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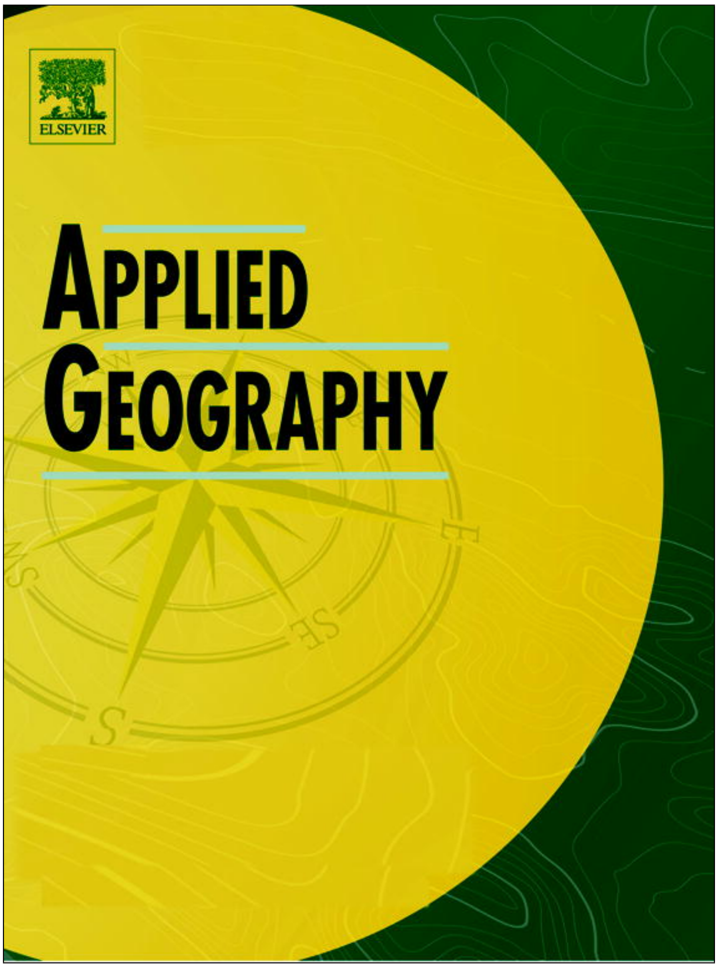


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Applied Geography 40 (2013) 191–198

Contents lists available at SciVerse ScienceDirect

Applied Geography

journal homepage: www.elsevier.com/locate/apgeog

# The retail site location decision process using GIS and the analytical hierarchy process

Norat Roig-Tierno*, Amparo Baviera-Puig, Juan Buitrago-Vera, Francisco Mas-Verdu

*Department of Economics and Social Sciences, Universitat Politècnica de València, Camino de Vera s/n 46022, Valencia, Spain*

*Keywords:*
Retail site location
Geographic information systems (GIS)
Geodemand
Geocompetition
Kernel density
Analytical hierarchy process (AHP)

A B S T R A C T

The opening of a new establishment is a critical factor for firms in the retail sector because the decision carries with it a series of very serious financial and corporate image risks. This paper presents the development of a methodology for the process of selecting a retail site location that combines geographic information systems (GIS) and the analytical hierarchy process (AHP). The AHP methodology shows that the success factors for a supermarket are related to its location and competition. The proposed retail site location decision process was applied to the opening of a new supermarket in the Spanish city of Murcia.
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## Introduction

Geography plays a key role in the success of a business (Alcaide, Calero, & Hernández, 2012; García-Palomares, Gutiérrez, & Latorre, 2012). In the retail sector, the opening of a new site is a critical decision because the choice of location implies serious financial and corporate image risks for the firm in question (Alarcón, 2011). For this reason, it is crucial to perform a solid analysis of the possible locations for new store openings (Hernández & Bennison, 2000).

Church (2002) asserted that the success of many future applications for retail site location selection may be closely linked to geographic information systems (GIS) because these are the systems used when working with spatial information. One of the reasons for the success of GIS is their capacity to generate visualizations of data, which greatly assist in such a complex decision-making process as retail site location (Hernández, 2007; Musyoka, Mutyauvyu, Kiema, Karanja, & Siriba, 2007). This facet of GIS allows managers who lack technical knowledge to understand geographic information, thereby helping them to make difficult yet highly important decisions (Ozimec, Natter, & Reutterer, 2010). In addition, GIS are capable of dealing with large quantities of information and linking digital maps to relational databases. The characteristics described here make GIS indispensable tools in the development of decision processes associated with retail site location selection (Mendes & Themido, 2004).

One of the factors that influence market share and substitution patterns between available commercial options is the spatial dispersion of both consumers and vendors (Davis, 2006). This spatial dispersion may be helpful in determining sites for new commercial establishments (Baviera-Puig, Castellanos, Buitrago, & Rodríguez, 2011). Two key concepts stem from this idea: geodemand and geocompetition. Geodemand can be defined as the location of the customers who purchase a product or service in a specific market. Geocompetition is the location of the competitors of a business and the delineation of their trade areas in a particular market. A trade area can be defined as the geographic area in which a retailer attracts customers and generates sales during a specific period (Applebaum & Cohen, 1961; Baviera-Puig, Buitrago-Vera, & Mas-Verdú, 2012).

Possible locations for a new retail establishment can be identified by jointly analyzing geodemand and geocompetition. However, on many occasions, the complexity and importance of deciding whether to open a new store goes much further than simply identifying several possible locations. The location strategy also implies making a decision as to the most suitable location from a list of possibilities (Wood & Reynolds, 2012).

Although the theory of location and the theory of GIS have evolved practically independently, they currently support one another. These theories can complement the study of decision-making models, where the techniques are equally applicable in both spatial and non-spatial fields (Church & Murray, 2009). Decision making is the process of choosing the best way to achieve an objective. To aid this process, decision makers often use multi-criteria decision models, which facilitate the decision-making

* Corresponding author. Tel.: +34 654547447.
*E-mail addresses:* horoitie@topo.upv.es, noratroig@gmail.com (N. Roig-Tierno), ambapui@upv.es (A. Baviera-Puig), jmbuitrago@esp.upv.es (J. Buitrago-Vera), fmas@upvnet.upv.es (F. Mas-Verdu).

