ASSET APPRAISAL METHOD BASED ON THE ANALYTIC NETWORK PROCESS

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Abstract

Asset appraisal is an important issue in any country. Interest in the appraisal field is justified by the large number of cases where the estimation of the value of the assets is needed: sales transactions, expropriations, heritage divisions, mortgages, etc. Due to the increasing economic development of the countries and to the increasing complexity of the appraisal problems, it becomes more and more necessary to make better and more accurate valuations.

This work presents an application of the Analytic Network Process (ANP) to asset appraisal. The purpose of this methodology is to solve some of the drawbacks found in classical appraisal methods, which cannot deal with contexts where only partial information is available and/or qualitative variables are used.

The ANP is a method based on the Multiple Criteria Decision Analysis (MCDA). The ANP provides an accurate approach for modeling complex environment because it allows the analysis of the quantitative and qualitative explanatory variables of the price and the incorporation of feedback and interdependence relationships among variables.

The proposed methodology has been applied to a case study of a retail space located in Valencia (Spain)..

Keywords: *Asset appraisal, MCDA, ANP*

Resumen

La valoración de activos es un tema importante en cualquier país. El interés por el campo de la valoración se justifica por la cantidad de casos en los que se necesita la estimación del valor de los activos: transacciones comerciales, expropiaciones, particiones de herencias, hipotecas, etc. Cada vez es más necesario hacer valoraciones más precisas debido al mayor desarrollo económico y al incremento de la complejidad de los problemas de valoración.

El presente trabajo presenta una aplicación del Proceso Analítico en Red (ANP) a la valoración de activos. El objetivo de esta metodología es resolver algunos de los inconvenientes de los métodos de valoración clásicos, los cuales no se pueden aplicar en contextos con información parcial y/o en los que se utilizan variables cualitativas.

ANP es un método basado en el Análisis Multicriterio de Decisiones (MCDA). ANP es un método adecuado para modelizar entornos complejos porque permite el análisis de variables explicativas del precio, tanto cuantitativas como cualitativas y también permite la incorporación de relaciones de interdependencia entre las variables.

La metodología propuesta se ha aplicado a la valoración de locales comerciales situados en Valencia (España)

***Palabras clave**: Valoración urbana, MCDA, ANP*

1. Introduction

The appraisal of assets in general, and of urban real estate in particular, is regulated in Spain by Order ECO/805/2003 and its modification Order EHA/3011/2007. The rpcoedures and methodology to be followed in each case are detailed in these Orders. One of the methods proposed in all cases is that of comparison, i.e. calculating the unknown value of a property by comparing it with similar properties (deemed comparable) whose value is known. The comparison process is called homogenization in Order ECO/805/2003, where it is defined as "a procedure by which the appraised property's characteristics are analysed in relation to others comparable to it, their similarities and differences, a selling price or homogenised rent for it."

Different comparison methods have been proposed in appraisal practice. A non-exhaustive list of those used in Spain would be: Ordinary Least Squares (Brañas and Caridad, 1996; Segura et al., 1998), Goal programming (Aznar and Guijarro, 2007a, 2007b), Spatial Regression (Chica, 1992; Montero, 2004), Valuation ratio, Beta method (Ballestero, 1973) and Neuronal networks (Caridad and Ceular, 2001). The most commonly used in professional practice is known as Multiple Correction Method, with similar versions used in other countries such as Mexico (endorsement method) or in Brazil (homogenization method). A classification of current methodologies can be found in Aznar et al. (2007, 2008).

One of the main differences between these comparative methods is the amount of information required for their application, the most demanding being those based on regression techniques. Information there must necessarily be quantifiable, so qualitative or quantitative variables with unknown values cannot be used.

On the other hand, value perception in modern societies is increasingly dependent on qualitative variables. Therefore, methods incorporating these values in the appraisal process are required.

The inconveniences mentioned have led researchers to the development of alternative methods for asset appraisal. These new approaches are based on multiple criteria decision analysis techniques, therefore referred to as Multicriteria Appraisal Methods or MVM (Aragonés-Beltrán et al., 2008; García-Melón et al., 2008). The MCDA methods allow tackling problems defined with little information and/or strongly weighted with qualitative and subjective variables. This is why the use of this group of methods is particularly interesting in appraising assets, overcoming some of the shortcomings inherent to traditional appraisal methods.

