UNIVERSITAT POLITÈCNICA DE VALÈNCIA

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Análisis de áreas comerciales mediante técnicas SIG:

Aplicación a la distribución comercial y centros tecnológicos

TESIS DOCTORAL

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als meus pares

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RESUMEN / ABSTRACT / RESUM

Resumen

El objetivo general de esta Tesis ha sido profundizar en la investigación de la distribución espacial y la localización tanto de establecimientos comerciales como de centros tecnológicos mediante la utilización de Sistemas de Información Geográfica (SIG).

La Tesis se ha estructurado en tres capítulos. Cada uno de ellos corresponde a un artículo publicado en una revista internacional y aborda un aspecto específico con el fin de cumplir el objetivo general que se acaba de señalar.

El primer artículo tiene como título ***"Business opportunities analysis using GIS: the retail distribution sector"***. Este trabajo se centra en la distribución minorista y la búsqueda de una estrategia de localización apropiada como factor diferenciador y de creación de ventajas competitivas. En este estudio se ha desarrollado un proceso que permite detectar nuevas oportunidades comerciales.

El segundo de los artículos se titula ***"The retail site location decision process using SIG and the analytical hierarchy process"***. En este artículo se desarrolla una metodología para determinar la localización de un establecimiento minorista aunando la aplicación de los SIG y los modelos de decisión multicriterio, particularmente, el proceso AHP (Analytical Hierarchy Process). La metodología utilizada ha permitido identificar los principales factores que influyen en el éxito de un supermercado que son los relacionados con el emplazamiento y la competencia para, posteriormente, aplicar la metodología desarrollada a la apertura de un nuevo establecimiento comercial.

El tercer artículo es ***"Comparing Trade Areas of Technology Centres using Geographical Information System"***. Esta investigación se centra en el análisis de la distribución espacial de las empresas asociadas a dos centros tecnológicos de diferentes sectores: AINIA (Asociación de Investigación de la Industria Agroalimentaria) y AIJU (Asociación de Investigación de la Industria del Juguete, Conexas y Afines). Se ha observado que la distribución de las empresas asociadas a los centros tecnológicos siguen patrones espaciales de agrupación y no son fruto de la aleatoriedad. Los resultados obtenidos en este artículo pueden contribuir al diseño de las estrategias de marketing de los centros tecnológicos.

Abstract

The main aim of this thesis was to broaden the research into the geographical distribution and location of both commercial and establishments and technology centres using geographic information systems (GIS).

The thesis consists of three chapters, each containing a paper that has been published in an international journal and that tackles a specific area within the scope of the thesis outlined above.

The first paper, ***"Business opportunities analysis using GIS: the retail distribution sector"***, focuses on the retail sector. More specifically, it looks at the distribution of retail outlets and the pursuit of a retail location strategy that can act as a differentiating factor and creator of competitive advantages. The paper presents a process that allows retailers to identify new business opportunities.

The second paper, ***"The retail site location decision process using GIS and the analytical hierarchy process",*** presents a method of determining the optimal location for a retail outlet by combining techniques from GIS and multi-criteria decision models, namely the analytical hierarchy process (AHP). The methodology yielded the main factors that affect the success of a supermarket (location and competition). It was then applied in a practical setting to determine the location for the opening of a new establishment.

The third paper, ***"Comparing Trade Areas of Technology Centres using Geographical Information System"***, focuses on the analysis of the geographical distribution of firms from two technology centres from different sectors: AINIA (Association for research into the agro-food industry) and AIJU (Association for research into the toy industry). The geographical spread of firms from the technology centres was found to follow non-random spatial grouping patterns. The study yielded results that may contribute to the design of marketing strategies for technology centres.

Resum

L'objectiu general d'aquesta Tesi ha sigut aprofundir en la recerca de la distribució espacial i la localització tant d'establiments comercials com de centres tecnològics mitjançant la utilització de Sistemes d'Informació Geogràfica (SIG).

La Tesi s'ha estructurat en tres capítols. Cadascun d'ells correspon a un article publicat en una revista internacional i aborda un aspecte específic amb la finalitat de complir l'objectiu general que s'acaba d'assenyalar.

El primer article té com a títol ***"Business opportunities analysis using GIS: the retail distribution sector"***. Aquest treball se centra en la distribució minorista i la cerca d'una estratègia de localització apropiada com a factor diferenciador i de creació d'avantatges competitius. En aquest estudi s'ha desenvolupat un procés que permet detectar noves oportunitats comercials.

El segon dels articles es titula ***"The retail site location decision process using SIG and the analytical hierarchy process".*** En aquest article es desenvolupa una metodologia per a determinar la localització d'un establiment minorista conjuminant l'aplicació dels SIG i els models de decisió multicriteri, particularment, el procés AHP (Analytical Hierarchy Process). La metodologia utilitzada ha permès identificar els principals factors que influeixen en l'èxit d'un supermercat que són els relacionats amb l'emplaçament i la competència per a, posteriorment, aplicar la metodologia desenvolupada a l'obertura d'un nou establiment comercial.

El tercer article és ***"Comparing Trade Areas of Technology Centres using Geographical Information System".*** Aquesta recerca se centra en l'anàlisi de la distribució espacial de les empreses associades a dos centres tecnològics de diferents sectors: AINIA (*Asociación de Investigación de la Industria Agroalimentaria*) y AIJU (*Asociación de Investigación de la Industria del Juguete, Conexas y Afines*). S'ha observat que la distribució de les empreses associades als centres tecnològics segueixen patrons espacials d'agrupació i no són fruit de la aleatorietat. Els resultats obtinguts en aquest article poden contribuir al disseny de les estratègies de màrqueting dels centres tecnològics.

ÍNDICE

CAPÍTULO I

CAPÍTULO II

CAPÍTULO III

CAPÍTULO IV

CAPÍTULO V

CAPÍTULO I

INTRODUCCIÓN

CAPÍTULO I

INTRODUCCIÓN

Una adecuada localización supone un factor clave para la creación de ventajas competitivas. De modo concreto, la localización constituye uno de los elementos fundamentales para el éxito de la distribución comercial (Ghosh & McLafferty, 1982). Sin embargo, el proceso de determinación el lugar en el que ubicar un negocio es una tarea compleja y rodeada de incertidumbre, más todavía en un entorno como el actual.

Por ello, la geografía está recibiendo una atención creciente por su potencial contribución a la hora de determinar de forma eficiente la localización empresarial. En este sentido, la literatura más actual (Baviera-Puig et al. 2011; Alcaide et al. 2012) hace hincapié en el papel del análisis espacial y la información geográfica para la toma de decisiones en los procesos estratégicos de localización. Sin embargo, estas bases teóricas parece que no se están llevando de forma suficientemente amplia al terreno aplicado (Wood & Reynolds, 2012).

De forma específica, los Sistemas de Información Geográfica (SIG) resultan especialmente pertinentes para la investigación aplicada en el campo económico-empresarial. En efecto, los SIG, trabajan con bases de datos y con información cartográfica y poseen, además, herramientas de análisis estadístico (Chasco, 2003).

El campo de análisis y aplicación de los SIG ha experimentado un gran avance (Berry, 2007). Así, en la actualidad, estos sistemas pueden contribuir al diseño de estrategias de marketing y gestión por parte de las empresas. Las técnicas utilizadas en este campo se basan en la delimitación y análisis espacial de las áreas de negocio de las empresas. El conocimiento de los límites del área comercial o del mercado es fundamental puesto que permite a las empresas ajustar las estrategias de marketing a las características locales o regionales de una determinada área de actuación.

Si bien es cierto que, de un lado, la teoría de la localización y, de otro, el campo de estudio de los SIG han evolucionado de manera independiente, en la actualidad se detecta una convergencia y ambas disciplinas se apoyan mutuamente en la investigación de operaciones que estudian modelos de toma de decisiones. En tales modelos, las técnicas son igualmente aplicables tanto en áreas de carácter espacial como no espacial (Church & Murray, 2009). En particular, en la investigación de esta Tesis se utiliza el Proceso Analítico Jerárquico o *Analytical Hierarchy Process* (AHP) desarrollado por Saaty en 1980, que consiste en definir un modelo jerárquico que represente problemas complejos mediante criterios y alternativas planteadas inicialmente, para luego poder elegir la mejor decisión posible.

OBJETIVO

El objetivo general de esta Tesis ha sido profundizar en la investigación de la distribución espacial y la localización tanto de establecimientos comerciales como de Centros Tecnológicos mediante la utilización de Sistemas de Información Geográfica.

Por lo tanto, el objetivo global de la investigación es el de analizar las posibles aplicaciones que pueden tener los SIG en diferentes campos de la economía. En esta línea, se ha tomado en consideración la componente geográfica para determinar la influencia que tiene la ubicación tanto en los espacios comerciales como en la relación de los centros tecnológicos con las empresas asociadas mediante la aplicación de Sistemas de Información Geográfica como metodología de análisis.

ESTRUCTURA

La Tesis se estructura en tres capítulos. Cada uno de ellos es un artículo publicado en una revista internacional. Dos de las revistas en las que se han publicado los artículos que conforman esta Tesis están incluidas en el *Journal of Citation Reports* –JCR–, situándose en el primer cuartil dentro de las categorías de *management* (*The Service Industries Journal*) y geografía (*Applied Geography*), respectivamente.

Cada artículo aborda un aspecto específico con el fin del cumplir el objetivo general de la Tesis.

El primer artículo tiene como título **"*Business opportunities analysis using GIS: the retail distribution sector*"** y ha sido publicado en la revista *Global Business Perspectives*. Este trabajo se centra en la distribución minorista y la búsqueda de una estrategia de localización apropiada como factor diferenciador y de creación de ventajas competitivas. Con carácter general, el papel que puede jugar la variable geográfica para entender el éxito de un negocio ha sido estudiado, pero no ha tenido suficiente aplicación práctica. Para cubrir este hueco, en este estudio se ha desarrollado un proceso que permite detectar nuevas ubicaciones de negocio. La metodología utilizada consiste en realizar un análisis, desde el punto de vista del marketing, aplicando los Sistemas de Información Geográfica (SIG). Este enfoque se conoce como *geomarketing*. La ventaja de esta metodología reside en la capacidad de los SIG para manejar grandes cantidades de información, tanto espaciales como no espaciales. Una aplicación práctica del proceso desarrollado para detectar posibles ubicaciones comerciales exitosas se ha llevado a cabo en Murcia (España) mediante el estudio de 100 supermercados.

El segundo de los artículos que conforman la Tesis se titula **"The retail site location decision process using SIG and the analytical hierarchy process"** y ha sido publicado en la revista *Applied Geography* indexada en el *Social Science Citation Index* con un factor de impacto de 3.082.

La apertura de un nuevo local en el sector minorista constituye un factor crítico. Por ello, en este artículo se desarrolla una metodología para determinar la localización de un establecimiento minorista aunando la aplicación de los SIG con los modelos de decisión multicriterio, en particular, el Proceso Analítico Jerárquico o *Analytical Hierarchy Process* (AHP). La metodología utilizada permite identificar los principales factores que influyen en el éxito de un supermercado para, posteriormente, desarrollar y aplicar el proceso de decisión para la apertura de un nuevo supermercado a un caso particular, en la ciudad española de Murcia.

El tercer artículo, cuyo título es **"*Comparing Trade Areas of Technology Centres using Geographical Information Systems*"**, ha sido publicado en

The Service Industries Journal, revista indexada *en el Social Science Citation Index* con un factor de impacto de 2.579*.*

Esta investigación se centra en el análisis de la distribución espacial de las empresas asociadas a dos centros tecnológicos de diferentes sectores: AINIA (Asociación de Investigación de la Industria Agroalimentaria) y AIJU (Asociación de Investigación de la Industria del Juguete, Conexas y Afines). Las técnicas utilizadas en el diseño de las estrategias de implantación de áreas de comercio minorista se basan en la delimitación de dichas zonas existentes y en su análisis espacial. En esta investigación, este criterio procedente del ámbito de conocimiento propio de la distribución comercial se ha aplicado a los centros tecnológicos, considerados como proveedores de servicios intensivos en conocimiento o *knowledge intensive services* (KIS) a sus empresas asociadas. El objetivo del estudio se centra en el análisis de la distribución espacial de las empresas miembros de los centros tecnológicos. En particular, se observa que la distribución de las empresas asociadas a los centros tecnológicos sigue patrones espaciales de agrupación y no es fruto de la aleatoriedad.