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process by identifying one or more solutions from among the available alternatives, according to some criteria (Rybarczyk & Wu, 2010). In their research, Berumen and Llamazares (2007) differentiated between discrete multi-criteria decision problems and multiobjective decision problems. Multi-criteria decision problems present finite alternatives (Simon, 1983, 2005; Thaler, 1986), whereas multiobjective decision problems have an infinite number of possible solutions. The main discrete multi-criteria decision methods are linear weighting (scoring), multiattribute utility (MAUT), overrating relations and the analytic hierarchy process (AHP), the last of which is the principal method employed in this study.

The analytic hierarchy process (AHP) was developed by Saaty (1980) and consists of defining a hierarchical model that represents complex problems through criteria and alternatives that are set out initially. This procedure is designed to break a complex problem into a set of simpler decisions, thus making the problem easier to understand and therefore easier to solve (Arquero, Álvarez, & Martínez, 2009). Using multi-criteria decision models, it becomes possible to select and/or prioritize the opening of different retail sites. At the same time, AHP determines the criteria that affect the success of the chosen business (Gbanie, Tengbe, Momoh, Mebo, & Kabba, 2013; Suárez-Vega, Santos-Peñate, Dorta-González, & Rodríguez-Díaz, 2011).

We analyzed the commercial distribution sector of frequently purchased products in Murcia (Spain). The main aim was to develop a methodology that identifies sites for new supermarkets using GIS and multi-criteria decision models. This general objective can be broken down into two more specific aims: 1) the determination and weighting of the main factors or attributes that affect the supermarket's success, based on the existing literature; and 2) the ranking of possible sites for a new commercial opening, via the joint analysis of geodemand and geocompetition.

Section 2 (The retail site location decision process) presents the proposed retail site location decision process; Section 3 (Factors that affect the success of a supermarket) describes the success factors for a supermarket, determined with the help of AHP; Section 4 (Locating a new supermarket in Murcia) presents an example of a supermarket site location selection using the proposed procedure; and Section 5 (Conclusions) summarizes conclusions drawn from this research and suggests future lines of research to extend the work presented in this paper.

## The retail site location decision process

To determine the best site for a new retail outlet, we first conduct an analysis of geodemand, which is used to locate the clients of a product or service. Second, geocompetition is analyzed, which means spatially locating the firm's competition. Third, the possible commercial sites are determined by combining the results of the two previous steps, together with the use of kernel density analysis. The software used in these three steps is ArcGis 10. Finally, depending on the resources available to the firm, multi-criteria decision models are used to help select the best location from among the possibilities identified in the previous analysis steps.

### *Identifying geodemand and geocompetition*

When geolocating the demand, our procedure drills down to the city block level, which provides a greater level of detail than that available from other site selection procedures, which work with information at the census tract level. This high level of detail makes it necessary to calculate the number of housing units per city block from the cadastral data and, based on this number, to estimate the average number of residents per city block.

First, to calculate the number of housing units per city block, alphanumeric data from the municipal cadastral database are linked to the graphical data of the city blocks using GIS. Second, to estimate the average number of residents per city block, data from the municipal census are linked to the number of housing units per city block. This process yields an estimate of the number of people living in each city block. This second step is more complex than the previous one because the information from the municipal census pertains to the census tract level, and a census tract consists of several city blocks. To complete this second step, we first use the municipal census to identify the inhabitants of the municipality in question, along with the census tracts in which they live. The inhabitants are then allocated among the housing units in each census tract, taking into account multi-family and single-family units.

After identifying and geolocating the competition, spatial Cartesian coordinates ($x$, $y$) are allocated to the addresses of the selected commercial establishments. The establishments of the chain that is planning to open a new store are also included because these existing sites can be considered competition due to the phenomenon of cannibalization (Suárez-Vega, Santos-Peñate, & Dorta-González, 2012). Once the geocompetition has been identified and analyzed, the trade area for each of the retail outlets is calculated. In contrast with other theories (Christaller's central place theory, Hotelling's duopolistic competition and Losch's concept of the range of the good), Reilly (1931) proposed that consumers consider not only the distance to but also the attractiveness of different retail alternatives. Huff (1963) suggested that the utility of a store is positively related to the size of the outlet and negatively related to the distance. For this reason, the trade area of a supermarket is defined as an isochrone based on its sales floor area. This isochrone takes into consideration the physical features of the urban landscape. According to Table 1, a site with a surface area of 500 m$^2$ corresponds to an isochrone of 5 min, which is equivalent to a maximum distance of 333 m for pedestrian customers. This distance increases with the surface area of the supermarket and decreases accordingly if the supermarket has a smaller sales floor area.

### *Determining the possible locations*

We match the information resulting from the joint analysis of geodemand and geocompetition to obtain a third layer that shows areas where the population does not have any range of commercial offer or where the range of commercial services is poor. At this stage, kernel density analysis can identify the areas with higher concentrations of potential clients.

Kernel density estimation is a non-parametric way to estimate the probability density function of a random variable (Rosenblatt, 1956). Conceptually, the goal of kernel density estimation is to calculate the density of points in a given area using the distance between the points, if and only if the points have the same weight. However, different weights may be assigned to each point to assign greater importance to specific points relative to the rest. The final result is expressed in units of a particular phenomenon per unit of surface area.

