva, Gastélum & Solano, 2014). The system is available on the URL http://mcdss.udo.mx/xgdss (see Fig. 1).

Figure 1. Configuring a draft classification in SADGAGE



A number of factors influenced the specific selection of the ELECTRE III-MOEA methodology for the problem of comparing the competitiveness of tourist destinations. First, in this paper, we present a "MOEA to exploit a valued outranking relation, but it is interesting to demonstrate the functionality of the combination of ELECTRE III and MOEA with a real-world application" (Leyva, Gastélum & Urías, 2013, p. 715). Second, there exist a set of tourist destinations and a set of attributes to determine the competitiveness of the destination that can be easily converted into a set of criteria.

> Additionally, the problem type addressed in this study can be modeled as a multicriteria ranking problem. Based on the literature, the ELECTRE family of methods is considered appropriate for addressing a problem type such as the one addressed in this study. This is especially true for the ELECTRE III Method. Third, ELECTRE was originally developed by Roy (1990) to incorporate the fuzzy (imprecise and uncertain) nature of decision making by using thresholds of indifference and preference. This feature is appropriate for solving this problem. (Leyva et al., 2013, pp. 715-716).

A further feature of ELECTRE, which distinguishes it from many multiple-criteria solution methods, is that it is fundamentally non-compensatory.

In particular,

> this means that good scores on other criteria cannot compensate a very bad score on a criterion […] Another feature is that ELECTRE models allow incomparability. Incomparability, which should not be confused with indifference, occurs between some alternatives *a* and *b* when there is no clear evidence in favor of some type of preference or indifference. (Leyva et al., 2013, p. 716).

Finally, the choice of ELECTRE III was also influenced by successful applications of the approach (Figueira, Greco, Roy & Slowinski, 2010) for a list of successful applications of ELECTRE.

5.1 General procedure of NSGA-II with preferences

Given a set of alternatives $A=\{a_1,a_2,\ldots, a_m\}$ evaluated by a set of criteria $G=\{g_1, g_2, \ldots, g_n\}$, the NSGA-II (embedded in SADGAGE) used in this study generates a ranking of classes, where all the alternatives located in a particular class are indifferent from each, and preferred or incomparable relative the other ones, which are located in different classes.

5.1.1 Objective functions

The evolutionary algorithm tries to solve a multi-objective optimization problem defined by three objectives. The first one is known as maximum level cut objective, which is related with the credibility level for a crisp outranking relation defined over the set of alternatives A. This objective is defined with a maximization orientation in a range of [0, 1]. A potential solution with a credibility level close to 1 is more trustworthy. The second objective is called MinCut. This objective tries to maximize the indifference among the alternatives within the classes; when an alternative that belong, a class is not indifferent to another one which is in the same class, then this situation is penalized. The third one is known as the minimum pair-wise preference disagreement objective; this objective tries to minimize the number of preference between the alternatives in the crisp outranking relation which are in disagreement in the sense of the crisp asymmetric outranking relation among the classes.

The multi-objective optimization problem that the MOEA tries to solve is defined as follow:

$$Min(Min\ Cut\ (\tilde{p})), Min(n_v\ (\tilde{p})), Max\ (\lambda(\tilde{p}))$$

Subjet to:

$$\tilde{p} \in \Omega$$

$$\lambda \in [0,1],\ \lambda \geq \lambda_0$$

Where

Ω is the set of crisp antisymmetric outranking relations of classes of alternatives of *A*.

$\tilde{P}$ is a crisp antisymmetric outranking relations of classes for a set of alternatives in *A*.

λ_0 is a minimum level of credibility.

Min Cut $(\tilde{P})$ is the min-cut objective.

Min$(n_v(\tilde{P})$ is the minimum pair-wise preference disagreement objective.

Max $(\lambda(\tilde{P})$ is the maximum level cut objective. (Solano, Leyva y Gastélum, 2015, p. 479).

Due that typically, there is no single best solution for this optimization task; we use the framework of Pareto optimality.

5.1.2 Final step to obtain a recommendation

Once that the NSGA-II finished its generations, it is necessary to use a repetitive selection mechanism and a Hasse diagram representation so that to obtain a recommendation. This procedure is a variation of the one proposed by Patil and Taillie (2004), that generates the Hasse diagram of the obtained classes. That diagram represents a partial order of classes of alternatives.