METODOLOGÍA

Técnicas de análisis

En la investigación realizada en la Tesis se han utilizado diferentes técnicas de análisis basadas en el uso de los Sistemas de Información Geográfica para la consecución de los objetivos de cada uno de los artículos. Entre las técnicas utilizadas, destacamos las siguientes:

- El análisis del posicionamiento de los demandantes de un producto o servicio en un mercado concreto se ha llevado a cabo mediante un estudio que se ha denominado "análisis de la geodemanda". A su vez, para posicionar a las empresas competidoras se ha realizado un análisis denominado "análisis de la geocompetencia".
- El mercado libre ha sido determinado mediante un *análisis de densidad Kernel* (De Cos, 2004; Härdle, 1991) que ha permitido observar la concentración de potenciales clientes que no están siendo atendidos por la oferta comercial actual.
- Las *trade areas* o áreas de negocio de los centros tecnológicos, así como el patrón espacial de las empresas asociadas a centros de tecnología, se ha llevado a cabo mediante el uso de técnicas de estadística espacial (Moreno, 2007; Chasco, 2003).
- Las posibles ubicaciones comerciales para nuevos establecimientos de distribución comercial minorista se han determinado mediante la utilización de modelos de análisis de decisión multicriterio: el Proceso Analítico Jerárquico o AHP (Satty, 1980).

Bases de Datos

En el caso de los dos artículos relacionados con el sector de la distribución comercial, el análisis se ha centrado en la ciudad de Murcia (España). En estos papers, se han utilizado dos bases de datos. En primer lugar, la información demográfica se ha extraído del INE, 2011, (un total del 442.203 habitantes divididos en 386 secciones censales). Además, se han estudiado 194.615 viviendas distribuidas en 48.748 parcelas cuya superficie total es superior a los 20 millones de metros cuadrados. En segundo lugar, y de acuerdo con la base de datos Nielsen (2012), se han analizado los supermercados existentes; hay que considerar que la ciudad analizada (Murcia) cuenta con 100 supermercados de 23 enseñas diferentes que suman una superficie comercial total de 133.646 m^2.

En el tercero de los artículos, el publicado en *The Service Industries Journal,* la investigación se ha llevado a cabo tomando como base las empresas que figuran como miembros de los centros AINIA y AIJU. Para ello, se ha hecho uso de las memorias respectivas de ambos centros tecnológicos que recogen las empresas asociadas a dichos institutos tecnológicos. El número de empresas analizadas de AINIA es 874, mientras que el número de empresas examinadas correspondientes a AIJU es 581. De forma complementaria, se ha contado con información adicional sobre las características (dimensión por empleo, volumen de facturación, etc.) de dichas empresas a partir de la base de datos SABI (Sistema de Análisis de Balances Ibéricos).

CAPÍTULO II

ANÁLISIS DE OPORTUNIDADES DE NEGOCIO UTILIZANDO SIG: EL SECTOR DE LA DISTRIBUCIÓN COMERCIAL MINORISTA

CAPÍTULO II

Análisis de Oportunidades de Negocio utilizando SIG:
el sector de la Distribución Comercial Minorista

Artículo

BUSINESS OPPORTUNITIES ANALYSIS USING GIS:
THE RETAIL DISTRIBUTION SECTOR

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BUSINESS OPPORTUNITIES ANALYSIS USING GIS: THE RETAIL DISTRIBUTION SECTOR

ABSTRACT

The retail distribution sector is facing a difficult time as the current landscape is characterized by ever-increasing competition. In these conditions, the search for an appropriate location strategy has the potential to become a differentiating and competitive factor. Although, in theory, an increasing level of importance is placed on geography because of its key role in understanding the success of a business, this is not the case in practice. For this reason, the process outlined in this paper has been specifically developed to detect new business locations. The methodology consists of a range of analyses with Geographical Information Systems (GIS) from a marketing point of view. This new approach is called geomarketing. First, geodemand and geocompetition are located on two separate digital maps using spatial and non-spatial databases. Second, a third map is obtained by matching this information with the demand not dealt with properly by the current commercial offer. Third, the Kernel density allows users to visualize results, thus facilitating decision-making by managers, regardless of their professional background. The advantage of this methodology is the capacity of GIS to handle large amounts of information, both spatial and non-spatial. A practical application is performed in Murcia (Spain) with 100 supermarkets and data at a city block level, which is the highest possible level of detail. This detection process can be used in any

commercial distribution company, so it can be generalized and considered a global solution for retailers.

KEYWORDS

Business opportunities, retailers, location, strategy, GIS, geomarketing.

2.1. INTRODUCTION

It has always been said that the key variables of a successful retail distribution company are location, location, location, so from this statement it is easy deduce the importance of a proper location strategy for retailers (Ghosh and McLafferty 1982). In retail companies, the opening of a new store or outlet carries an inherent risk because of the high monetary costs associated. Also, a store that is unsuccessful due to a poor choice of location can have a significant negative impact on the image of the company. Consequently, the analysis of location is vital for retail and commercial enterprises (Hernández and Bennison 2000).

If the process of choosing the site of a retail establishment has always been complicated, this is now truer than ever, since environmental circumstances have recently worsened. The current situation is characterized by ever-increasing competition, resulting in lower margins and the exploitation of all possible market segments. Any element of competition that can triumph in this environment has a very high value (Clarke 1998). The search for an optimal location strategy has the potential to become the differentiating factor. This is the reason why developing methodologies and processes that identify new business locations is essential.

Geography is being handed an increasing importance for its key role in the current understanding of the success of a business (Alcaide et al. 2012). Nevertheless, Wood and Reynolds (2012) point out that although the literature places great importance on spatial analysis and geographic information in decision-making in the location strategy of companies, this is not the case in practice. Thus, there are possibilities to develop methodologies for determining new commercial locations by integrating such spatial and geographic information with clear, practical applications. Therefore, the objectives of this research are as follows.

(i) First, to use statistical information together with spatial components to identify demand and competition. Given the combination of the statistical and spatial components in this identification process, these concepts are referred to as geodemand and geocompetition.
(ii) Second, to determine new locations for commercial establishments by jointly analyzing geodemand and geocompetition.

To do this, the commercial distribution sector of frequently purchased products is analyzed in a given Spanish city (Murcia).

The paper is structured as follows. First, the theoretical framework on which this research is based is presented. Second, the methodology used in the analysis is developed. Then, the results of the study are shown and discussed, and, finally, the main conclusions from the results are drawn.

2.2. THEORETICAL FRAMEWORK

Numerous authors have contributed in different ways to the methodology used by retailers to determine the location of new establishments. Church (2002) states that the success of many future applications of the location of retail outlet sites may be closely linked to Geographical Information Systems (GIS) due to the fact that these systems are responsible for working with spatial information. For this reason, the use of GIS as a site evaluation tool is presented, as well as different definitions derived from its implementation (geomarketing, geodemand, geocompetition and trade area).

Site evaluation tools: the use of GIS

In complex decision processes involving a wide variety and volume of information, along with a substantial subjective component, visualization methods are extremely useful. Therefore GIS, based on matching digital maps with relational databases, will undoubtedly be essential for the future development of the decision processes for locating establishments (Mendes and Themido 2004).

While it is true that location theory and GIS have evolved almost independently, they currently support each other together with research into operations. This research studies models for decision-making in which the techniques are equally applicable in areas of spatial and non-spatial character (Church and Murray 2009).

In fact, the use of GIS by companies and organizations is increasing (Rob 2003; Chen 2007). In recent years, various associations between decision-making models and GIS packages have been made. Harris and Batty (1993) and Birkin et al. (2002) explore the different possibilities that these technologies can offer to solve the problems of planning and locating retail outlets. Such associations between applications are known as loosely coupled, whereas solutions that include the functionality of decision-making programming within the actual GIS packages are known as strongly coupled. This strategy is based on the acceptance that there is no single software tool or technology that can meet the needs of planners and, therefore, they will have to adapt the current (and future) technologies to satisfy their needs (Harris and Batty 1993).

Instead, Murad (2003) defines the trade areas of two shopping centers and calculates its share of market penetration using various tools exclusively offered by GIS. Later, Murad (2007) evaluates the sites of shopping centers in relation to the customers' location, again using only GIS. The research of Clarkson et al. (1996) and Hernández and Bennison (2000) in the United Kingdom confirms the integration of GIS within the usual processes of location decision of firms, without introducing new methodologies, but rather by changing the approach that has been used up to now.

The visualization of the data and results in such a complex decision process is one of the reasons for its success (Hernandez 2007; Ozimec et al. 2010). Thus, the use of GIS has facilitated the understanding of geographical information for managers who lack expertise, helping them to make important yet difficult decisions. Furthermore, the latest advances in GIS allow technicians to define, monitor and automate the calculations and the creation of maps necessary for the resolution of a problem using flow charts (Suárez-Vega et al. 2012). These charts greatly improve the ease of work because the whole process is better understood and it reduces the working time when processing repetitive tasks. This is often the case when evaluating different site locations over and over again.

GIS and Geomarketing

With the integration of GIS in decision-making processes, the spatial variable takes a relevant role as a descriptive and explanatory variable. In fact, Sleight et al. (2005) state that people who share geographic environments also tend to share behaviors, consumption habits and related attitudes. The location of customers and the analysis of their environment become especially relevant. The integration of GIS in the study and analysis of the customer, both from a spatial and non-spatial perspective, opens the way for a new field of study called geomarketing (Baviera-Puig et al. 2009).

Latour y Le Floc'h (2001) define the term geomarketing as an integrated system for data processing software, and statistical and graphical methods designed to produce useful information for decision-making, through instruments that combine digital maps, graphs and tables. Meanwhile, Chasco (2003) states that geomarketing is a set of techniques for analyzing the economic and social reality from a geographical point of view, through mapping tools and spatial statistics tools.

From a more sociological viewpoint, Alcaide et al. (2012) argue that geomarketing is the area of marketing that is aimed at global customer knowledge, and the needs and behaviors of customers within a given geographical area. All this information helps the company to have a more complete view of its customers and to identify their needs. Finally, Baviera-Puig et al. (2013) suggest that geomarketing can be defined as the discipline that uses GIS as a tool for analysis and decision-making in marketing, in order to meet the needs and wants of consumers in a profitable way for the company.

Geomarketing involves the following elements: databases, cartographic information and GIS for processing and managing information. Databases can be either internal (sales, corporate data, customers, etc.) or external (statistical institutes, municipal census, Chambers of Commerce, etc.). The digital maps can come from several sources, such as private companies (TeleAtlas, Navteq, etc.) or Cartographic Institutes. For example, in Spain the National Institute of Statistics (Instituto Nacional de Estadística, INE), Electronic Office of Cadastre (Sede Electrónica del Catastro) and the National Centre for Geographic Information (Centro Nacional de Información Geográfica, CNIG) all manage and provide digital maps. Finally, GIS is the tool in charge of linking databases with geographic information. As a result, data processing can be performed with this tool and any studies or analysis required may be carried out.

There are two new concepts that can be derived from those defined above: geodemand and geocompetition. The former, geodemand, can be defined as the location on a digital map of the customers of a product or a service in a particular market. On the other hand, geocompetition is the location on a digital map of the competitors of a business, and the delineation of their trade area in a particular market.

Another important concept within spatial analysis is the trade area or market area of a retail establishment. It can be defined as the geographic area in which the retailer generates all of its sales during a specific period (Applebaum and Cohen 1961). Baviera-Puig et al. (2012) define the trade area of a retailer as the geographic area in which the company is able to attract customers and generate sales.