Some of the MCDA methods, such as the CRITIC method (Diakoulaki et al., 1995), Goal Programming (GP) (Charnes and Cooper, 1961) and the Analytic Hierarchy Process (AHP) (Saaty, 1980; Moreno, 2002), have already been successfully used in the appraisal of various assets (Kettani y Khelifi, 2001; Aznar y Guijarro, 2004, 2007a, 2007b). The objective of the present paper is to continue the research into new multiple criteria decision analysis methods by applying the Analytical Network Process (ANP) (Saaty, 1996) to real estate appraisal cases. In practice, the ANP will be used in appraising a retail space in the seaside district of Valencia (Spain)

The rest of the paper is structured as follows. Section 2 is an introduction to ANP methodology. Then, Section 3 describes the use of ANP in urban real estate and the relevance of regional differences in its application. Section 4 illustrates the proposal with a real case study of an urban Retail Space. Finally, Section 5 presents the main conclusions drawn from the study.

2. Background of the ANP

The AHP was proposed by Saaty in 1980 as a solution to specific decision making problems. This method shows satisfactory results when dealing with decision problems in which a criteria hierarchical structure can be stated and independence among criteria can be assumed and verified. However, in many real world problems this independence cannot be verified. With the aim of solving this, Saaty proposed the ANP (Saaty, 2001). The ANP represents any decision making problem as a network of criteria and alternatives (which are all called elements), grouped into clusters. All the elements in the network can be related in any possible way, which means that a network can incorporate feedback and interdependent relationships within and between clusters, which allows working with interdependencies among criteria. This provides a more accurate approach for modelling complex environments. The influence of elements in the network on other elements in that network can be represented in a supermatrix. This new concept is a two-dimensional matrix of elements by elements which adjusts the relative importance weights in individual pairwise comparison matrices to form a new overall supermatrix with the eigenvectors of the adjusted relative importance weights. According to Saaty (2001), the ANP comprises four main steps:

(i) Conducting pairwise comparisons on the elements.

(ii) Placing the resulting relative importance weights (eigenvectors) in pairwise comparison matrices within the supermatrix (unweighted supermatrix).

(iii) Adjusting the values in the unweighted supermatrix so that it can achieve column stochastic (weighted supermatrix). (This condition is needed to derive meaningful limiting priorities (Saaty, 226, p.53))

(iv) Raising the weighted supermatrix to limiting powers until the weights have converged and remain stable (limit supermatrix).

The ANP method has already been applied to different decision-making problems. The most recent applications can be found in: urban solid waste management (Khan y Faisal, 2008), evaluation of sustainable forest management (Wolfslehner y Vacik, 2008), soil contamination recovery treatments selection (Promentilla et al., 2008), supplier selection (Demirtas y Üstün, 2008), , among others. There are only a few ANP applications of ANP to asset appraisal (Aragonés-Beltrán et al., 2008; García-Melón et al., 2008), but they still have not been applied to the particular case of urban retail spaces, which require to satisfy specific legal conditions dependent on the country. Therefore, the aim of this paper is to propose an ANP based appraisal method for the specific case of retail spaces adapted to the Spanish legislation. The proposed methodology has been applied to a real case of a retail space located in a maritime district of the city of Valencia (Spain)

3. Valuation methodology for properties based on ANP

3.1. Formulation of the problem

Firstly, the information required for the correct formulation of the valuation problem needs to be gathered. This information consists of the features of the property to be valued (problem property) which affect its value, structural features of the building, features of the urban environment and location of the property.

3.2. Selection of comparables

Subsequently an analysis of the segment of the property market should be carried out and, based on the specific information concerning real transactions and firm offers properly corrected where necessary, properties with their current cash sale price should be obtained. Comparables or reference properties are the ones which are deemed similar to the property to be valued, or suitable for the application of the homogenization process. This process consists of analyzing the characteristics of the property to be valued with other comparables so as to deduce, by comparison of similarities and differences in the relevant attributes, a purchase price. The more similar the comparables are to the problem property, the greater the accuracy of the estimate of its market value will be. Consequently, similarity to the problem property is an important aspect when selecting comparables.