6. The case study

In this section, a multicriteria ranking problem is resolved with the aim of finding the most competitive destination. Fourteen tourist destinations are evaluated, six could be the considered sun and beach destinations, located on the shores of the Pacific, (which are the most visited), such as Ensenada, La Paz, Los Cabos, San Carlos, Mazatlán and Playas de Rosarito; we could also classify five of them as business destinations: Ahome, Culiacán, Mexicali, Tijuana and Hermosillo and three small towns that are under the program "magic towns, which are targeted by SECTUR for tourism because of their charm, which are El Fuerte, Tecate and Loreto (see table 1).

Table 1. Destinations to assess

Tag	*Destination*
A1	Ahome
A2	Culiacán
A3	El Fuerte
A4	Mazatlán
A5	Ensenada
A6	Mexicali
A7	Playas de Rosarito
A8	Tecate
A9	Tijuana
A10	Los Cabos
A11	La Paz
A12	Loreto
A13	San Carlos
A14	Hermosillo

Source: Own elaboration.

The competitiveness model developed by Crouch and Richie (2010) presents a great list of attributes to evaluate the competitiveness of the destinations as much qualitative or quantitative data that could be used in this investigation. In his research 36 attributes were grouped in 5 main criteria. In this sense, we adapt this model to our problem, changing some attributes and eliminating some others (e.g. special events, physiography and climate, culture and history, mix of activities, entertainment, superstructure, location, infrastructure, cost/value, interdependences, awareness/image and carrying capacity), and adding some that were not considered in his work (e.g. libraries, auditoriums, theaters, fairs and festivals, museums, municipal tourism departments, municipal cultural institution, universities, state funds for culture and arts and human resources development). Our final competitiveness model considers the factors: Factors and resources of attraction, Factors and resources of support, planning and policy of destination, management of destiny and restrictive determinants.

The criteria used in the assessment are shown in tables 2 and 3, with their respective values for each alternative (destination) with respect to each criterion, this is the performance array.

Table 2. Criteria of the assessed destinations

Tag	*Criteria*
C1	Factors and attraction resources
C2	Factors and support resources
C3	Planning and policy of the destination
C4	Destination management
C5	Restrictive determinants

Source: Own elaboration.

In the development of the model, Crouch (2010) included generic concepts that resulted in a model that posits the competitiveness of the tourist destination, which is determined by five dimensions, in this way: where $n= |A|$, being $F= \{g_1, g_2, \dots g_j, \dots g_n\}$ a finite set of criteria (Almeida et al. 2006).

In this sense, the variables grouped in compound indicators are integrated and considering the processes of normalization of the individual indicators and the assignment of weights for these indicators, values obtained from the experts, the criteria emanated from the grouping process are developed. Where, for each criterion C_j, A series of indicators are set ($x_1, x_2 \dots x_n$) on a group of destinations (a_i), from these, a set of criteria is calculated ($C_1, C_2 \dots, C_n$). Each C_j where ($j=1 \dots, n$) is a combination of $x_1, x_2, \dots x_n$ originals by weight (w_j) for each criterion.

That is to say:

$$C_j(a_i) = (\mathrm{w}_j * x_i(a_i)) + (\mathrm{w}_2 * x_2(a_2)) + \dots + \mathrm{w}_n * x_n(a_n))$$

Therefore, the performance matrix of the alternatives (table 3), which is generated to determine the competitiveness of tourism destinations and which is developed in this research, is constructed in the sense that integrates the following five criteria: factors and resources of attraction (C1), factors and support resources (C2), destination planning and policy (C3), destination management (C4) and restrictive determinants (C5) (Crouch & Ritchie, 1999).

Table 3. Performance matrix of alternatives

	C1	*C2*	*C3*	*C4*	*C5*
A1	0.0547	0.0657	0.0403	0.0145	0.0775
A2	0.1023	0.1058	0.0569	0.0997	0.0918
A3	0.0462	0.0129	0.0224	0.0596	0.0684
A4	0.1223	0.1152	0.1522	0.0616	0.0773
A5	0.0929	0.0602	0.0484	0.1298	0.0932
A6	0.0793	0.1081	0.0563	0.0445	0.0895
A7	0.0411	0.0134	0.0409	0.0386	0.0578
A8	0.0289	0.0182	0.0333	0.0516	0.0591
A9	0.1366	0.1334	0.0795	0.1205	0.1009
A10	0.1276	0.1262	0.2766	0.0432	0.0496
A11	0.0817	0.0695	0.0506	0.1006	0.0554
A12	0.0286	0.0284	0.0346	0.0374	0.0436
A13	0.0401	0.0305	0.0441	0.0466	0.0579
A14	0.1103	0.1124	0.0640	0.1519	0.0780

Source: Own elaboration.