2.3. METHODOLOGY

This research uses three different techniques but they all have the support of GIS. First, geodemand analysis is performed to locate the customers of a product or a service on a digital map. Second, competition is also located on a digital map as it is one of the main factors to consider when determining the site of a new store. This process is known as geocompetition analysis. The third and final technique is to define the possible sites for new stores considering all the previous steps as a whole.

Data

This study is conducted in the city of Murcia (Spain) and analyzes the commercial distribution sector of frequently purchased products.

Using the INE (2011) as a source of information, Murcia has a population of 442,203 inhabitants divided into 386 census tracts. A census tract is a territorial unit which is defined according to operational criteria for fieldwork in statistical operations depending on its population size. In Murcia, the average population of a census tract is 1,146 inhabitants, with a minimum of 650 and a maximum of 2,630 inhabitants.

From the Electronic Office of Cadastre (2012), in Murcia there are 194,615 housing units in 48,748 city blocks. The sum total of the surface area of these city blocks is 20,888,346.37 m^2, the average size being 428.49 m^2. Only those city blocks with residential use are considered.

According to Nielsen (2012), Murcia has 100 supermarkets from 23 different chains (Table 1).

Table 1. Supermarkets in Murcia

CHAIN	Nº OF SUPER-MARKETS	% SUPER-MARKETS	SUM TOTAL OF NIELSEN SURFACE (m^2)	% SURFACE	AVERAGE SURFACE (m^2)
1	3	3.00	2600	1.95	866.67
2	3	3.00	1450	1.08	486.33
3	3	3.00	2776	2.08	925.33
4	1	1.00	375	0.28	375.00
5	10	10.00	4613	3.45	461.30
6	1	1.00	800	0.60	800.00
7	4	4.00	8270	6.19	2067.50
8	1	1.00	9108	6.82	9108.00
9	2	2.00	22531	16.86	11265.50
10	4	4.00	1963	1.47	490.75
11	2	2.00	20677	15.47	10338.50
12	6	6.00	3396	2.54	566.00
13	1	1.00	750	0.56	750.00
14	2	2.00	699	0.52	349.50
15	1	1.00	1050	0.79	1050.00
16	1	1.00	5000	3.74	5000.00
17	4	4.00	3255	2.44	813.75
18	21	21.00	28591	21.39	1361.48
19	15	15.00	7187	5.38	479.13
20	1	1.00	700	0.52	700.00
21	7	7.00	5120	3.83	731.43
22	2	2.00	985	0.74	492.50
23	5	5.00	1750	1.30	350.00
TOTAL	100	100.00	133646	100.00	---

Source: Nielsen, 2012.

Geodemand analysis

The steps for geodemand analysis are twofold: (i) calculate the number of housing units per city block from cadastral data; and (ii) estimate the average number of people per city block.

To calculate the number of housing units per city block, alphanumeric data of the city blocks from the cadastral database of the municipality is associated to the graphical data with the help of GIS. Next, this data is matched with the number of people from the Municipal Census (Padrón Municipal).

As a result, an estimate of people living in each city block is obtained. This step is more complicated because the information from the Municipal Census refers to the census tract and, therefore, contains several city blocks. The process for calculating the number of people per household in each census tract is as follows.

(i) First, obtain the Municipal Census data from the INE, along with the census tracts, for the municipality in question so that this information can subsequently be integrated in the GIS.

(ii) Second, the residents within each census tract are grouped into the housing units present in that tract.

Geocompetition analysis

The steps to perform geocompetition analysis are threefold: (i) identify the competition; (ii) locate competitors on a digital map; and (iii) define their trade areas.

First, all the supermarkets which are in the city are selected in order to be geolocated. The geolocation consists of providing coordinates (x,y) for the addresses of the establishments. This task is performed entirely by GIS.

Once the competitors have been geolocated, the trade areas of each supermarket are calculated and delineated. The trade area is defined in terms of the surface area or size of the establishment. The surface area or size is a determining factor in calculating the trade area of a supermarket (Reilly 1931; Huff 1963). According to Table 2, a supermarket with a surface area of 800 m^2 corresponds to an isochrone of 8 minutes, equivalent to a maximum distance traveled of 533 meters. This maximum distance increases if the surface area or size of the supermarket is greater, and it decreases if the surface area is smaller.

Table 2. Trade areas of supermarkets according to their size

SURFACE AREA OR SIZE OF SUPERMARKET (m^2)	**MAXIMUM DISTANCE TRAVELED (m)**	**ISOCHRONE (minutes)**
$300<S\leq 600$	333	5’
$600<S\leq 1000$	533	8’
$1000<S\leq 2500$	667	10’
$S>2500$	1200	18’

When two or more trade areas overlap due to the proximity between two or more supermarkets, the resulting area acquires the power of attraction of the sum of the corresponding trade areas. Potential customers who live in that area have a higher commercial offer; therefore, this area is more saturated or occupied. In the literature, this process is known as cannibalization because supermarkets fight to get those customers (Kelly et al. 1993). In other words, cannibalization is understood as the portion of the market share of the new store captured from the existing stores (Suárez-Vega et al. 2012).

Kernel density estimation

Kernel density is a non-parametric estimation of the density function of a random variable (Rosenblatt 1956). The basic concept of spatial density refers to a relationship between the level of presence of such a variable in a given zone and the surface area of the zone. The final result is expressed in units of the particular phenomenon per unit area. Conceptually, the Kernel density function aims to calculate the density of points in a given area according to the distance between the points, as long as the points have the same weight. However, different weights can be assigned to each point in order to attribute different points with greater or lesser relative importance.

Although there exist different types of models when using Kernel estimators (Moreno 1991), Härdle (1991) claims that the choice of model is almost irrelevant for the quality of the estimate and, consequently, for the final outcome of the analysis. Therefore, in this study the quadratic Kernel function described by Silverman (1986) is used. It is also the estimator integrated in the GIS employed to conduct the research.

Generically, and for the univariate case, the estimator can be written as follows:

$$\hat{f}(x) = \frac{1}{nh}\sum_{i=1}^{n} K\left(\frac{x - x_i}{h}\right),$$

where $\hat{f}(x)$ is the estimator of the Kernel density function, *x* is the point where density is estimated, x_i is the value of the variable in the case *i* = 1, …, n, *h* is the window width or smoothing parameter. This parameter limits the influence of each datum to a field, defined by the window. As the width of the window is bigger, it causes an increased smoothing in the resulting map. The choice depends on the purpose of the study, *K* is the Kernel symbol. In the case of the Kernel quadratic function

$$K = \frac{3}{\pi}(1-u^2)^2 \text{, for } |u| \leq 1 \text{, where } u = (x-h_i)/h$$

More specifically, in this research, based on Moreno (2007), the unit of study is the pixel. The pixel is a square of size designed to represent a portion of the space on the digital map, and which is associated with a value or color, in turn associated with the element represented in that portion of territory. In this new scenario, a circular environment is defined for every pixel in the map and is then used as a baseline. The centroid of each pixel is the centre of the circle and the points that fall within it are used to form the dividend. Each point is weighted unevenly, according to its proximity to the centroid of the pixel: the pixels nearer the centroid have a greater weight than those farther away. The expression used is:

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

where L_j is the density estimated in the pixel, d_{ij} is the distance between points *i* and j, *r* is the width of the window or search radius, which determines the degree of smoothing, $C_j = \{i | dij<r\}$, so that the set is formed by the *i* points whose distance to the centroid of the pixel *j* is smaller than the radius of the circle prescribed.

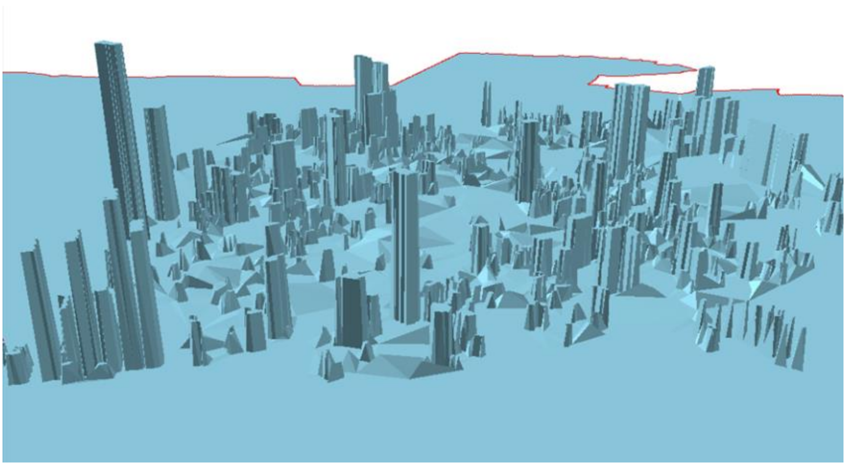
In this research, a pixel size of 5 meters has been defined. Such a small value is chosen because the smallest unit of reference is the city block and, therefore, a larger pixel size would cover several city blocks. A search radius of 300 meters has also been established, considering the average radius of a trade area.

2.3. RESULTS AND DISCUSSION

Geodemand and Geocompetition identification

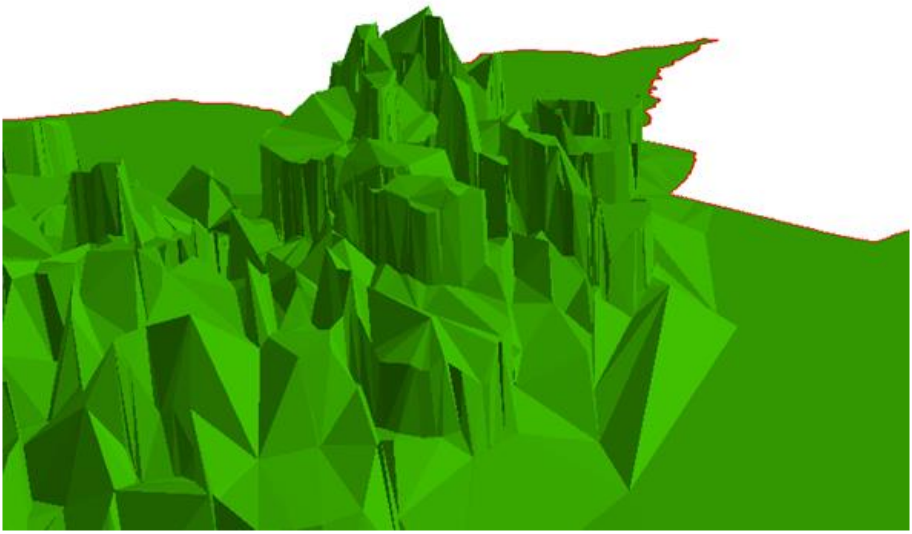
One of the big questions that geomarketing aims to answer is where the potential business clients are. Based on the analysis of geodemand, and once the number of persons per household in each census tract has been estimated, a map of the population density of the study area is generated. Figure 1 represents the commercial demand of a portion of the city of Murcia on a 3D map. It appears that the high peaks coincide with an accumulation of population, so the greater the number of people that there are at one point, the higher the peak.

Fig. 1 Geodemand of a portion of the city of Murcia



Nevertheless, competition is one of the main factors to consider when determining the site of a new store. For this reason, it is important to conduct a detailed analysis to determine geocompetition in the city of Murcia in a quantitative and visual way. Areas with a higher retail space, previously called saturated or occupied, can then be detected. These areas are those that are more or less covered by a trade area of some establishment. Similarly, those areas with a lower retail space or with low commercial offer are also determined. As shown in Figure 2, there is a high saturation in the centre of the city as this is where most trade areas of different stores overlap.