3.3. Selection of explanatory variables

Explanatory variables are attributes or features which justify or explain the price of a given asset, in this case a urban retail space. Their selection depends on the known features of comparables and their similarity to the problem property.

In the case of urban retail space valuation, some of these variables will be directly observable or quantifiable, such as the surface area or age of the building, among others. Other qualitative variables, however, will also be important, such as the quality of build, the shopping environment, the urban environment, among others. To quantify this type of variables pairwise comparisons will be used, which enable qualitative variables to be quantified and to be included in the valuation process.

3.4. Modelling of the valuation problem as a network

Before applying ANP to the valuation of retail space properties the multicriteria vocabulary used by ANP needs to be adapted to the normal terminology of valuation practice. For this reason, hereinafter “explanatory variable” will replace “criterion” and “alternatives” will be substituted by “properties” (problem property and comparable properties). Explanatory variables and properties are the elements of the network in ANP.

The task of modelling a valuation problem as a network of interdependent elements grouped into clusters may be broken down into the following steps: (i) to identify the elements, (ii) to group the elements into clusters and (iii) to determine the influences between elements. The resulting network will reflect the expertise and experience of the valuer.

3.5. Homogenization process using ANP

The homogenization process consists of comparing the problem property with the comparables, based on the explanatory variables, in order to estimate the market value of the problem property. This process will be undertaken using ANP, which is capable of prioritizing and weighting the reference properties and the problem property by pairwise comparison and the creation of supermatrices. From the limit supermatrix the overall importance weights of the properties involved in the homogenization process may be elicited. These weights will enable to rank all the properties quantitatively.

3.6. Determining the value/weighting ratio

Having determined the overall importance weights of the properties, a ratio comparing the weight of the problem property with its market value, which is unknown, will be obtained. The ratio will be based on the geometric mean of all the individual ratios:

$$r = \left(\prod_{i=1}^{n-1} \frac{v_i}{w_i} \right)^{1/n-1} \qquad (1)$$

where n–1 is the number of comparables involved in the homogenization process (excluding the problem property), the market value of the i-th comparable known from the analysis of the segment of the property market and is the global weight of the i-th comparable obtained using ANP.

3.7. Calculation of the problem property price

From the ratio obtained in the previous step, and the global weight of the problem property being known , its market value is calculated as:

$$v_n = r \cdot w_n \qquad (2)$$

3.8. Analysis of the goodness-of-fit of the result

In order to analyze the goodness-of-fit of the result obtained in the previous step, the value obtained for the problem property will be compared with its actual market value, which is also known.

4. Case study. Retail space valuation in Valencia.

4.1. Formulation of the valuation problem

The aim of this case study is to estimate the market value of a Retail space in the city of Valencia (Spain), of which a series of relevant characteristics for its valuation are known. The information is held on a database of a valuation company on features and market values of several representative properties in segment of the property market. In the Spanish sphere, property valuation is governed by "Ministerial Order ECO/805/2003", which requires a minimum of six comparables in order to be able to issue a valuation report. Assuming this restriction, six different retail spaces are chosen from the database (properties 1 to 6) of similar characteristics to the one to be valued (property X) and situated in an area close to property X. Table 1 shows the information known about the seven properties.

		T1	X	T2	T3	T4	T5	T6
RETAIL SPACE CHARACTERISTICS	1.1 Build quality	housing building	housing building	luxury commercial building	luxury commercial building	luxury commercial building	housing building	housing building
	1.2 Balcony area	0	0	0	0	0	0	0
	1.3 Building age	5	3	30	20	20	35	30
	1.4 Frontage/area	0,591	0,590	0,119	0,768	1,240	0,018	0,324
	1.5 Floor area	114	124,1	165	100	110	150	100
	1.6 Hight	ground floor	ground floor	ground floor	ground floor	ground floor	ground floor	ground floor
		T1	X	T2	T3	T4	T5	T6
ENVIRONMENT SOCIAL CHARACTERISTICS	2.1 Shopping environment	good	good	good	good	good	good	good
	2.2 Urban environment	good	good	good	good	good	good	good
	2.3 Population density	medium	medium	high	high	high	medium	high
	2.4 Income level	medium	medium	medium	medium	medium	medium	medium
	2.5 Street category	2nd	2nd	2nd	2nd	2nd	2nd	2nd
	Price	220000		475000	360000	400000	180000	146000