According to the ELECTRE III (Roy, 1990) methodology, the following weights, thresholds of indifference and preference associated with each criterion (see table 4 and 5) were considered. We recruited the help of an expert to serve as a Decision Maker (DM) for our problem and asked about his preference, although there are techniques for working groups of experts, such as those pointed out by Gutiérrez-Fernández, Cloquell and Cloquell (2012), it was carried out with the technique Personal Construct Theory recommended by Roger, Bruen and Maystre (2000). With the obtained results, we can argue that is not necessary to consider the use of veto threshold. Another input we obtained from the DM is the definition of the weights for criteria 5.

Table 4. Weights and criteria (*w*)

Tag	*Criteria*	*w*	*Orientation*
C1	Factors and attraction resources	0.294	Maximize
C2	Factors and support resources	0.294	Maximize
C3	Planning and policy of the destination	0.235	Maximize
C4	Destination management	0.118	Maximize
C5	Restrictive determinants	0.059	Minimize

Source: Own elaboration.

On the other hand, the threshold values were generated using a process involving the values of the average between the maximum and minimum points. The result is then multiplied by the minimum and indifference threshold is obtained, the same result is added to the minimum threshold and preference value is obtained, see e.g.:

Method of calculating the threshold of indifference (q):

$$q = Max.\frac{Max - Min}{n(a_i)}$$

Method of calculating the threshold of preference (q):

$$q = Min\frac{Max - Min}{n(a_i)}$$

Table 5. Pseudo-criteria parameters: indifference (q), preference (p) and veto (v) threshold

Tag	*Criteria*	*q*	*p*	*v*
C1	Factors and attraction resources	0.001	0.036	0
C2	Factors and support resources	0.001	0.021	0
C3	Planning and policy of the destination	0.005	0.041	0
C4	Destination management	0.001	0.046	0
C5	Restrictive determinants	0.000	0.048	0

Source: Own elaboration.

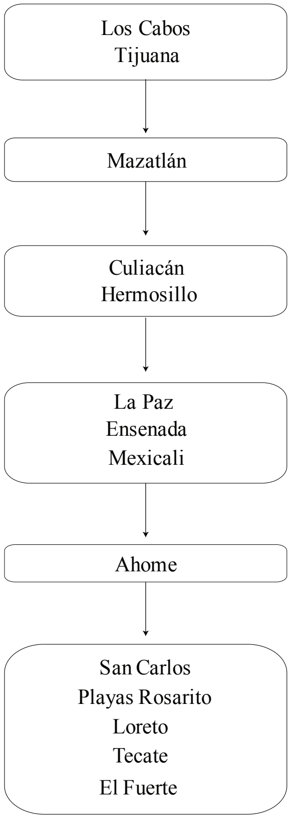
Continuing with the ELECTRE IIImethodology, we built outranking relations among the different alternatives (destinations). The procedure takes the information generated and the integration model of preferences for the alternatives as a fuzzy outranking relation, with the aid of the concordance and discordance principle, as it is used in the ELECTRE III. Once the model is obtained, the next step is the exploitation of the relationship of *outranking* valued using multi-objective algorithm and a procedure to derive a regulation, in order to present a recommendation in the form of ranking (Gastélum, Solano & Leyva, 2014).

As mentioned before, the SADGAGE software was used to obtain the result of a ranking in order of decreasing preference, thus generating a recommendation for the decision-maker.

$$\{A10 \succ A9\} \succ A4 \succ \{A14 \succ A2\} \succ \{A5 \succ A6 \succ A11\} \succ A1 \succ \{A3 \succ A8 \succ A7 \succ A12 \succ A13\}$$

Decoding the labels of tourist destinations, they are classified in descending order according to their level of competitiveness, as shown in figure 3.