Fig. 2 Geocompetition of a portion of the city of Murcia



Determination of business opportunities

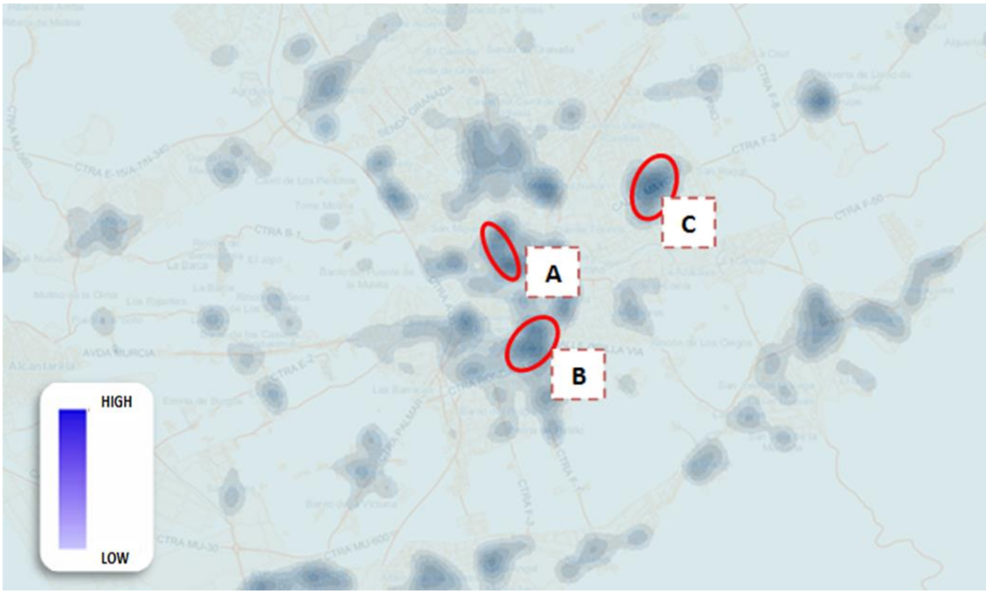
Davis (2006) describes how the spatial dispersion of consumers and sellers influences market shares and substitution patterns between different retail options. Therefore, this spatial dispersion can also contribute to determining site locations for new stores. The term business opportunity refers to an area that offers a high population density and little or no commercial competition. Consequently, business opportunities translate as potential site locations for new commercial establishments.

To identify such opportunities in the city of Murcia, geodemand and geocompetition are analyzed jointly.

(i) After matching information resulting from both analyses, a third map is obtained that shows, on the one hand, the population free from commercial offer and, on the other hand, areas with a low commercial offer.

(ii) Following this, Kernel density analysis is carried out for this third map to determine which areas have a greater concentration of potential customers and how many potential clients can be found. In Figure 3, the darker areas correspond to a higher population density with little access to commercial offer; i.e. not adequately served by the potential commercial offer available.

Fig. 3 Business opportunities analysis



After the Kernel density estimation, a study and a description of the features of the areas most likely to host a new retail site are performed. In this case, areas A, B and C are investigated in depth, as they are the points that form the output of the study. The location of these three areas appears in Table 3. As a result, one or two of them can be selected or they can be prioritized in order to open a new store.

Table 3. Location of the areas that form the output of the study

AREA	COORDINATES OF THE CENTER[a] (m)		AXES OF THE AREA (m)	
	X	Y	LONG	SHORT
A	664415.36	4205893.97	406.33	195.85
B	664920.28	4204419.34	407.82	300.56
C	666780.34	4206937.11	419.36	295.78

[a]Projected Coordinate System ETRS 1989 UTM Zone 30 N.

Managerial implications

With the proposed methodology, the aim is to determine the most appropriate site when opening a new store in order to conduct a proper location strategy. The benefits of an appropriate location strategy are manifold (Ghosh and McLafferty 1982). These benefits include a better distribution of the financial resources of the company (Alarcón 2011), increased competition (Clarke 1998), a better image for consumers and, of course, the survival of the company.

This methodology can be used in any commercial distribution company, regardless of the industry, and can therefore be considered a global solution for retailers. While Murad (2007) uses GIS to assess the sites of shopping centers in relation to the location of customers, the study only considers two malls. However, the current research takes into account 100 different supermarkets and population data at the city block level, representing the highest degree of detail. This is possible because GIS is able to handle large amounts of information. In addition, GIS rules out sites depending on the land use or because potential commercial sites do not meet the minimum size requirements. Despite handling so much information and having to perform a large number of calculations, all these processes can be automated and visualized using flowcharts offered by GIS.

With Kernel density, a representation of the trend or overall pattern of distribution of the population with no commercial offer, or with very little commercial offer, is obtained. The final product is an isopleth, or isodensity map, for easy viewing of the results and to facilitate decision-making by managers, regardless of their professional background (Musyoka *et al.* 2007).

2.4. CONCLUSIONS

The objective of this research consists of creating a process that contributes to the definition of the location strategy for retailers. To do so, GIS tools were used as a means of exploiting alphanumeric and spatial databases from the viewpoint of geomarketing.

Under the first objective, the geodemand and the geocompetition are identified on a digital map and geodemand is then calculated, quantified, and visualized for the city of Murcia. As a result, by using GIS, it has been possible to determine the distribution of potential customers in this area. It can be observed here that the population is not evenly distributed in the city, as there is a series of peaks that show high concentrations of people; i.e. potential markets. The geocompetition analysis quantitatively and visually determines the areas of the city of Murcia with the highest retail space (saturated or occupied areas) and those areas not served by the fully available current commercial offer.

Regarding the second objective, by creating an intersection between the geodemand and the geocompetition, those areas of Murcia where geodemand is unmet by the geocompetition can be detected. Thanks to Kernel density estimation, these areas can be distinguished in a quantitative and visual way. These locations are the main output of the study and correspond to possible sites for new commercial establishments.

As future research, the analysis performed with GIS can be complemented with multicriteria decision techniques. These techniques can be discrete if the decision alternatives are finite, or multiobjective when the problem takes an infinite number of possible alternatives (Thaler 1986). In the case of this particular study, the former would be chosen as the results uncovered here are of a finite number of options. According to Berumen and Llamazares (2007), the main discrete multicriteria decision methods are linear weighting (scoring), Multiattribute Utility (MAUT), overrating relations and Analytic Hierarchy Process (AHP).

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CAPÍTULO III

EL PROCESO DE DECISIÓN SOBRE LA LOCALIZACIÓN DEL COMERCIO MINORISTA UTILIZANDO SIG Y EL PROCESO ANALÍTICO JERÁRQUICO

CAPÍTULO III

El proceso de decisión sobre la Localización del Comercio Minorista utilizando SIG y el Proceso Analítico Jerárquico

Artículo

THE RETAIL SITE LOCATION DECISION PROCESS USING GIS AND THE ANALYTICAL HIERARCHY PROCESS

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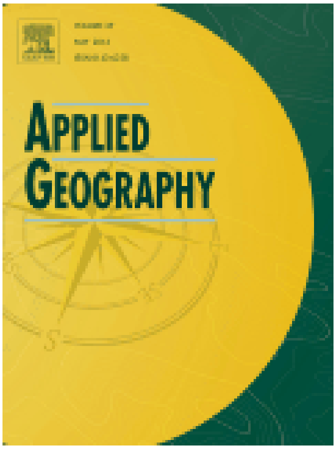

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GEOGRAPHY	73	6	Q1

THE RETAIL SITE LOCATION DECISION PROCESS USING GIS AND THE ANALYTICAL HIERARCHY PROCESS

ABSTRACT

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.

KEYWORDS

Retail site location; geographic information systems (GIS); geodemand; geocompetition; kernel density; analytical hierarchy process (AHP).

3. 1. INTRODUCTION

Geography plays a key role in the success of a business (Alcaide et al., 2012; García-Palomares et al., 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 et al*.,* 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 et al*.,* 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 et al., 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 et al., 2012a).

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 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 et al., 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 et al., 2013; Suárez-Vega et al., 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 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.

3.2. 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 et al., 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 five minutes, 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.

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

Sales floor area (m^2)	**Time/Isochrone (minutes)**	**Maximum distance traveled (m)**
$300<S\leq 600$	5’	333
$600<S\leq 1000$	8’	533
$1000<S\leq 2500$	10’	667
S>2500	18’	1200

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.

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*;

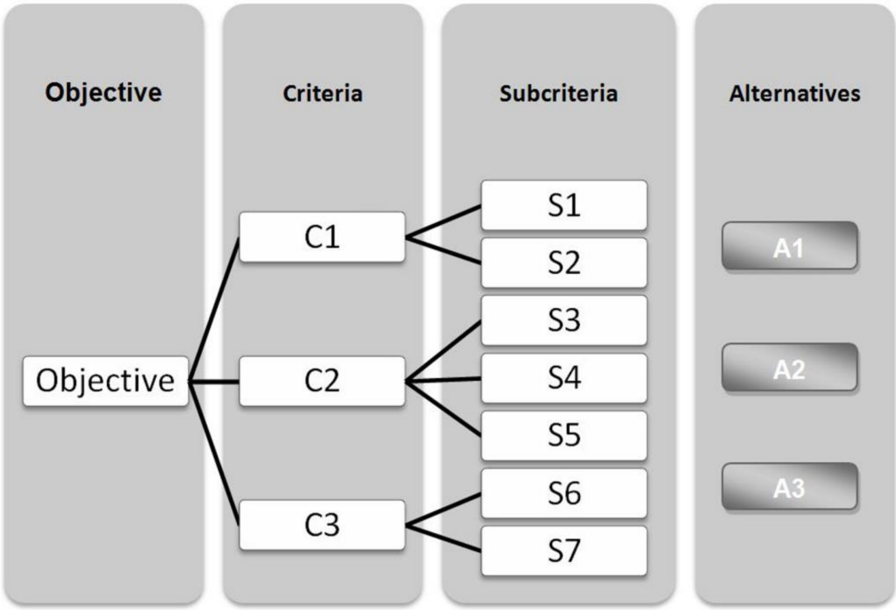
r = width of the window or search radius, which determines the degree of smoothing; and

$C_j = \{i | d_{ij} < r\}$, 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 (Figure 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.

Figure 1. Hierarchical model



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, 307p).

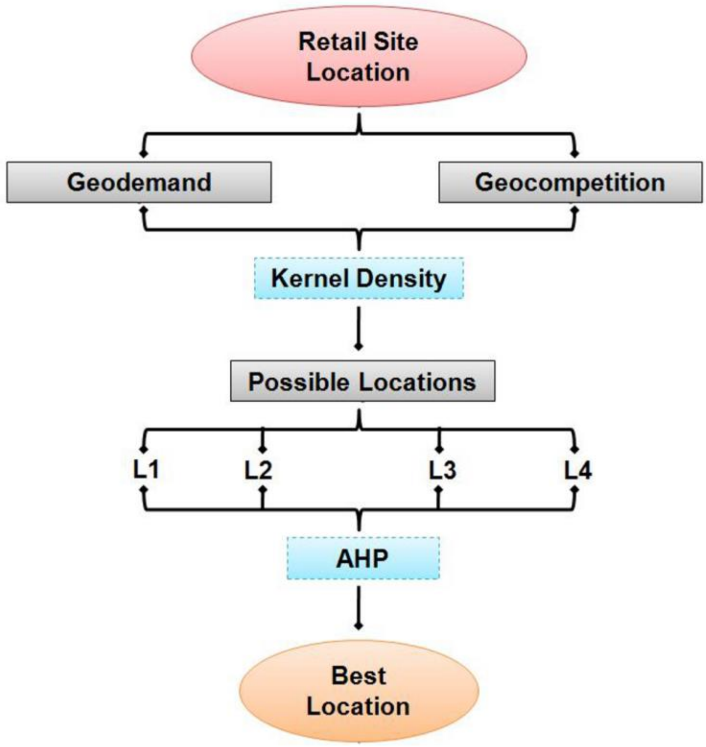
To establish a ranking of priorities from this matrix of pairwise comparisons, one eigenvector per decision maker is obtained. At this stage, it is necessary to aggregate the scores of the decision makers into one unique solution. There are three different processes that can be used to calculate this 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±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±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. Figure 2 depicts the full decision process proposed for retail site location.