Table 1. Properties characteristics

The market value of the comparables, expressed in Euros, corresponds to the current purchase price of the properties known from recent transactions. The floor area is a quantitative variable which is measured in square metres and affects the balcony area and the frontage/area relationship. The surface area of the balcony is measured in square metres, a null value indicating the absence of a balcony for the property. The age in years of the buildings is a quantitative variable which inversely affects the price of the properties. The quality of build has been expressed by taking the quality of state-subsidized housing as a reference point. The shopping and urban environments are two qualitative variables measured using a subjective scale: acceptable, good and very good. The income level and population density of the area have also been expressed on a qualitative scale (medium or high), due to the lack of more precise information.

Although information on measurable and observable attributes of the properties is available (such as the surface area, for example), most of the variables are expressed qualitatively. This is due to the difficulty when quantifying some variables, such as build quality, and the non-existence of more specific information for defining other variables, such as in the case of population density. This valuation context, characterized by scant accurate information and by the strong influence on market value of qualitative variables, makes it difficult to tackle using traditional urban property valuation methods. This fact justifies the application of a multicriteria valuation method for solving the problem. The existence of interdependences among the explanatory variables indicates the application of the valuation methodology based on ANP proposed in this study.

4.2. Selection of comparables and explanatory variables

Properties 1 to 6 are located in the same environment as property X and their characteristics are similar, a requirement of Spanish legislation, as shown in Table 1. Given that their current market value is also known, properties 1 to 6 are taken as comparables.

Explanatory variables will be grouped in variables relating to the characteristics of the retail space (EV1), and variables relating to the social environment of the property (EV2) (see table 1)

4.3. Solution of the valuation problem

The valuation problem has been solved with an ANP model, so that interdependences between variables and properties, among variables and among properties themselves may be represented.

To calculate the value/weighting ratio [1] will be used and to compare the goodness-of-fit of the obtained solution it will be compared with the actual market price of the property, which is already known.

The model solves the valuation problem with ANP, setting out a network of elements grouped into clusters (Figure 1). The network elements are the explanatory variables and the properties, which have been grouped into three clusters: property characteristics, environment characteristics and assets to be valued (A).

For the determination of the influences a zero-one interfactorial dominance matrix was used whose elements aij take the value 1 or 0 depending on whether there is or there is not some influence of element i on element j. The rows and columns of the matrix are formed by all the elements of the network.

	1.1	1.2.	1.3	1.4	1.5	1.6	2.1	2.2	2.3	2.4	2.5	T1	T2	T3	T4	T5	T6	X
1.1			1									1	1	1	1	1	1	1
1.2.												1	1	1	1	1	1	1
1.3												1	1	1	1	1	1	1
1.4												1	1	1	1	1	1	1
1.5		1		1								1	1	1	1	1	1	1
1.6												1	1	1	1	1	1	1
2.1								1	1	1	1	1	1	1	1	1	1	1
2.2									1	1		1	1	1	1	1	1	1
2.3												1	1	1	1	1	1	1
2.4												1	1	1	1	1	1	1
2.5							1	1	1	1		1	1	1	1	1	1	1
T1	1	1	1	1	1	1	1	1	1	1	1							
T2	1	1	1	1	1	1	1	1	1	1	1							
T3	1	1	1	1	1	1	1	1	1	1	1							
T4	1	1	1	1	1	1	1	1	1	1	1							
T5	1	1	1	1	1	1	1	1	1	1	1							
T6	1	1	1	1	1	1	1	1	1	1	1							
X	1	1	1	1	1	1	1	1	1	1	1							