**Table 1**
Trade areas of supermarkets based on the sales floor area.

| Sales floor area (m$^2$) | Time/isochrone (minutes) | Maximum distance traveled (m) |
|---|---|---|
| $300 < S \le 600$ | 5′ | 333 |
| $600 < S \le 1000$ | 8′ | 533 |
| $1000 < S \le 2500$ | 10′ | 667 |
| $S > 2500$ | 18′ | 1200 |

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Following the example of Moreno (2007), we used the pixel as the unit of study. The pixel is a square designed to represent a portion of space on a digital map. This square is associated with a value that is in turn associated with the element that actually occupies that portion of territory. In the site selection process described in this paper, for every pixel on the map, a circular region is defined, and this region is then used as a baseline. The centroid of each pixel is chosen to be the center of the circle, and the points that make up the circle are used to form the dividend. These points can be unequally weighted, depending on their distances from the centroid of the pixel (i.e., pixels that are closer to the centroid have greater weights than those farther away). This can be expressed as follows (Moreno, 2007; Silverman, 1986):

$$L_j = \sum_{i \in C_j} \frac{3}{\pi r^2} \left(1 - \frac{d_{ij}^2}{r^2}\right)^2$$

where:

$L_j$ = estimated density of the pixel;
$d_{ij}$ = distance between points $i$ and $j$;
$r$ = width of the window or search radius, which determines the degree of smoothing; and
$C_j = \{i | d_{ij} < r\}$, so that the set consists of the $i$ points whose distances from the centroid of pixel $j$ are less than the established radius of the circle.

*Selection of the best site*

The kernel density analysis identifies the areas with greater concentrations of potential clients, which make up the set of potential locations for new retail establishments. AHP is then applied to these potential sites. The model proposed by Saaty (1980) is based on the construction of a hierarchical model with three levels: objectives, criteria and alternatives (Fig. 1). The objective is the goal that the process aims to achieve, the criteria are the validation rules for the achievement of the objective, and the alternatives are the elements to which the criteria are applied.

The AHP method does not require quantitative information about each of the alternatives. Instead, it is based on the value judgments of the persons making the decisions (Berumen & Llamazares, 2007). These preferences depend on the scores assigned in pairwise comparisons, by which the criteria are evaluated on an intensity-of-importance scale from one to nine. Once the decision makers have evaluated the criteria using the scale described above, a matrix of comparisons is drawn up that contains the pairwise comparisons of all the different alternatives or criteria. In this matrix, all the elements are positive and possess the properties of reciprocity and consistency. Consistency is calculated using the consistency ratio, which reflects how consistent the judgments are relative to large samples of purely random judgments. If the consistency ratio exceeds 10%, the judgments are considered untrustworthy (Saaty, 1992, 307 p.).

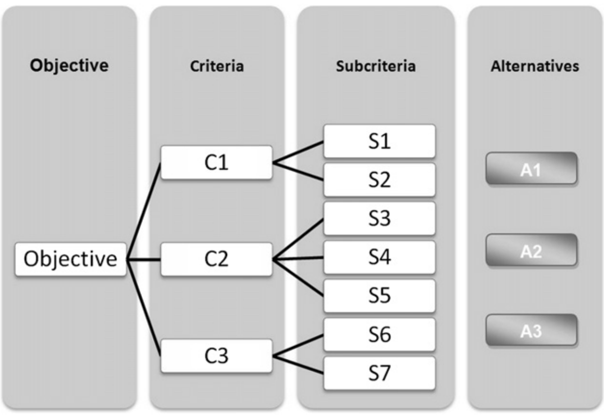


**Fig. 1.** Hierarchical model.

To establish a ranking of priorities from this matrix of pairwise comparisons, one eigenvector per decision maker is obtained. At this stage, it is necessary to aggregate the scores of the decision makers into one unique solution. There are three different processes that can be used to calculate this aggregate: calculating the arithmetic mean, calculating the geometric mean, or calculating the solution that minimizes the positive and negative deviations with respect to the unique solution. The differences between the three methods should not produce differences in the hierarchy of the alternatives, but it is important to consider all three possibilities (Rivera, 2010).

There are several advantages to the AHP method (Osorio & Orejuela, 2008). First, this method makes it possible to analyze and study how changes made at one of the levels affects the other levels. Second, AHP provides information on the system and permits users to gain a general view of the problems being solved and the objectives proposed. Finally, AHP gives users some flexibility when making changes so that these changes do not affect the general structure of the objective.

The AHP method is not, however, without limitations. It becomes more difficult mathematically to detect inconsistencies as the number of items being compared increases. Given this fact and that the simultaneous comparison of more than $7 \pm 2$ items is a difficult task for people (Miller, 1956), comparison matrices should include a maximum of seven items. This problem can easily be avoided by separating the criteria into different groups so that none of the groups has more than $7 \pm 2$ items (i.e., Miller's number).

Thus, the application of AHP in the decision-making process fulfills the two objectives of this study: 1) evaluating and ranking the attributes that influence a supermarket's success and 2) prioritizing the business opportunities identified by the kernel density analysis. Fig. 2 depicts the full decision process proposed for retail site location.

## Factors that affect the success of a supermarket

AHP identifies the criteria that influence the success of a supermarket. To carry out this identification process, we set four main criteria: establishment, location, demographic factors and competition (Baviera-Puig, Buitrago-Vera, & Rodríguez-Barrio, 2012). Each of these four criteria gives rise to another four subcriteria, as shown in Fig. 3.

The first criterion, establishment, pertains to the characteristics of the property itself. These characteristics include the number of square meters of the sales floor (the sales floor area), whether the establishment has parking facilities (parking), the number of product departments (number of departments), and the number of checkouts available to the customer (number of checkouts).

The second criterion, location, encompasses all of the characteristics related to the location of the store. These characteristics include the ease of access by car (accessibility by car), the ease of access by foot (accessibility by foot), the distance from which the store is visible and recognizable to potential clients (visibility), and the volume of passing trade in the surrounding area of the store (volume of passing trade).