Figure 2. Tourist destinations sorted in decreasing competitiveness order



Source: Results from ELECTRE III-NSGA.

7. Sensitivity analysis

In this sense, and in most cases, the process of decision support does not end with the acceptance by the decider of the recommendation made by the analyst; it is usually necessary to perform a sensitivity analysis. The purpose of sensitivity analysis is to measure the robustness of an optimal solution in terms of changes in the weights and/or indifference threshold values and yields, as the end results the information of preferences of the decision maker (Leyva, 2005).

This analysis allows us to interpret the effects of modifying the values of the weights or preferences and indifference thresholds. To do so, the decision maker provides a range of consistent values, also taking into account their preferences. A proposal about how to perform this type of analysis on the weights of the criteria and the performance values of the alternatives is presented by Triantaphyllou and Sánchez (1997). Other related examples of the application of a sensitivity analysis can be found in Briggs, Kunch & Mareschal (1990); Goicoechea, Hansen & Duckstein (1982), Ríos Insua & French (1991) and Leyva (2005).

A sensitivity analysis can be addressed by changing the following parameters:

– changes in the values of the relative importance *(w)* in a single criterion,

– changes in the values of the relative importance *(w)* on several criteria,

– changes in the values of indifference *(q)* and/or preference *(p)* thresholds in a single criterion and

– changes in the values of indifference *(q)* and/or preference *(p)* thresholds in several criteria.

The results of the sensitivity analysis for this empirical study are shown in table 6.

The results observed in the experiment, after changing the weights and thresholds in one or more criteria, were carried out with executions of NGSA and, as can be corroborated, the rankings obtained were 100% consistent with the final recommendation. Of the 13 cases of changes, it mostly preserved the assessment presented in figure 2, in the competitiveness of destinations. Thus, the changes in the range of parameters, which are modified in this analysis, and the sensitivity of the outcome to the final system, can be considered negligible.

Table 6. Effect of changes in weights of the criteria and changes to the threshold in the final results

Range changes specific parameters related to preferences of the decision maker [1]	*Changes to the parameter values* [2]	*Final results after making changes in the parameters* [3]
1. Changing values of relative importance (*w*) for two or more criteria simultaneously	C1: w1=0.340 C2: w2=0.284	{A9>A10}>A4>{A2>A5>A14>}>{A11>A1}>{A8>A3>A13>A7>A12}
	C1: w1=0.284 C2: w3=0.304	{A9>A10}>A4>{A2>A5>A14>}>{A11>A1}>{A8>A3>A13>A7>A12}
	C3: w3=0.225 C5: w5=0.069	{A9>A10}>A4>{A2>A5>A14>}>{A11>A1}>{A8>A3>A13>A7>A12}
	C2: w2=0.284 C3: w3=0.245	{A9>A10}>A4>{A2>A5>A14>}>{A11>A1}>{A8>A3>A13>A7>A12}
	C3: w3=0.225 C4: w4=0.128	{A9>A10}>A4>{A2>A5>A14>}>{A11>A1}>{A8>A3>A13>A7>A12}
2. Change the values of *q* and *p* thresholds for a single criterion.	C1: q=0.002, p=0.050	{A9>A10>A4}>{A2>A14}>{A6>A11>A5}>A1>{A3>A7>A8>A12>A13}
	C2: q=0.002, p=0.030	{A9>A10>A4}>{A2>A14}>{A5>A6>A11}>A1>{A3>A7>A8>A12>A13}
	C3: q=0.002, p=0.045	{A9>A10}>A4>{A2>A14}>{A5>A6>A11}>A1>{A3>A7>A8>A12>A13}
	C4: q=0.002, p=0.055	{A9>A10}>A4>{A2>A14}>{A5>A6>A11}>A1>{A3>A7>A8>A12>A13}
	C5: q=0.002, p=0.050	{A9>A10}>A4>{A2>A14}>{A5>A6>A11}>A1>{A3>A7>A8>A12>A13}
3. The changes in the values of *q* and *p* to several criteria.	C1: q=0.002, p=0.050	{A9>A10}>{A2>A4>A14}>{A5>A6>A11}>A1>{A3>A7>A8>A12>A13}
	C4:q=0.002, p=0.055	
	C2:q=0.002, p=0.030	{A5>A6>A11}>{A2>A14}>{A4>A9>A10}>A1>{A3>A7>A8>A12>A13}
	C4:q=0.002, p=0.055	
	C1: q=0.002, p=0.050	{A9>A10}>{A2>A4>A14}>{A5>A6>A11}>A1>{A3>A7>A8>A12>A13}
	C3: q=0.002, p=0.045	
	C5: q=0.002, p=0.050	