Table 2. Interfactorial matrix for the case study

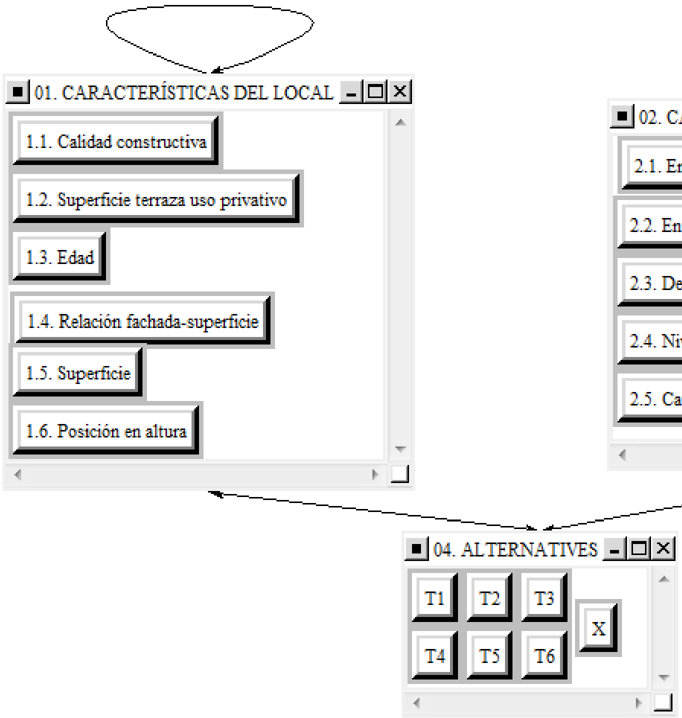

Figure 1. Network model for the case study

The bidirectional arrows, which join the property cluster to each of the clusters of explanatory variables, indicate mutual influence: on the one hand the influence of the explanatory variables on the market value of each of the properties is weighted, and on the other hand the dominance of the properties for each explanatory variable is weighted. The relations between elements have also been added; consequently dependences between the explanatory variable clusters and within them appear.

The relative importance weights of all the elements in the network are shown arranged on the unweighted supermatrix (Table 3). In order to obtain the weighted supermatrix (table 4) the corresponding priorities of the clusters have been obtained. By raising the weighted supermatrix to successive powers until convergence of their inputs is reached, the limit supermatrix is obtained (table 5) with a global importance weight vector [0.045, 0.018, 0.030, 0.121, 0.086, 0.078, 0.030, 0.031, 0.040, 0.014, 0.028, 0.070, 0.062, 0.069, 0.096, 0.052, 0.058, 0.071]T. The global importance weights of the properties may be taken from the limit supermatrix in order to calculate the value/weighting ration as per [1] and the value of property X (Table 6). The value obtained for property X is 287,729 €.

	1.1.	1.2.	1.3.	1.4.	1.5.	1.6.	2.1.	2.2.	2.3.	2.4.	2.5.	T1	T2	T3	T4	T5	T6	X
1.1.	0,000	0,000	1,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,060	0,213	0,168	0,125	0,104	0,089	0,055
1.2.	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,051	0,045	0,052	0,040	0,057	0,070	0,046
1.3.	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,168	0,045	0,051	0,040	0,054	0,070	0,165
1.4.	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,398	0,087	0,449	0,532	0,065	0,270	0,383
1.5.	0,000	1,000	0,000	1,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,120	0,416	0,084	0,085	0,480	0,119	0,167
1.6.	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,203	0,193	0,196	0,178	0,240	0,382	0,185
2.1.	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,500	0,258	0,258	1,000	0,243	0,061	0,061	0,175	0,243	0,175	0,243
2.2.	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,637	0,637	0,000	0,243	0,212	0,212	0,175	0,243	0,175	0,243
2.3.	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,192	0,434	0,434	0,417	0,192	0,417	0,192
2.4.	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,130	0,133	0,133	0,094	0,130	0,094	0,130
2.5.	0,000	0,000	0,000	0,000	0,000	0,000	1,000	0,500	0,105	0,105	0,000	0,192	0,160	0,160	0,139	0,192	0,139	0,192
T1	0,077	0,143	0,342	0,159	0,132	0,143	0,176	0,143	0,067	0,143	0,143	0,000	0,000	0,000	0,000	0,000	0,000	0,000
T2	0,231	0,143	0,049	0,033	0,191	0,143	0,059	0,143	0,200	0,143	0,143	0,000	0,000	0,000	0,000	0,000	0,000	0,000
T3	0,231	0,143	0,085	0,155	0,116	0,143	0,059	0,143	0,200	0,143	0,143	0,000	0,000	0,000	0,000	0,000	0,000	0,000
T4	0,231	0,143	0,085	0,366	0,127	0,143	0,176	0,143	0,200	0,143	0,143	0,000	0,000	0,000	0,000	0,000	0,000	0,000
T5	0,077	0,143	0,049	0,031	0,174	0,143	0,176	0,143	0,067	0,143	0,143	0,000	0,000	0,000	0,000	0,000	0,000	0,000
T6	0,077	0,143	0,049	0,095	0,116	0,143	0,176	0,143	0,200	0,143	0,143	0,000	0,000	0,000	0,000	0,000	0,000	0,000
X	0,077	0,143	0,342	0,159	0,144	0,143	0,176	0,143	0,067	0,143	0,143	0,000	0,000	0,000	0,000	0,000	0,000	0,000