The third criterion, demographics, pertains to the profile of the clients living in the trade area of the new retail site. This profile consists of the number of people living in the trade area (potential

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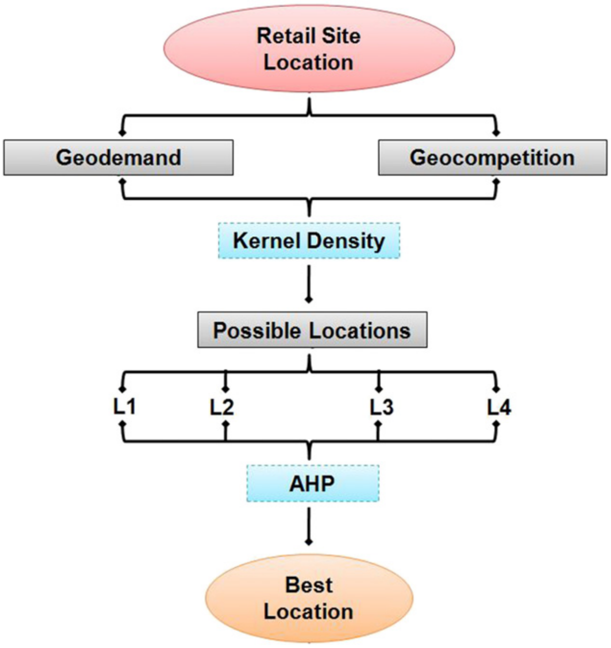


**Fig. 2.** Retail site location decision process.

market – TA), the specific type of clients living in the trade area with respect to factors such as purchasing power and family structure (socio-demographic characteristics), the forecasts for expansion and development in the surrounding area (growth in the area), and the fluctuation of sales throughout the year (seasonality).

The final criterion, competition, pertains to the characteristics of the establishments that provide competition. These characteristics include the distance between the site under consideration and the competitors (distance to competition), the degree of knowledge of the brand in the area (brand recognition), the total sales floor area available to the competition (size of competition), and the commercial strategy employed by the competition (type of competition).

In the example application of the site selection process described in this paper, once the criteria and subcriteria described above had been defined, they were scored using the pairwise comparison technique also described above, using a nine-point scale. This is an intensity-of-importance scale, which is used to measure the importance of each of the criteria, according to the procedure proposed by Saaty (1980). The criteria were evaluated using the responses to questionnaires obtained through the pairwise comparison technique in individual, face-to-face interviews with decision makers.

The decision makers are a group of retail site location and marketing experts. Some of them belong to the academic field, and the rest are professionals. These professionals work in the Marketing Department and the Market Development Department in the same supermarket chain. This chain is one of the top five supermarket chains in Spain. The group of experts was designed to be heterogeneous to foster a range of views and discriminate among their judgments (Wedley, Schoner, & Tang, 1993).

Based on the comparison matrix obtained for the criteria and the expert in each interview, scores with a consistency ratio of greater than 10% were discarded. This process yielded the eigenvectors associated with each one of the Saaty matrices. The eigenvectors for each one of the experts' scores were then grouped together using the arithmetic mean technique. Once the weights associated with each one of the items had been obtained, the subcriteria were ranked. The numbers in parentheses in Table 2 represent the weights associated with each of the items and the score obtained for each subcriterion.

The most influential subcriteria in a supermarket's success, according to the experts consulted, were the volume of passing trade

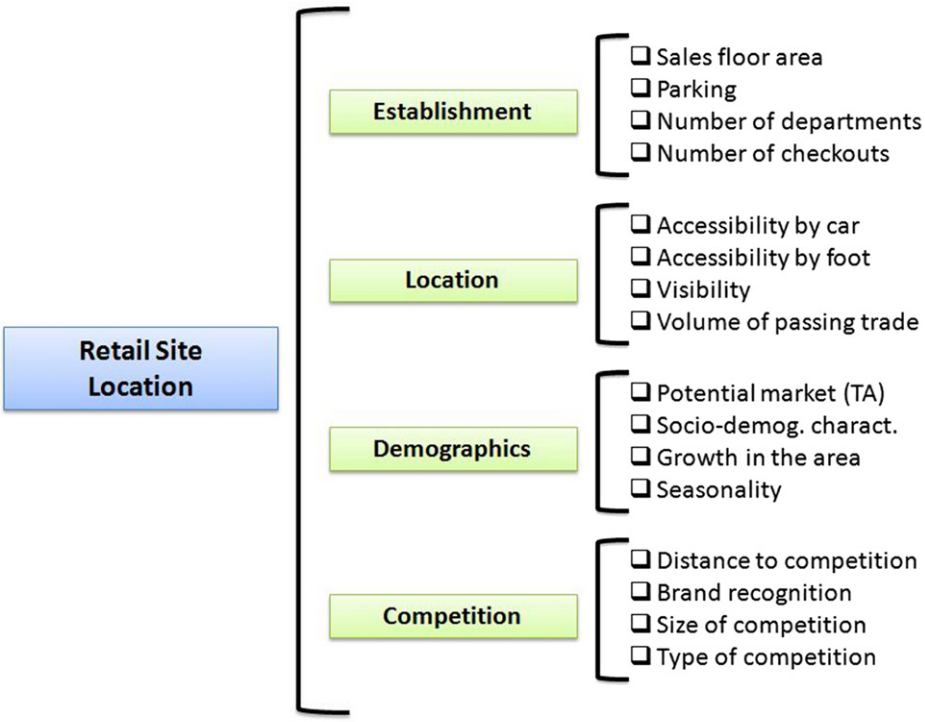


**Fig. 3.** Factors that affect the success of a supermarket.

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**Table 2**
Ranking of the subcriteria that determine the success of a supermarket.

| Ranking | Criteria | Subcriteria | Score |
|---|---|---|---|
| 1 | Location (0.509) | Volume of passing trade (0.342) | 17.44% |
| 2 | Location (0.509) | Visibility (0.287) | 14.62% |
| 3 | Competition (0.245) | Distance to competition (0.591) | 14.49% |
| 4 | Demographics (0.188) | Potential market (TA) (0.519) | 9.75% |
| 5 | Location (0.509) | Accessibility by car (0.191) | 9.71% |
| 6 | Location (0.509) | Accessibility by foot (0.180) | 9.17% |
| 7 | Competition (0.245) | Brand recognition (0.227) | 5.56% |
| 8 | Demographics (0.188) | Seasonality (0.250) | 4.69% |
| 9 | Establishment (0.057) | Number of departments (0.575) | 3.30% |
| 10 | Competition (0.245) | Type of competition (0.128) | 3.13% |
| 11 | Demographics (0.188) | Growth in the area (0.147) | 2.75% |
| 12 | Demographics (0.188) | Socio-demographic characteristics (0.085) | 1.60% |
| 13 | Competition (0.245) | Size of competition (0.055) | 1.35% |
| 14 | Establishment (0.057) | Sales floor area (0.179) | 1.03% |
| 15 | Establishment (0.057) | Parking (0.154) | 0.88% |
| 16 | Establishment (0.057) | Number of checkouts (0.092) | 0.53% |

(17.44%), the visibility of the store (14.62%), the distance from competitors (14.49%), the potential market within the trade area (9.75%), the accessibility by car (9.71%) and the accessibility by foot (9.17%). Grouping these six subcriteria together explains more than 75% of the success of a supermarket. From these results, we can assert that the experts consulted perceived the most important factors to be those related to location and competition.