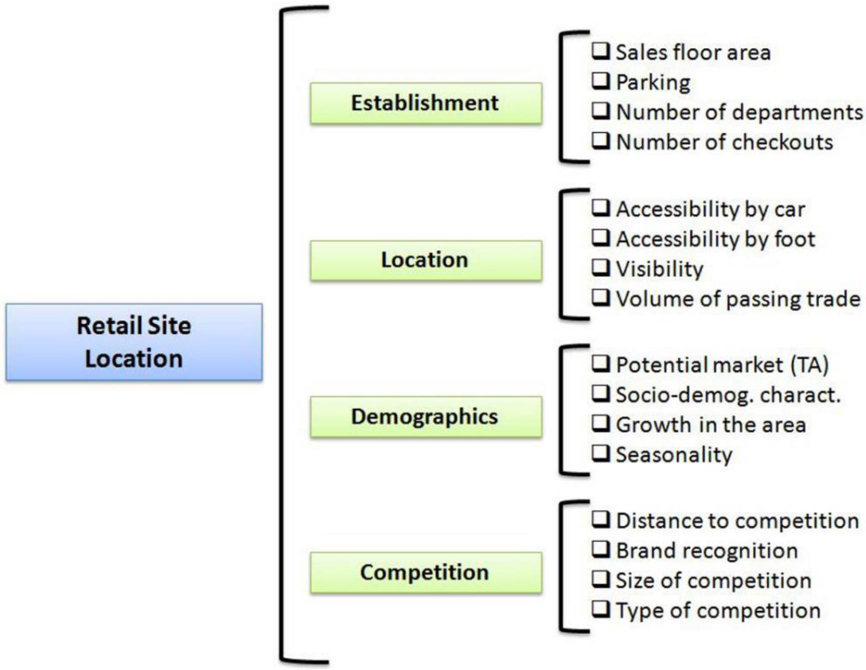
Figure 2. Retail site location decision process



3.3. 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 et al., 2012b). Each of these four criteria gives rise to another four subcriteria, as shown in Figure 3.

Figure 3. Factors that affect the success of a supermarket



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 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 et al., 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.

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

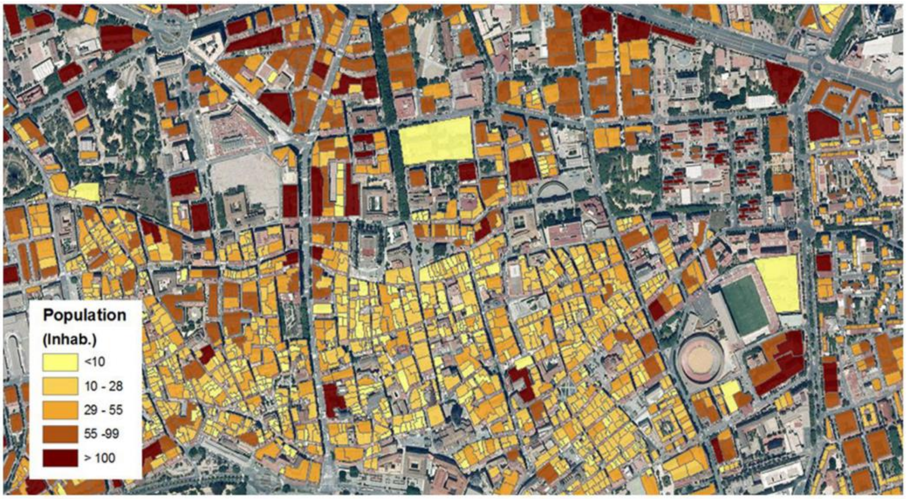
Ranking	Criteria	Subcriteria	Score
1	Location (0.509)	Volume of passing trade (0.342)	17.44%
2	Location (0.509)	Visibility (0.287)	14.62%
3	Competition (0.245)	Distance to competition (0.591)	14.49%
4	Demographics (0.188)	Potential market (TA) (0.519)	9.75%
5	Location (0.509)	Accessibility by car (0.191)	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%

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

3.4. LOCATING A NEW SUPERMARKET IN MURCIA

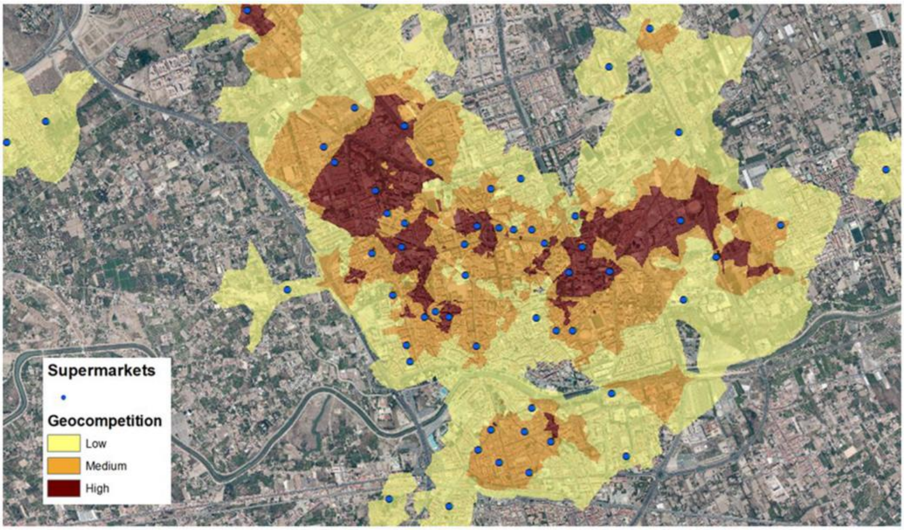
In this study, we analyzed the commercial distribution sector of frequently purchased products in Murcia (Spain). Murcia has a population of 442,203 spread across 386 census tracts (INE, 2011). A census tract is a territorial unit that is used in fieldwork for statistical activities and essentially depends on population volume. In Murcia, the average population size of these tracts is 1,146 people, with a minimum of 650 and a maximum of 2,630 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 (Figure 4).

Figure 4. Identifying the geodemand



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 (Figure 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.

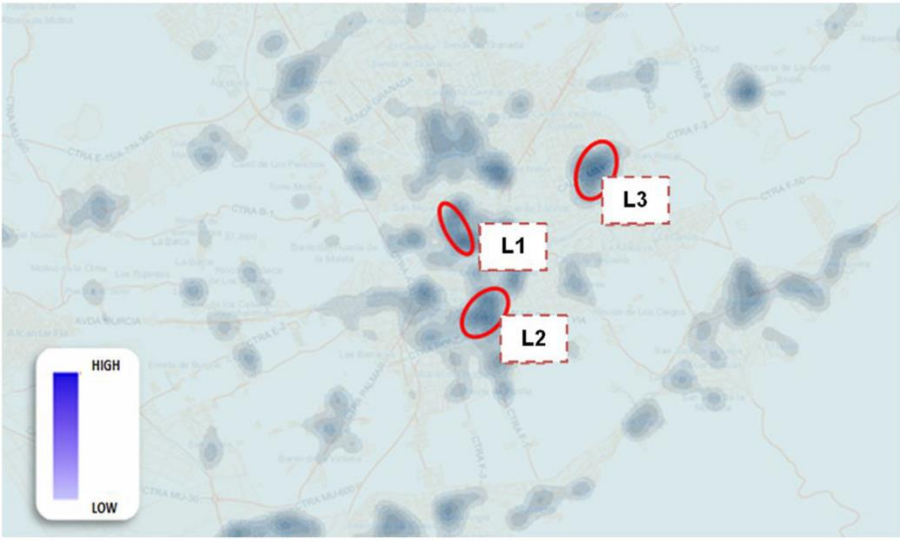
Figure 5. Identifying the geocompetition



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 five meters 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 meters was chosen.

The kernel density analysis allowed us to easily identify the possible locations for a new supermarket. Figure 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.

Figure 6. Identifying possible new retail sites using kernel density estimation



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 supermarket acted as a moderating variable, allowing us to estimate how a new store might function. Figure 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.

Figure 7. The AHP for the four possible locations

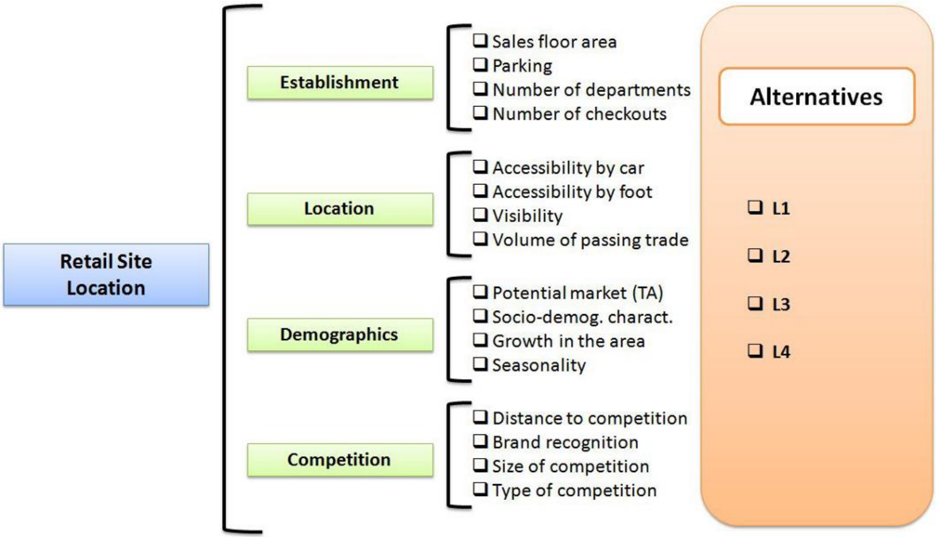


Table 3. Characteristics of the four possible locations

	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

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).

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.

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 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.)

3.5. 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 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.

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CAPÍTULO IV

COMPARACIÓN DE ÁREAS DE NEGOCIO DE CENTROS TECNOLÓGICOS MEDIANTE LA UTILIZACIÓN DE SISTEMAS DE INFORMACIÓN GEOGRÁFICA

CAPÍTULO IV

Comparación de Áreas de Negocio de Centros Tecnológicos mediante la utilización de Sistemas de Información Geográfica

Artículo

COMPARING TRADE AREAS OF TECHNOLOGY CENTRES USING 'GEOGRAPHICAL INFORMATION SYSTEMS'

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COMPARING TRADE AREAS OF TECHNOLOGY CENTRES USING 'GEOGRAPHICAL INFORMATION SYSTEMS'

ABSTRACT

Advances in geographical information systems have contributed to location and marketing design strategies on the part of retailers. The techniques used in this field are based on delimiting trade areas and spatial analysis. The same approach is applied in this study to technology centres, which are considered as suppliers of knowledge-intensive services to their associated firms. The research objective focuses on analysing the spatial distribution of firms associated with two technology centres from different sectors. The results indicate that firms associated with a technology centre present spatial patterns that are similar to those observed in retailing, while significant differences were also found between the two technology centres used for the study.

KEYWORDS

Trade areas, technology centre, geographical information systems (GIS)

4.1. INTRODUCTION

In recent years, spatial data analysis has attracted growing interest from the scientific community (Haining, 2003), in particular due to advances in geographical information systems (GIS) (Berry, 2007).

The application of this type of analysis is becoming increasingly common, and even more so in business contexts (Longley, Goodchild, Maguire, & Rhind, 2005). In the field of commercial distribution, GIS have had a marked effect due to their use in location and marketing design strategies (Campo, Gijsbrechts, Goossens, & Verhetsel, 2000; Church & Murray, 2009). The key concept for designing both types of strategy is that of the trade area, which is considered as the area where commercial retailing establishments generate sales, as a result both of proximity and local socio-demographic characteristics (Applebaum & Cohen, 1961; Grewal, Levy, Mehrotra, & Shama, 1999).