Table 3. Unweighted supermatrix

	1.1.	1.2.	1.3.	1.4.	1.5.	1.6.	2.1.	2.2.	2.3.	2.4.	2.5.	T1	T2	T3	T4	T5	T6	X
1.1.	0,000	0,000	0,125	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,045	0,160	0,126	0,094	0,078	0,067	0,041
1.2.	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,038	0,034	0,039	0,030	0,043	0,052	0,034
1.3.	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,126	0,034	0,038	0,030	0,041	0,052	0,124
1.4.	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,298	0,065	0,337	0,399	0,049	0,203	0,287
1.5.	0,000	0,125	0,000	0,125	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,090	0,312	0,063	0,063	0,360	0,090	0,125
1.6.	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,152	0,145	0,147	0,134	0,180	0,286	0,139
2.1.	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,083	0,043	0,043	0,167	0,061	0,015	0,015	0,044	0,061	0,044	0,061
2.2.	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,106	0,106	0,000	0,061	0,053	0,053	0,044	0,061	0,044	0,061
2.3.	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,048	0,109	0,109	0,104	0,048	0,104	0,048
2.4.	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,033	0,033	0,033	0,024	0,033	0,024	0,033
2.5.	0,000	0,000	0,000	0,000	0,000	0,000	0,167	0,083	0,017	0,017	0,000	0,048	0,040	0,040	0,035	0,048	0,035	0,048
T1	0,077	0,125	0,299	0,140	0,132	0,143	0,147	0,119	0,056	0,119	0,119	0,000	0,000	0,000	0,000	0,000	0,000	0,000
T2	0,231	0,125	0,043	0,029	0,191	0,143	0,049	0,119	0,167	0,119	0,119	0,000	0,000	0,000	0,000	0,000	0,000	0,000
T3	0,231	0,125	0,074	0,136	0,116	0,143	0,049	0,119	0,167	0,119	0,119	0,000	0,000	0,000	0,000	0,000	0,000	0,000
T4	0,231	0,125	0,074	0,321	0,127	0,143	0,147	0,119	0,167	0,119	0,119	0,000	0,000	0,000	0,000	0,000	0,000	0,000
T5	0,077	0,125	0,043	0,028	0,174	0,143	0,147	0,119	0,056	0,119	0,119	0,000	0,000	0,000	0,000	0,000	0,000	0,000
T6	0,077	0,125	0,043	0,083	0,116	0,143	0,147	0,119	0,167	0,119	0,119	0,000	0,000	0,000	0,000	0,000	0,000	0,000
X	0,077	0,125	0,299	0,140	0,144	0,143	0,147	0,119	0,056	0,119	0,119	0,000	0,000	0,000	0,000	0,000	0,000	0,000