## Locating a new supermarket in Murcia

In this study, we analyzed the commercial distribution sector of frequently purchased products in Murcia (Spain). Murcia has a population of 442,203 spread across 386 census tracts (INE, 2011). A census tract is a territorial unit that is used in fieldwork for statistical activities and essentially depends on population volume. In Murcia, the average population size of these tracts is 1146 people, with a minimum of 650 and a maximum of 2630 inhabitants. Murcia has 194,615 housing units spread across 48,748 city blocks. The total surface area of these city blocks is 20,888,346.37 $m^2$, with an average surface area per city block of 428.49 $m^2$ (Electronic Cadastral Register – Sede Electrónica del Catastro, 2012). According to Nielsen (2012), Murcia has 100 supermarkets belonging to 23 different chains, with a total surface area of 133,646 $m^2$. The first step was to identify the geodemand, locating the demand for each city block in the city of Murcia. Only those city blocks deemed inhabitable by the municipal town planning design were included in the study (Fig. 4).

Second, the geocompetition was analyzed in a different layer. To carry out this analysis, all supermarket establishments (100 in total, as mentioned above) were geolocated, and their trade areas were calculated as a function of their size (Fig. 5). If two or more trade areas overlapped because of the proximity of two or more supermarkets, their respective trade areas were considered to be in conflict. The area resulting from the overlap acquired the pulling power of the sum of the trade areas in question. The potential clients living in this area have greater commercial choice, and therefore, the area will be more saturated or more heavily occupied. The geocompetition was thus classified into three categories: low, medium and high.

From the superposition of the two layers, a third layer was obtained with the regions in which the commercial offer is very low or nonexistent. Next, we used the 'Kernel Density' application in the 'Spatial Analysis' tools of the ArcGis software to carry out the kernel density analysis on this third layer. A pixel size of 5 m was defined to do this. We chose this relatively small size because the minimum unit of reference was the city block, and therefore, a larger pixel size would have covered several city blocks. Taking into account the average trade area radius, a search radius of 300 m was chosen.

The kernel density analysis allowed us to easily identify the possible locations for a new supermarket. Fig. 6 shows a visualization of this analysis, with the darker zones corresponding to higher *free* population densities, that is, higher densities of the population not currently being offered an adequate supermarket shopping choice.

We found that the possible locations for a new store opening were L1, L2 and L3. These locations were ranked according to the AHP method. Within each one of these areas, a property was found with its own particular characteristics. To improve the analysis and to obtain an estimate of the future sales of the new outlet, an existing supermarket was included in the study. This new