Technology centres, when conceived as advanced service providers for enabling innovation (COTEC, 2003), might also be considered to be retailers. Hence, the concept of trade areas could also be applied to technology centres in terms of location and design strategies, among other aspects. Several authors highlight the importance of the geographical proximity of technology centres if they are to offer effective service and support to businesses (Barrio & García-Quevedo, 2005; Tödtling & Kaufmann, 2001). This research takes a closer look at this field by applying GIS in an attempt to improve knowledge on the determinants of spatial distribution among firms associated with a technology centre. The conclusions derived from this study can be considered relevant in light of the fact that other research has shown that technology centres promote business innovation in the areas where they are established (García - Quevedo, Mas-Verdu, & Ribeiro, 2011; Lee, Olson, & Trimi, 2012).

Therefore, the objectives of this study are two-fold. It first defines the market scope of a technology centre in order to specify the geographical area that encompasses businesses to whom the centre can offer its services. The second goal involves identifying whether certain firm characteristics act as a moderating influence on the effect of distance.

The study analyses spatial distribution and the characteristics of firms associated with two technology centres located in Spain: Asociación de Investigación de la Industria Agroalimentaria (AINIA) a technology centre from the agrifood sector; and Asociación de Investigación de la Industria del Juguete, Conexas y Afines (AIJU) from the toy manufacturing sector. These centres were chosen due to the fact that the number of associated firms is extremely high, and these firms are geographically located all over the country.

The structure of the study is as follows: having established the objectives and relevance of the study, we first present the theoretical framework for the research, while the following section contains a description of the methodology. We go on to present and discuss the results, and end with the main conclusions to be drawn.

4.2. THEORETICAL FRAMEWORK

The theoretical framework of the research is based on three core interrelated elements: technology centres, trade areas and GIS.

Technology Centres

Certain public policies designed as drivers of innovation (Lee, Hwang, & Choi, 2012) have focused on providing advanced services through the creation and promotion of technology centres as suppliers of knowledge-intensive services (KIS). KIS encompass a wide variety of activities and services, which include marketing, legal services, consulting, engineering and technical analysis, among others (Mas-Verdú, Wensley, Alba, & García, 2011).

Together with other bodies, technology centres form a part of the infrastructures or support organizations for innovation within the Spanish Innovation System (COTEC, 2003). The objective of this type of infrastructure is to facilitate innovative activity among firms, supplying them with the material and human means to carry out R + D + i, advisory services in technology, problem-solving and management techniques, as well as information and a wide variety of other technology-based services (Mulet, 2003).

In light of their function as service providers, this study applies the trade area approach to technology centres used in commercial distribution. This new approach may contribute to designing efficient location and marketing strategies for technology centres.

Trade Areas

In the field of commercial distribution, the market zone or area of influence of a retail establishment can be defined as the geographical area where the business obtains all of its sales over a particular period of time (Applebaum & Cohen, 1961).

Huff (1964) later defined the concept more specifically as the geographically delimited region that contains potential customers whose probability of buying a given product or service offered by a business or organization is greater than zero. Ghosh and McLafferty (1987) provide a broader approximation by defining the trade area as the space within which an organization's market share is increased.

Applebaum (1966) distinguishes between three market subareas: (a) the primary market area covers somewhere between 60% and 70% of customers. It is the closest area to the establishment and contains the highest density of customers; (b) the secondary market area is adjacent to the primary one and is made up of the following 15–25% of the total number of customers; (c) the tertiary market area describes all the remaining clientele.

GIS play a vital role in delimiting the different market areas of a commercial retail establishment as it enables visualization, design and analysis. This analysis also includes spatial pattern and profile research.

Geographical Information Systems

No clear consensus exists on exactly what GIS consist of, although their components and functions are normally integrated within the same concept.

The National Centre for Geographic Information and Analysis (1990) in the USA defines GIS as 'a system of hardware, software and procedures created to enable the acquisition, management, analysis, modelling, representation and output of spatially referenced data to solve complex planning and management problems' (pp. 1–3).

Moreno (2007) describes GIS as 'a technology (…) for gathering, storing, manipulating, analysing, modelling and presenting spatially referenced data' (p. 4). However, this author goes a step further by stating that what is specific about GIS lies in characteristics such as their capacity to store large masses of geo-referenced information or the power to analyze this information, which makes them ideal for addressing planning and management problems; in other words, for decision-making.

Despite the amount of varying definitions that can be found in the literature, they all coincide in their description of GIS as being an integrated system for working with spatial information, which constitutes a fundamental tool for analysis and decision making in a variety of knowledge fields (Andrienko et al., 2007). Currently, the novelty of GIS lies in a progressive capacity to adopt new geographical information technologies to satisfy geo-information needs in a fast, flexible way, which can be adapted to measure a variety of analytical objectives.

From a practical point of view, GIS greatly facilitate the work in this research as the number of firms associated with AINIA and AIJU centres is so high. GIS allow for the georeferencing, storage, management, comparison, study and representation of all these firms and their corresponding technology centres. GIS also help identify the trade area of each technology centre and analyse it.

In this sense, and from a theoretical point of view, GIS can contribute to an in-depth study of the spatial relationship between the suppliers and users of KIS in order to improve decision making processes (Mainardes, Alves, & Raposo, 2011; van Riel, Semeijn, Hammedi, & Henseler, 2011) involving the planning and management issues of these technology centres. This scenario is possible if these centres are conceived as suppliers of KIS, based on the concept of trade area used in retailing.

4.3. DATA AND METHODOLOGY

This research uses three different techniques. The first (customer-spotting data) is used to delimit the trade areas in line with the first objective of this study. The two others (Nearest Neighbour Analysis and Ripley's K Statistic) are employed to analyse the spatial pattern of firms associated with technology centres in relation to the second objective.

Data

Firms listed with the AINIA and AIJU centres form the basic data for this research. This information was provided directly by the technology centres themselves. The number of firms analysed that are associated with the AINIA is 874, while the number of firms associated with the AIJU is 581.

Additional information on the characteristics of the firms analysed was taken from the SABI database, which uses the data supplied by companies to an official, public registry (Registro Mercantil).

Customer spotting data

Applebaum (1966) proposes a method for determining market areas known as ‘customer spotting’, in which the customers of a commercial retail establishment are located and marked on a map. The primary, secondary and tertiary market areas of the establishment can then be drawn manually.

For the purposes of this research, and via the use of GIS, the businesses associated with the two technology centres were geo-referenced on the digital map and, subsequently, their related market areas were calculated. From this point on, several types of analysis can be carried out on the spatial distribution of businesses associated with a technology centre.

Nearest Neighbour Analysis

Nearest Neighbour Analysis (Clark & Evans, 1954; Ebdon, 1977) is specifically designed to measure patterns in terms of the arrangement of a set of points. The Nearest Neighbour Ratio R is calculated as:

$$R = r_{obs} / r_{\exp} \qquad (1)$$

where r_{obs} is the observed mean Distance and $r_{\exp}$ is the expected mean distance for a random arrangement of points.

If $r_{obs} > r_{\exp}$ or $R > 1$, it indicates that the observed pattern is more dispersed than the random pattern. Nevertheless, if $r_{obs} < r_{\exp}$ or $R < 1$, it suggests a more clustered pattern.

In this research, the set of points represents the firms associated with a technology centre. Therefore, R specifies whether the spatial pattern of all the firms analysed around their corresponding technology centre is clustered, random or dispersed. With the purpose of testing the statistical significance of the results, the Z score value is calculated. Z scores are measures of standard deviation and are associated with a standard normal distribution. This distribution relates standard deviations with probabilities and allows significance and confidence to be attached to Z scores (Ebdon, 1977).

Ripley's K Statistic

The K function describes the extent to which there is spatial dependence in the arrangement of events (Ripley, 1976, 1977). It identifies the scale and significance of the clustering over a range of distances. Furthermore, it comprehensively captures the local variational characteristics in the study region. The formula is as follows:

$$K(t) = n^{-2} A \sum_{i}^{n} \sum_{j \neq i} w_{ij} I_t(u_{ij}) \qquad (2)$$

where t is the radius of a circle whose centre is a point in the pattern, n is the number of points, A is the plot area, w_{ij} is a weighting factor to correct for edge effects, and I_t is a counter variable which is set to 1 if the distance u_{ij} between points i and j is $\leq t$, otherwise $I_t = 0$.

Besag (1977) proposes a linear transformation of $K(t)$. The result is the L function which is more used as it is easier to interpret:

$$L(t) = \sqrt{\frac{K(t)}{\pi}} - t \qquad (3)$$

If $L(t) > 0$, it suggests that the observed distribution is geographically concentrated at that distance t. In contrast, if $L(t) < 0$ it denotes dispersion. At last, under complete spatial randomness, $L(t) = 0$.

Just as ÓhUallacháin and Leslie (2007) calculate unweighted and employment-weighted distance-based clustering of different establishments, this research also calculates several K functions according to the following firm characteristics (Cáceres, Guzmán, & Rekowski, 2011; Idris & Tey, 2011; Montoro-Sánchez, Mas-Verdú, & Ribeiro, 2008): (a) profile: sector, size and age; (b) performance: income, turnover, productivity and profitability.

The unweighted functions demonstrate the scale and significance of the clustering of firms over a range of distances, based exclusively on its location or spatial distribution. The weighted functions show firm clustering depending on their characteristics, in other words, taking into account their profile. In order to test the significance of the different K functions, confidence envelopes are computed, which can be translated into confidence intervals to a level of 1%.

4.4. RESULTS AND DISCUSSION

Spatial Distribution

Studies on commercial distribution indicate the importance of managers being aware of the geographical extension of their market for each shop before they can proceed with any kind of performance evaluation (Rosenbloom, 1976). Technology centres also have their own primary, secondary and tertiary market sectors. In the case of AINIA, the radius of the primary area is 270 km, and the secondary area covers 338 km. For

AIJU, the radius of the area that encompasses 60% of its associated businesses is 88 km, while the radius that includes 80% of firms covers 382 km. The results indicate that there is a greater concentration of firms from the toy manufacturing sector around the technology centres than for the agrifood sector.

This distinction between market areas derives from the fact that the number of customers decreases as distance from the establishment increases. If we create a histogram of the associated businesses, it can be seen that this phenomenon is also true for technology centres. The exception to this rule occurs in the metropolitan areas of Madrid and Barcelona, where there is an increase in the number of associated firms in outlying parts of the market area. As with retailing, the spatial organization of cities and, consequently, where there are major concentrations of the population should be taken into account (Baviera-Puig, Castellanos, Buitrago, & Rodríguez, 2011). In the case of this research, areas where there are major agglomerations of businesses is a major factor to bear in mind.

Table 1. Average Nearest Neighbour test.

	AINIA	*AIJU*
Observed Mean Distance	5,073.87	7,161.33
Expected Mean Distance	14,732.61	31,105.60
Nearest Neighbour Ratio	0.34	0.23
z-score	-37.08	-33.45
p-value	0.00	0.00

It is worthwhile noting that 40% of the businesses associated with AINIA and 61% of those on the AIJU listings are found within the first 90 km radius around the technology centres. These results confirm that there is a greater concentration of businesses associated with the toy manufacturing sector around their technology sector than in the agrifood sector.

On carrying out the Nearest Neighbour Analysis, in both cases there is less than 1% likelihood that this clustered pattern could be the result of random chance (Table 1). Therefore, there is a spatial pattern in the global distribution of these firms and this pattern is clustered. This result coincides with the unweighted K functions (Figures 1 and 2), which analyse the spatial distribution of associated businesses throughout the whole range of distances without taking into account their characteristics.

Figure 1. AINIA's unweighted K function.