Notes:

1. Range of changes of specific parameters related to the decision maker's preferences.

2. Assumed changes in parameter values.

3. Final results after the changes in parameters have been introduced.

Source:

8. Conclusions

This work presents an empirical analysis of the well-known Crouch-Ritchie model to determine the competitiveness of fourteen cities in Mexico. The ranking of the cities was developed with the aid of an outranking method, using the attributes that best reflect the competitiveness of destinations. This empirical analysis can be considered a prototype of procedure to use the Crouch-Ritchie model in a multicriteria ranking problem, to assess the competitiveness of tourism destinations.

The process of comparing touristic destinations located in the northwest of Mexico, presented in this research, was done following the order established in the methodology, among which the analysis of values obtained from INEGI, SECTUR Federal, state and municipal governments were accentuated, tourism experts and other relevant sources of information.

It was of interest to this study the competitiveness of tourist destinations in a way that contribute to the design of public policies in tourist destinations that show low competitive performance, as well as those who showed consistent indicators, locating them as detonating destinations in tourism and in those where is evidence of efforts to raise their competitive indicators.

Additionally, the most representative set of indicators for the construction of the evaluation criteria were chosen according to the dimensions proposed by Crouch and Ritchie (1999 and 2010) in their model to determine the competitiveness of tourist destinations. For this reason, five compound indicators were selected and constructed, which in this research had the character of criteria decision.

We evaluated 14 alternatives for each of the selected criteria, thus constructing the performance matrix, including the relative importance values of weights *(w)*, indifference thresholds *(q)* and preference *(p)* of these criteria, then perform the calculations of the method in the software sadage developed by Leyva and Álvarez (2013), which has incorporated a multi-objective evolutionary algorithm for problems of medium size (NSGA) (Leyva, Solano, Gastélum & Sánchez, 2013).

The results of the investigation –which resulted from the analysis of 14 destinations located in the northwest of Mexico– were in a decreasing order in which they stood out those that were presented in illustration 14. The following was found:

- Outstanding tourist destination Tijuana, Baja California (A_9), consistently in the first position.
- Los Cabos, Baja California Sur, was located in the second position (A_{10}).
- Destinations that consistently prevail in the third place are Mazatlán, Sinaloa (A_4); Hermosillo, Sonora (A_{14}); and Culiacán, Sinaloa (A_2).
- Destinations of La Paz, Baja California Sur (A_{11}); Ensenada (A_5) y Mexicali, Baja California (A_6), were consistently ranked fourth.
- The destination of Ahome, Sinaloa (A_1), reached the fifth position.
- San Carlos, Sonora (A_{13}), was placed in position six.
- Finally, the destinations of Playas de Rosarito, Baja California (A_7); Loreto, Baja California (A_{12}); Tecate, Baja California (A_8); and El Fuerte, Sinaloa (A_3), were placed in the seventh position, the lowest ranking.

The review of the state of the art in similar experiences allowed us to discover that applications for the multicriteria analysis, and in particular of the ELECTRE III method, are found in numerous applications. Also, that most of the problems focused in solving real-life issues usually are in the middle between subjectivity and objectivity, where what matters most is the opinion of those involved and are required to make tangible criteria and priorities for decisions.

However, with regards to its applications, the ELECTRE research involved measuring the competitiveness of the tourist destinations (only a few of them) and those that we found have been conducted in individual cases with a single destination, or at the town level. There was not a clear guide to the process in those applications, or was not published.

As for the analysis of the competitiveness of destinations, in conditions of uncertainty, there is were no complications, since we are working with information generated in an objective way, expressed in hard data. Yet, one of the main features in the sector is uncertainty, and as a result, the handling of the model becomes more complicated. The ELECTRE method is a success in this regard, given that it allows to explain and understand the competitive order of the tourist destinations in the study.

For future works, this procedure could be used to assess more tourism destinations, and with a bigger sample, identify which factors are the most important or attractive for tourists.

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