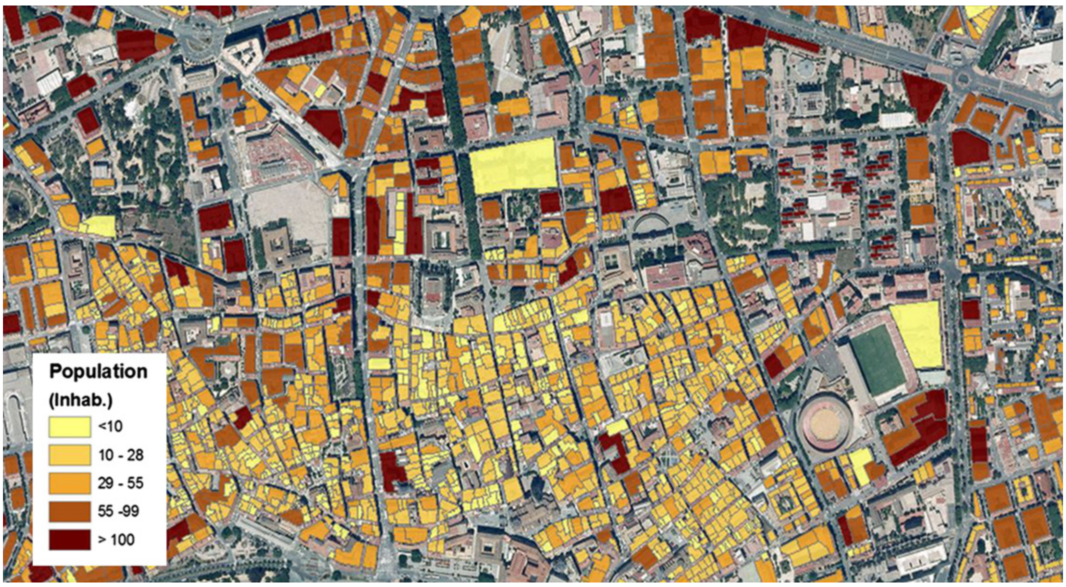


**Fig. 4.** Identifying the geodemand.

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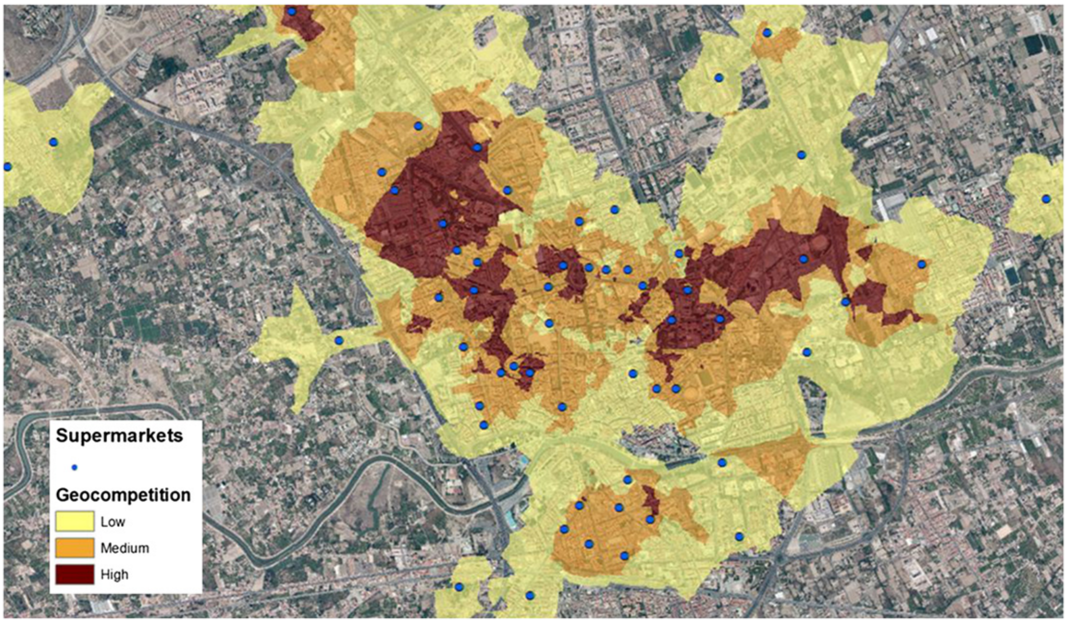


**Fig. 5.** Identifying the geocompetition.

supermarket acted as a moderating variable, allowing us to estimate how a new store might function. Fig. 7 illustrates the alternative L4, which corresponds to the existing supermarket, within the AHP flow. Table 3 summarizes the data for the four possible locations.

As for the process of determining the factors that influence the success of the supermarket, experts were called upon to offer their views. However, whereas the previous process involved administering the questionnaire to each one of the experts and combining the results, in this process, a single questionnaire was administered to a focus group, forcing the experts to compare their criteria and points of view to provide a definitive common response. The AHP method yielded the following ranking of the possible locations (Table 4).

The results given in Table 4 indicate that the best location in Murcia is L1, with a score of 0.3. This method also provided a sales estimate, which was made possible by the inclusion of an existing supermarket, L4, in the study. This site acted as a moderating variable; its sales were extrapolated and applied to the other three sites. Thus, the sales of L1 were estimated to be the highest (2,864,537.61 euros) in comparison to the rest of the locations. This fact does not mean that the remaining locations are not suitable for hosting new supermarkets but rather that the best option of the four is L1. The ranking of the possible locations offers the

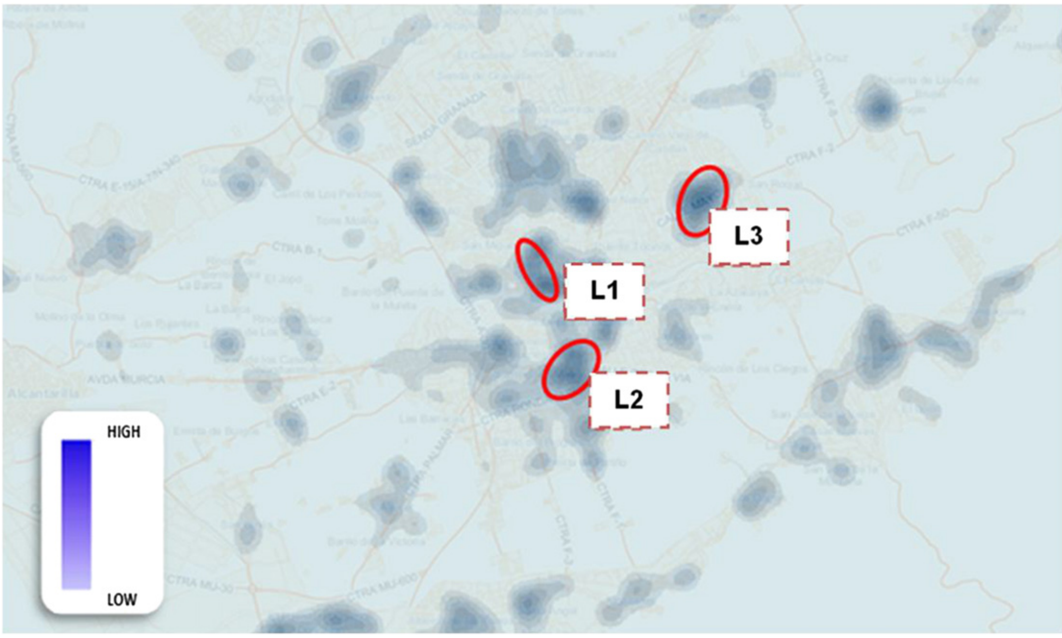


**Fig. 6.** Identifying possible new retail sites using kernel density estimation.

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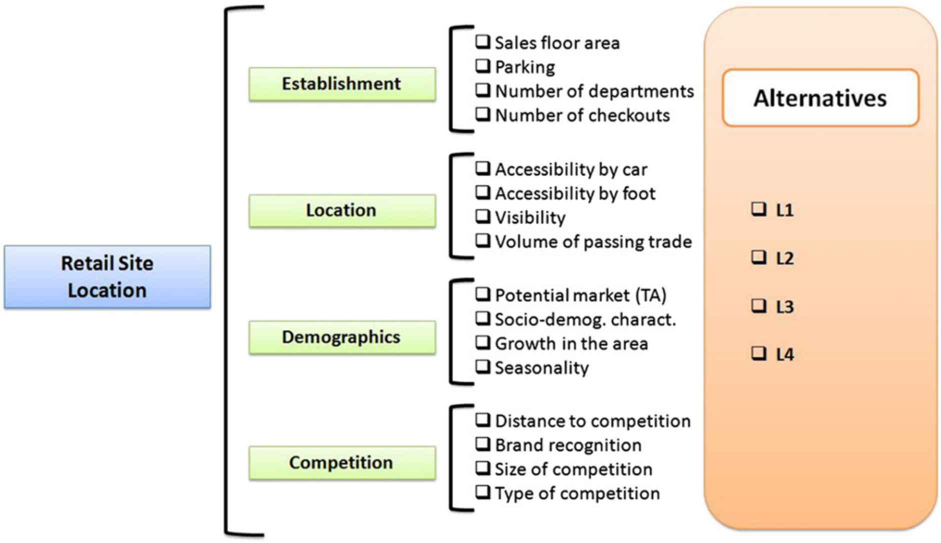