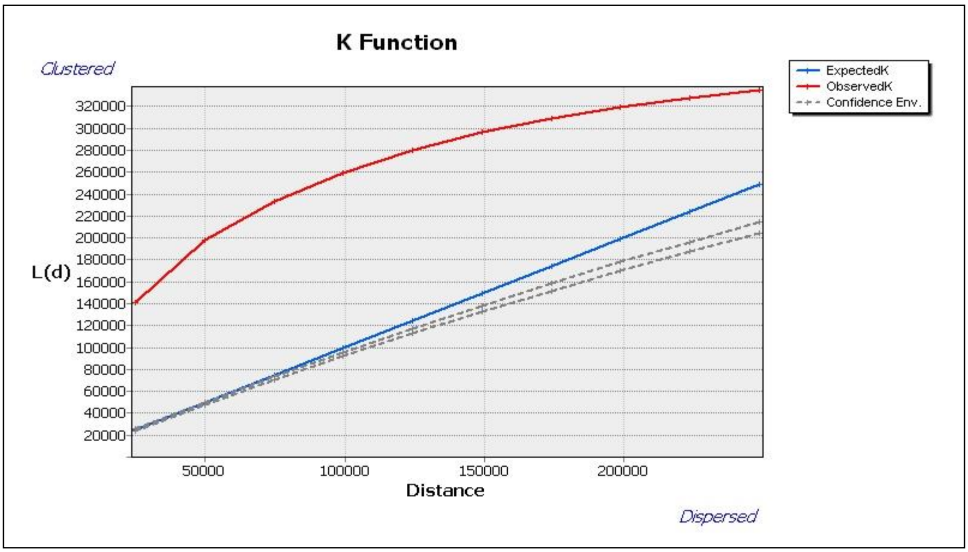
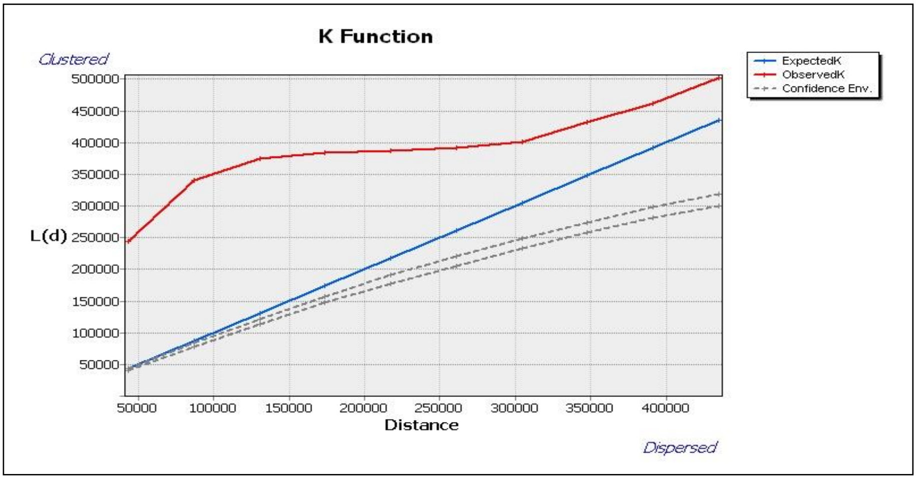


Figure 2. AIJU’s unweighted K function.

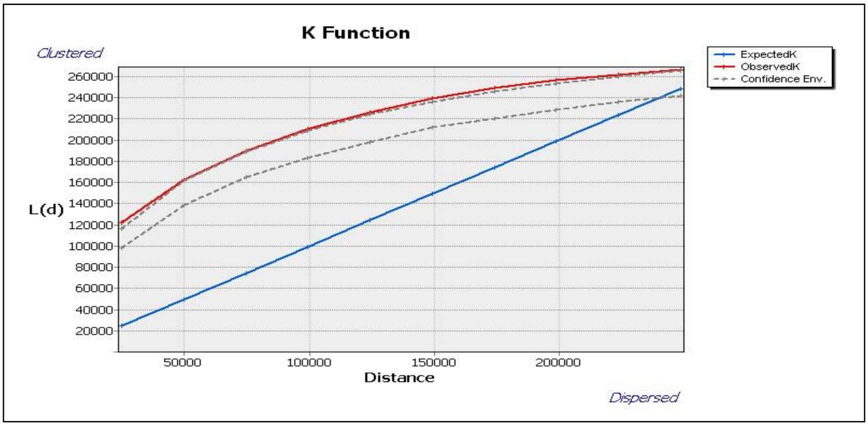


Profile Analysis

Grether (1983) proposes the use of spatial analysis as part of the marketing theoretical framework, as spatial organization and relations are organically linked. Precise knowledge of the limits of the market area is vitally important for organizations, as it allows them to adjust their marketing strategy to local characteristics (Baray & Cliquet, 2007). Two major aspects are relevant to this issue: (a) who are the customers and who is the competition? (b) where do these customers live and where is the business itself located? (Baviera- Puig, Buitrago, Escriba, & Clemente, 2009).

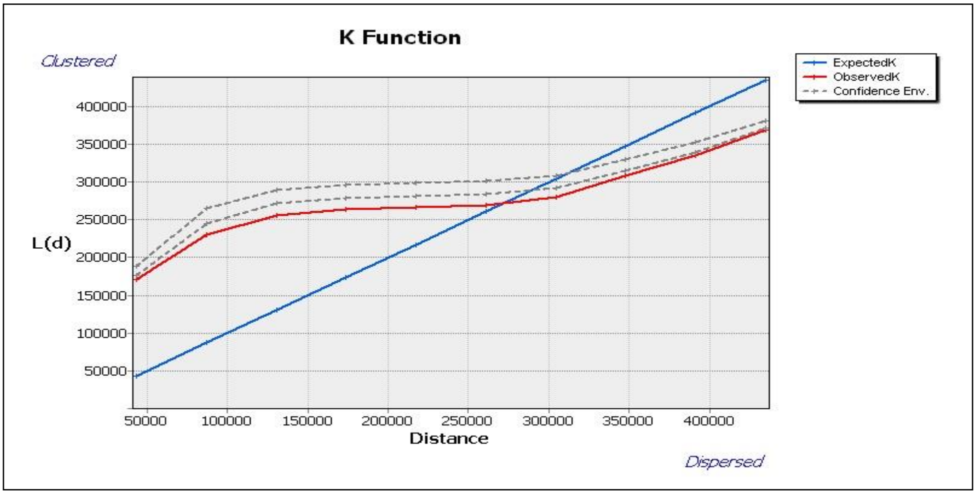
In this research, the businesses associated with the technology centres are notably heterogeneous (Garcia-Quevedo & Mas-Verdu, 2008) and their characteristics appear to vary in accordance with the distance considered. In the case of businesses associated with AINIA, the variable ‘Sector’ is the only variable that is statistically significant. The observed spatial pattern occurs throughout the range of distances analysed (Figure 3). The same cannot be said of businesses associated with AIJU, in which, on the one hand, we can observe a change in the spatial pattern from concentrated to dispersed; and on the other, there is a statistically significant dispersion for the area past a 270 km radius (Figure 4).

Figure 3. AINIA's sector-weighted K function.



We can deduce from this result that firms within the agrifood sector are spatially grouped throughout the entire national territory, which would explain the greater level of dispersion. Conversely, the businesses associated with AIJU are concentrated within a particular area of the country, which is where the technology centre has its base, and associated firms become dispersed from a radius of 270 km onwards. These results show the relevance of productive specialization in the spatial distribution businesses throughout the country. Firms present a different spatial pattern according to the sector being considered. Such results are consistent with the findings of García-Quevedo and Mas-Verdu (2008), which show that not only geographical proximity but also functionality (sector) is important in the relation between the suppliers and users of KIS.

Figure 4. AIJU's sector-weighted K function.



In the case of AIJU, apart from 'Sector', the variable 'Turnover' also turns out to be statistically significant, and has a dispersed pattern up to a 310 km radius.1 The reason for this circumstance could be that the firms associated with AIJU with a relatively large turnover are not geographically grouped within the same 310 km area of influence of the technology centre.

Implications for public policies

According to COTEC (2007), the consolidation of a network of offices that provide guidance to small and medium enterprises (SMEs) in their search for technological (BarNir, 2012; Siegel & Renko, 2012), organizational (Cegarra-Navarro, Sánchez-Vidal, & Cegarra-Leiva, 2011; Chang, Hughes, & Hotho, 2011; Hotho & Champion, 2011; Lee, Lim, & Pathak, 2011) and financial (Yang & Li, 2011; Zortea-Johnston, Darroch, & Matear, 2012) solutions for their innovation processes (Battistella, Biotto, & De Toni, 2012; Goktan & Miles, 2011; Reed, Storrud-Barnes, & Jessup, 2012) is still a pending issue. There are three key variables for success in the world of distribution, regardless of the other variables taken into account during the commercial planning process. These variables are location, location and location (Ghosh & McLafferty, 1982). Therefore, location should be included when designing this network of guidance offices for innovation of SMEs.

Knowing the spatial distribution of businesses in the area and using the tools presented herein may contribute to selecting the most appropriate location strategies for the efficiency of technology centres. This also leads to the establishment of suitable networks. As GIS allow for the geo-referencing of where firms are located on a digital map, it is possible to detect where market opportunities can be found and even to quantify them. If other existing or potential technology centres are added to the map, competition among centres can be avoided. This rivalry can be identified by any overlap in the trade areas of the technology centres considered. In retailing, this overlapping and duplication is known as cannibalization (Kelly, Freeman, & Emlen, 1993).

Nevertheless, it is not only a question of choosing a particular place, but also of juxtaposing the spatial characteristics of the market with corporate and commercial objectives (Ghosh & McLafferty, 1987). In this sense, as the results show that the profile of firms influences spatial pattern, it is important to include the characteristics of the firms in the location strategy design.

Considering the profiles of businesses depending on their spatial distribution may allow technology centres to adapt their marketing strategies to their current or potential client firms as in other sectors (Eggers, Hansen, & Davis, 2012; Huarng & Yu, 2011; Lindic & Marques da Silva, 2011). Consequently, technology centres could improve their commercial strategies in terms of efficiency, increase their market share and, therefore, obtain more benefits (Ashworth, 2012; Bettiol, Di Maria, & Finotto, 2012; Chaston & Scott, 2012). From all this spatial information, technology centres can also carry out other types of studies to evaluate their performance (Cavalcante, Kesting, & Ulhoi, 2011; Jafari, Rezaeenour, Mazdeh, & Hooshmandi, 2011).

In synthesis, this study offers several key concepts and tools to design location and marketing strategies of technology centres at a global and individual level. Globally, it would lead to greater consolidation of the network of offices that provide KIS to SMEs in an effort to facilitate their innovation processes. The results confirm that there are differences in the spatial distribution of the firms associated with two different technology centres. This is the reason why we consider that every case should be studied separately and all the factors involved should be considered.

4.5. CONCLUSIONS

The theoretical framework of this research is based on three core interrelated elements: technology centres, trade areas and GIS. Technology centres are chosen because it has been demonstrated that they promote business innovation in the areas where they are established as they provide KIS, among other aspects. The concept of trade area is used in retailing to define the geographical area where the retailer obtains sales over a particular period of time. Finally, GIS consist of technology for working with spatially referenced data to solve planning and management issues in different knowledge fields.

In this research, we employ GIS to provide an in-depth analysis of the spatial relationship between the suppliers and users of KIS in order to improve the decision making process among technology centres. This is possible if these centres are conceived as suppliers of KIS and firms associated with them are considered as users, based on the concept of trade area used in retailing.

With regard to the first objective (defining the market scope of a technology centre), primary, secondary and tertiary trade areas of technology centres are identified and delimited. Thanks to advances in GIS, we are able to see how, as in retailing, the number of businesses associated with a technology centre diminishes as the distance increases. However, this distribution also depends on the spatial organization of businesses in the area, in light of the fact that large concentrations of firms must be taken into account. Finally, the different results indicate that there is a greater concentration of firms from the toy manufacturing sector around the technology centres than firms from the agrifood sector.