Table 4. Weighted supermatrix

	1.1.	1.2.	1.3.	1.4.	1.5.	1.6.	2.1.	2.2.	2.3.	2.4.	2.5.	T1	T2	T3	T4	T5	T6	X
1.1.	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045	0,045
1.2.	0,018	0,018	0,018	0,018	0,018	0,018	0,018	0,018	0,018	0,018	0,018	0,018	0,018	0,018	0,018	0,018	0,018	0,018
1.3.	0,030	0,030	0,030	0,030	0,030	0,030	0,030	0,030	0,030	0,030	0,030	0,030	0,030	0,030	0,030	0,030	0,030	0,030
1.4.	0,121	0,121	0,121	0,121	0,121	0,121	0,121	0,121	0,121	0,121	0,121	0,121	0,121	0,121	0,121	0,121	0,121	0,121
1.5.	0,086	0,086	0,086	0,086	0,086	0,086	0,086	0,086	0,086	0,086	0,086	0,086	0,086	0,086	0,086	0,086	0,086	0,086
1.6.	0,078	0,078	0,078	0,078	0,078	0,078	0,078	0,078	0,078	0,078	0,078	0,078	0,078	0,078	0,078	0,078	0,078	0,078
2.1.	0,030	0,030	0,030	0,030	0,030	0,030	0,030	0,030	0,030	0,030	0,030	0,030	0,030	0,030	0,030	0,030	0,030	0,030
2.2.	0,031	0,031	0,031	0,031	0,031	0,031	0,031	0,031	0,031	0,031	0,031	0,031	0,031	0,031	0,031	0,031	0,031	0,031
2.3.	0,040	0,040	0,040	0,040	0,040	0,040	0,040	0,040	0,040	0,040	0,040	0,040	0,040	0,040	0,040	0,040	0,040	0,040
2.4.	0,014	0,014	0,014	0,014	0,014	0,014	0,014	0,014	0,014	0,014	0,014	0,014	0,014	0,014	0,014	0,014	0,014	0,014
2.5.	0,028	0,028	0,028	0,028	0,028	0,028	0,028	0,028	0,028	0,028	0,028	0,028	0,028	0,028	0,028	0,028	0,028	0,028
T1	0,070	0,070	0,070	0,070	0,070	0,070	0,070	0,070	0,070	0,070	0,070	0,070	0,070	0,070	0,070	0,070	0,070	0,070
T2	0,062	0,062	0,062	0,062	0,062	0,062	0,062	0,062	0,062	0,062	0,062	0,062	0,062	0,062	0,062	0,062	0,062	0,062
T3	0,069	0,069	0,069	0,069	0,069	0,069	0,069	0,069	0,069	0,069	0,069	0,069	0,069	0,069	0,069	0,069	0,069	0,069
T4	0,096	0,096	0,096	0,096	0,096	0,096	0,096	0,096	0,096	0,096	0,096	0,096	0,096	0,096	0,096	0,096	0,096	0,096
T5	0,052	0,052	0,052	0,052	0,052	0,052	0,052	0,052	0,052	0,052	0,052	0,052	0,052	0,052	0,052	0,052	0,052	0,052
T6	0,058	0,058	0,058	0,058	0,058	0,058	0,058	0,058	0,058	0,058	0,058	0,058	0,058	0,058	0,058	0,058	0,058	0,058
X	0,071	0,071	0,071	0,071	0,071	0,071	0,071	0,071	0,071	0,071	0,071	0,071	0,071	0,071	0,071	0,071	0,071	0,071

Table 5. Limit supermatrix

	supermatrix weight	normalized weight	value	ratio	geometric mean ratio	property X value
T1	0,070	0,146	220.000,00 €	1508192		
T2	0,062	0,130	475.000,00 €	3656344		
T3	0,069	0,145	360.000,00 €	2476128		
T4	0,096	0,200	400.000,00 €	1995111		
T5	0,052	0,109	180.000,00 €	1655043		
T6	0,058	0,122	146.000,00 €	1200277	1944863,499	
X	0,071	0,148				287.729,66 €

Table 6. Calculation of problem property value

4.4. Analysis of the goodness-of-fit of the result

The value obtained for the problem property will be compared with its actual market value, which is also known.

property X calculated value (€)	property X actual market value (€)	difference (€)	difference (%)
287729	290494	2765,00	0,95

Table 7. Calculation of the goodness of the result

5. Conclusions

ANP is a multicriteria decision aid technique, which allows to establish priorities for the alternatives taking into account the identified criteria. The novelty of this particular technique is that it takes into account the interdependencies among alternatives and criteria. The priorities obtained are measured in a ratio scale in a way that their value indicates a percentage of the global priority. Moreover, the method allows the weighting of the criteria at the same time.

The main advantage of this method is that it allows to integrate both quantitative and qualitative variables. It also allows a rigorous analysis of the characteristics of the different reference properties and to detect if they are actually comparable with the problem property.

The results obtained for the problem property show a difference of 2765 € between the calculated value and the actual market price. This represents a 0,95 % of deviation. Therefore, it can be concluded that the goodness-of-fit of the result obtained with the proposed method has been demonstrated.

However, this methodology is not free of criticism. It is a laborious method which is quite time consuming. For that, as a future recommended work, a software tool which allows appraisers automatize the procedure has to be developed.

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