**Fig. 7.** The AHP for the four possible locations.

**Table 3**
Characteristics of the four possible locations.

| | L1 | L2 | L3 | L4 |
|---|---|---|---|---|
| Sales floor area ($m^2$) | 985 | 1245 | 1064 | 1024 |
| Number of parking places | 14 | 32 | 22 | 24 |
| Number of departments | 12 | 14 | 16 | 15 |
| Number of checkouts | 6 | 9 | 8 | 9 |
| Potential market (approx.) | 8494 | 10024 | 6130 | 9575 |
| Average distance from competition (m) | 254 | 532 | 330 | 340 |
| Average size of competition ($m^2$) | 300 | 1421 | 1121 | 1400 |

**Table 4**
Ranking of the four possible locations.

| Ranking | Possible locations | Score | Sales estimate[a] (€) |
|---|---|---|---|
| 1 | L1 | 0.30 | 2,864,537.61 |
| 2 | L2 | 0.27 | 2,506,470.50 |
| 3 | L4 | 0.25 | 2,346,282.54 |
| 4 | L3 | 0.18 | 1,705,530.68 |

[a] A coefficient to distort the real figures was used to avoid providing real business data.

supermarket chain the choice of whether to open one, two or three new supermarkets, depending on the funds available. However, the first store that should be opened corresponds to site L1; the second, to site L2; and the third, to site L3. (Note that site L4 would not be chosen because a supermarket is already located there.)

## Conclusions

The overall goal of this investigation was to develop a method that combines GIS and multi-criteria decision models to allow retail chains to determine locations for new outlets. To demonstrate its practical applications, this methodology was applied in the Spanish city of Murcia to decide on the location for a new supermarket opening.

To achieve the first objective of this study, which was to determine the factors that influence the success of a supermarket, we employed the analytical hierarchy process (AHP) methodology. The results revealed that 75% of the success of a supermarket is explained by the volume of passing trade (17.44%), the visibility of the site (14.62%), the distance between a supermarket and its competitors (14.49%), the potential market within the supermarket's trade area (9.75%), and the accessibility by car (9.71%) and by foot (9.17%). Based on these findings, we draw the conclusion that the most important factors are those related to location and competition.

The second objective of the study was to rank the possible sites based on the combined results of geodemand and geocompetition analyses. The retail site location process proposed in the study consisted of first identifying the geodemand to locate clients. It is important to stress that demand was located at the city block level, which provides a greater level of detail than methods proposed in other studies that use measures of demand at the census tract level. The second stage of the process was to analyze the geocompetition by identifying and spatially locating the competition of the firm seeking to open a new store. The next step was to calculate the trade area of each of the competitors as a function of the area of the sales floor to assess whether the commercial choice in each area was low, medium or high. GIS is capable of dealing with large volumes of data, so in this study, we were able to work with information from 100 supermarkets. The third stage of the process linked the two prior analyses together to yield one layer showing the areas where residents do not have any commercial choice and the areas with a poor range of commercial options. Using kernel density analysis made it easy to determine the possible commercial retail sites for new stores. These sites were ranked in order of suitability using the criteria obtained in achievement of the first objective of the study, and the best location for a new commercial opening was selected. The results obtained also included sales forecasts for the possible sites. This was possible because of the inclusion of an existing supermarket, which acted as a moderating variable, in the AHP process.

It is hoped that in future investigations, new multi-criteria decision models (scoring, MAUT, etc.) can be tested and compared with the methodology presented in this paper. Future studies could examine how each multi-criteria decision model contributes to the retail site location decision process, as well as their advantages and limitations. Similar studies could investigate other retail sectors to verify that the analysis described here can be extrapolated. In such studies, the experts consulted should be decision makers from the sector being considered. The criteria and subcriteria and their corresponding scores may change as well. For example, in

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analyzing the retail car industry, the experts should be professionals from this sector who can evaluate the relevant criteria and provide scores of their relative importance.

## Acknowledgments

The authors would like to thank the *Consum-Universitat Politècnica de València* Chair (Cátedra) for its collaboration in this study.

## References

Alarcón, S. (2011). The trade credit in the Spanish agro-food industry. *Mediterranean Journal of Economics, Agriculture and Environment (New Medit), 10*(2), 51–57.
Alcaide, J. C., Calero, R., & Hernández, R. (2012). *Geomarketing. Marketing territorial para vender y fidelizar más* [*Geomarketing. Territorial marketing to sell and create brand loyalty*]. Madrid: ESIC.
Applebaum, W., & Cohen, S. B. (1961). The dynamics of store trading areas and market equilibrium. *Annals of the Association of American Geographers, 51*(1), 73–101.
Arquero, A., Álvarez, M., & Martínez, E. (2009). Decision Management making by AHP (analytical hierarchy process) trought GIS data. *IEEE Latin America Transactions, 7*(1), 101–106.
Baviera-Puig, A., Buitrago-Vera, J. M., & Mas-Verdú, F. (2012). Trade areas and knowledge-intensive services: the case of a technology centre. *Management Decision, 50*(8), 1412–1424.
Baviera-Puig, A., Buitrago-Vera, J., & Rodríguez-Barrio, J. E. (2012). Análisis metodológico del modelo de interacción espacial MCI [Methodological analysis of the MCI spatial interaction model]. In*Documentos de Trabajo de la Cátedra Fundación Ramón Areces de Distribución Comercial (DOCFRADIS)*, Vol. 8, (pp. 1–22).
Baviera-Puig, A., Castellanos, J., Buitrago, J. M., & Rodríguez, J. E. (2011). *Geomarketing: Determinación de las áreas de influencia de los supermercados* [*Determining the trade areas of supermarkets*]. Paper presented at the VIII Congreso de Economía Agraria, Madrid, Spain.
Berumen, S. A., & Llamazares, F. (2007). La utilidad de los métodos de decisión multicriterio (como el AHP) en un entorno de competitividad creciente [The utility of multi-criteria decision methods (such as AHP) in an increasingly competitive environment]. *Cuadernos Administrativos Bogotá (Colombia), 20*(34), 65–87.
Church, R. L. (2002). Geographical information systems and location science. *Computers & Operations Research, 29*, 541–562.
Church, R. L., & Murray, A. T. (2009). *Business site selection, location analysis and GIS*. Hoboken, NJ: John Wiley & Sons.
Davis, P. (2006). Spatial competition in retail markets: movie theaters. *The RAND Journal of Economics, 37*(4), 964–982.
García-Palomares, J. C., Gutiérrez, J., & Latorre, M. (2012). Optimizing the location of stations in bike-sharing programs: a GIS approach. *Applied Geography, 35*, 235–246.
Gbanie, S. P., Tengbe, P. B., Momoh, J. S., Mebo, J., & Kabba, V. T. S. (2013). Modelling landfill location using geographic information systems (GIS) and multi-criteria decision analysis (MCDA): case study Bo, Southern Sierra Leone. *Applied Geography, 36*, 3–12.
Hernández, T. (2007). Enhancing retail location decision support: the development and application of geovisualization. *Journal of Retailing and Consumer Services, 14*, 249–258.
Hernández, T., & Bennison, D. (2000). The art and science of retail location decisions. *International Journal of Retail & Distribution Management, 28*(8), 357–367.
Huff, D. (1963). Defining and estimating's trade area. *Journal of Marketing, 28*, 34–38.
Instituto Nacional de Estadística (INE) [National Institute of Statistics]. (2011). *Padrón de habitantes 2011* [*Municipal census 2011*]. http://www.ine.es. Accessed 09.10.12.
Mendes, A. B., & Themido, I. H. (2004). Multi-outlet retail site location assessment. *International Transactions In Operational Research, 11*, 1–18.
Miller, G. A. (1956). The magical number seven, plus or minus two. Some limits on our capacity for processing information. *The Psychological Review, 63*, 81–97.
Moreno, A. (2007). Obtención de capas raster de densidad. In A. Moreno (Ed.), *Sistemas y Análisis de la información Geográfica. Manual de autoaprendizaje con ArcGIS* (2a ed.). (pp. 685–691) Madrid: RA-MA.
Musyoka, S. M., Mutyauvyu, S. M., Kiema, J. B. K., Karanja, F. N., & Siriba, D. N. (2007). Market segmentation using geographic information systems (GIS). A case study of the soft drink industry in Kenya. *Marketing Intelligence & Planning, 25*(6), 632–642.
Nielsen. (2012). *Retailers database*. http://www.nielsen.com/global/en.html. Accessed 12.10.12.
Osorio, J. C., & Orejuela, J. P. (2008). El proceso de análisis jerárquico (AHP) y la toma de decisiones multicriterio. Ejemplo de aplicación [The analytical hierarchy process (AHP) and multi-criteria decision making: an applied example]. *Scientia et Technica, 14*(39), 247–252.
Ozimec, A. M., Natter, M., & Reutterer, T. (2010). Geographical information systems-based marketing decisions: effects of alternative visualizations on decision quality. *Journal of Marketing, 74*, 94–110.
Reilly, W. J. (1931). *The law of retail gravitation*. New York, NY: Knickerbocker Press.
Rivera, L. M. (2010). *Decisiones en marketing* [*Decisions in marketing*]. Clientes y Empresa. Valencia: Editorial Universitat Politècnica de València.
Rosenblatt, M. (1956). Remarks on some nonparametric estimates of a density functions. *Annals of Mathematical Statistic, 27*, 832–837.
Rybarczyk, G., & Wu, C. (2010). Bicycle facility planning using GIS and multi-criteria decision analysis. *Applied Geography, 30*, 282–293.
Saaty, T. L. (1980). *The analytical hierarchy process*. USA: Mc Graw Hill.
Saaty, T. L. (1992). *Decision making for leaders* (2nd ed.). Pittsburg, USA: RWS Publications.
Sede Electrónica del Catastro. (2012). *Datos Catastrales*. https://www.sedecatastro.gob.es/. Accessed 10.10.12.
Silverman, B. W. (1986). *Density estimation for statistics and data analysis*. New York, NY: Chapman and Hall.
Simon, H. A. (1983). *Reason in human affairs*. Stanford: Stanford University Press.
Simon, H. A. (2005). Darwinism, altruism and economics. In K. Dopfer (Ed.), *The evolutionary foundations of economics*). Cambridge: Cambridge University Press.
Suárez-Vega, R., Santos-Peñate, D. R., & Dorta-González, P. (2012). Location models and GIS tools for retail site location. *Applied Geography, 35*, 12–22.
Suárez-Vega, R., Santos-Peñate, D. R., Dorta-González, P., & Rodríguez-Díaz, M. (2011). A multi-criteria GIS based procedure to solve a network competitive location problem. *Applied Geography, 31*, 282–291.
Thaler, R. (1986). The psychology and economics conference handbook: comments on Simon, on Einhorn and Hogarth, and on Tversky and Kahneman. *The Journal of Business, 59*(4), 279–284.
Wedley, W. C., Schoner, B., & Tang, T. S. (1993). Starting rules for incomplete comparisons in the analytic hierarchy process. *Mathematical and Computer Modelling, 17*(4–5), 93–100.
Wood, S., & Reynolds, J. (2012). Leveraging locational insights within retail store development? Assessing the use of location planners' knowledge in retail marketing. *Geoforum, 43*, 1076–1087.

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