In reference to the second objective (to identify whether certain firm characteristics act as a moderating influence on the effect of distance), there is a spatial pattern in the global distribution of the firms associated with AINIA and AIJU. This pattern is clustered in both cases. However, the 'Sector' variable establishes significant differences between the businesses associated with each of the technology centres, leading to a variation in the spatial patterns. The variable 'Turnover' only results in significant differences in the case of businesses associated with AIJU; spatial distribution around the technology centre is heterogeneous for this variable.

These results may contribute to the location design strategies of technology centres. In this way, it is possible to consider several variables simultaneously, from detecting market opportunities to determining how large they are, and even establishing the ways in which networks can be consolidated. One of the conclusions of this study is the need to include the profile of the businesses considered in the analysis, as this factor influences the spatial pattern. Determining this strategy could also contribute to the design of efficient marketing strategies on the part of technology centres for their current or potential client firms.

With regard to future lines of research, we would recommend including the 'time' variable with a view to carrying out a dynamic analysis of the spatial distribution of businesses associated with technology centres. It would also be of interest to carry out a broader comparison, including technology centres from different countries.

Notes

1. All the K-functions calculated here are available on request.

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CAPÍTULO V

CONCLUSIONES

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CONCLUSIONES

El objetivo general de esta Tesis ha sido analizar la distribución espacial y la localización, tanto de establecimientos comerciales como de centros tecnológicos, mediante la aplicación de Sistemas de Información Geográfica (SIG). Los SIG consisten en sistemas digitales que, a través de un conjunto de herramientas de hardware y de software, permiten el análisis y manipulación de datos geográficos proporcionando una modelación de la realidad (Barredo, 1996).

Los SIG se han utilizado como técnicas de análisis para explotar conjuntamente bases de datos alfanuméricas y espaciales. Esto ha permitido llevar a cabo los análisis espaciales necesarios para determinar la localización de los potenciales clientes y competidores (en el caso de los supermercados) o la ubicación de las empresas usuarias (en el caso de los centros tecnológicos) en una zona determinada. Todo ello de cara a la delimitación y cuantificación de las áreas de influencia de cada uno de los supermercados o centros analizados.

Por lo tanto, el objetivo genérico de esta Tesis ha sido analizar diferentes áreas comerciales mediante la utilización de SIG. Esto ha permitido realizar diversas aplicaciones de estas técnicas en diferentes áreas de la economía. El objetivo general se puede descomponer en tres objetivos específicos:

- el análisis de la geodemanda y la geocompetencia,
- el estudio las ubicaciones comerciales y
- la delimitación de las áreas comerciales y su análisis espacial.

Con respecto al primer objetivo específico (el análisis de la geodemanda y la geocompetencia), se ha procedido a su cálculo, cuantificación y visualización en el caso concreto de un sector (minorista) en una ciudad (Murcia). Ello ha permitido, mediante la utilización de los SIG, alcanzar dos resultados: (i) por un lado, determinar la distribución de los clientes potenciales de cada uno de los supermercados analizados; (ii) por otro lado, ha permitido definir y delimita,r en primer lugar, las zonas que presentan mayor superficie comercial (zonas saturadas) y, en segundo lugar, las zonas no atendidas suficientemente. A partir de dicho análisis ha resultado posible la detección de oportunidades de nuevas ubicaciones. En efecto, con la superposición de la geodemanda y la geocompetencia se ha conseguido demarcar, tanto cuantitativa como visualmente, las zonas en las que existe una geodemanda no cubierta por la geocompetencia.

En relación con el segundo objetivo específico (estudio de ubicaciones comerciales), se ha llevado a cabo una priorización y valoración de dichas oportunidades mediante el proceso analítico jerárquico (AHP) desarrollado por Saaty (1980). Con la utilización de este proceso de análisis ha resultado posible determinar cuáles son los principales atributos (emplazamiento y competencia) que influyen en la apertura de un nuevo establecimiento. De este modo se han podido valorar y ordenar las distintas oportunidades comerciales.

Finalmente, y por lo que se refiere al tercer objetivo específico (delimitación y análisis espacial de las áreas comerciales) se ha realizado una geolocalización, mediante técnicas SIG, de las empresas asociadas a dos centros tecnológicos (AINIA –industria agroalimentaria- y AIJU –sector del juguete-). Para ello, los centros tecnológicos han sido considerados como centros proveedores de servicios intensivos en conocimiento para sus usuarios (empresas asociadas). De este modo se ha analizado la relación espacial que existe entre los ofertantes (centro tecnológicos) y los demandantes de servicios intensivos en conocimiento (empresas asociadas). Como resultado ha sido posible determinar que las ubicaciones de las empresas asociadas a los diferentes centros tecnológicos no se distribuyen de forma aleatoria sino que siguen un patrón definido por las características de las empresas y la ubicación del centro prestador de servicios.

Cada uno de los artículos que conforman la Tesis se ha centrado en uno o varios de los objetivos específicos que se acaban de presentar. A continuación, se exponen las conclusiones particulares extraídas de los artículos que componen la Tesis.

Business opportunities analysis using GIS: the retail distribution sector

La finalidad del primer artículo ha consistido en generar un procedimiento que contribuya a la definición de la estrategia de localización de los puntos de distribución de compra frecuente. Para ello, se han utilizado los SIG como medio para gestionar bases de datos desde el punto de vista del geomarketing.

En primer lugar, se han identificado la geodemanda y la geocompetencia en mapas digitales. Con respecto a la geodemanda, se observa que la población no se distribuye uniformemente en la ciudad, sino que existen una serie de agrupaciones que pone de manifiesto una concentración importante de personas en un área determinada. Del análisis de la geocompetencia se han podido determinar, de un lado, las zonas de la ciudad de Murcia que presentan mayor superficie comercial (zonas saturadas); y, de otro lado, las zonas no atendidas por la oferta comercial actual. En segundo lugar, a la hora de determinar las distintas oportunidades comerciales, parece necesario analizar tanto la localización de la competencia como la localización de la demanda para establecer cuáles son las zonas no atendidas por la distribución comercial existente. Por ello, se ha realizado una superposición de la geodemanda y la geocompetencia y se han obtenido las zonas de la ciudad de Murcia donde existe una geodemanda no atendida por la geocompetencia, es decir, aquellas zonas donde existen potenciales ubicaciones para nuevos establecimientos comerciales.

The retail site location decision process using GIS and AHP

El objetivo de este paper ha consistido en desarrollar una metodología que permita, mediante el uso combinado de SIG y modelos de decisión multicriterio, determinar las mejores ubicaciones para nuevos establecimientos comerciales. Como aplicación práctica, se emplea dicha metodología para ayudar a definir el lugar de ubicación de un nuevo supermercado en la ciudad de Murcia.

En primer lugar, se han determinado los factores de éxito de un supermercado mediante la utilización del proceso analítico jerárquico (AHP). Los resultados obtenidos revelan que los factores más importantes son los relacionados con el emplazamiento y la competencia.

En segundo lugar, se ha identificado la geodemanda para poder localizar a los clientes. Es importante destacar que la demanda se ha localizado a nivel de parcela, lo que supone un mayor grado de detalle en comparación con otros estudios que lo hacen a nivel de sección censal. Por otra parte, se analiza la geocompetencia, es decir, se identifica y localiza espacialmente a la competencia de la empresa. Una vez realizado este análisis, se calcula el área de influencia de cada uno de los competidores en función de su superficie comercial para analizar si la oferta comercial es baja, media o alta. Finalmente, al cruzar la información anterior, se obtienen las zonas con la población libre de oferta comercial y las zonas o áreas que presentan una oferta comercial baja.

Utilizando el análisis de Densidad Kernel, se han determinado las posibles ubicaciones comerciales para nuevos establecimientos de distribución comercial minorista. Así, se han logrado priorizar distintos establecimientos localizados en las ubicaciones posibles mediante los criterios obtenidos en la primera parte del estudio. De esta manera, se ha realizado una selección de la mejor ubicación para la nueva apertura y se ha llegado, incluso, a estimar la cifra de ventas de la futura apertura gracias a la inclusión de un supermercado existente que actúa como variable moderadora.

Comparing Trade Areas of Technology Centres using GIS

Este artículo se ha centrado en el análisis de la distribución espacial de las empresas asociadas a dos centros tecnológicos de diferentes sectores. Los estudios sobre la distribución comercial (Church y Murray, 2009) han destacado la importancia de la proximidad geográfica del mercado como medida de *performance* de una tienda. Los centros tecnológicos también tienen su propio mercado primario, secundario y terciario. La diferencia entre estas áreas deriva del número de clientes, que disminuye a medida que aumenta la distancia al establecimiento, en este caso, centro tecnológico. El concepto de *trade area*, es decir, el área en la que los establecimientos generan ventas, se ha aplicado a los centros tecnológicos. Se ha destacado la importancia de la proximidad geográfica a los centros tecnológicos para aquellas empresas que desean demandar sus servicios y su apoyo.

En la investigación, se han empleado los SIG para analizar en detalle la relación espacial existente entre los proveedores (centros tecnológicos) y los usuarios (empresas asociadas) de servicios intensivos en conocimiento. Como ya se ha comentado, se trata de una relación espacial basada en el concepto de “zona de comercio” (*trade area*), de amplia aplicación en el sector de la distribución comercial minorista.

En primer lugar, se ha definido el alcance de mercado de un centro tecnológico y, para ello, se han identificado y delimitado las zonas comerciales principales, secundarias y terciarias de dichos centros. Los diferentes resultados indican que existe una mayor concentración de empresas del sector del juguete en torno al centro tecnológico que en el caso del sector agroalimentario. En segundo lugar, se han identificado las características de las empresas que tienen una influencia moderadora sobre el efecto de la variable *distancia*. Así, se observa que hay un patrón espacial en la distribución global de las empresas asociadas con AINIA y AIJU. Este patrón está agrupado en ambos casos. Sin embargo, la variable *sector* refleja diferencias significativas entre las empresas asociadas con cada uno de los centros tecnológicos, que conducen a una variación en los patrones espaciales. Por su parte, la variable *volumen de negocios* sólo da lugar a diferencias significativas en el caso de las empresas asociadas a AIJU.

Los resultados obtenidos pueden contribuir al diseño de estrategias de marketing de los centros tecnológicos. En efecto, una de las principales conclusiones de este estudio es la conveniencia de incluir determinadas características de las empresas consideradas por su influencia en el patrón espacial. La consideración de estos factores podría contribuir al diseño de acciones de marketing más eficientes por parte de los centros tecnológicos de cara a sus empresas clientes actuales o potenciales.

Limitaciones y futuras líneas de investigación

Como limitaciones principales de la Tesis habría que indicar, de un lado, que la aplicación del análisis se ha centrado en una ciudad en particular, lo que puede ser una restricción de cara a la generalización de las conclusiones extraídas al caso de otros ámbitos territoriales con características diferentes. Por otro lado, sólo se ha examinado un sector (distribución comercial minorista) lo que puede resultar una limitación en términos de comparabilidad y extrapolación a otras actividades económicas. En este sentido, y como futuras líneas de investigación convendría realizar nuevas aplicaciones en otras ciudades y/o sectores para contrastar la validez general del modelo o de las conclusiones alcanzadas.

Igualmente, y como línea futura de investigación, aparte del modelo de decisión AHP utilizado, se podrían aplicar otras técnicas de decisión multicriterio, para observar cuál se ajusta mejor a la casuística de la distribución comercial. En este sentido resultaría conveniente tomar en cuenta que las técnicas de decisión multicriterio pueden ser discretas, si las alternativas de decisión son finitas, o pueden ser multiobjetivo, cuando el problema toma un número infinito de alternativas posibles (Thaler 1986). En esta investigación, se ha optado por las primeras ya que se obtiene un número determinado de opciones. Sin embargo, dentro de las futuras líneas de investigación sería conveniente experimentar con nuevos modelos de decisión multicriterio (scoring, MAUT, etc.). De este modo, se podría realizar una comparación con la metodología propuesta en este estudio de cara a establecer las ventajas y debilidades de cada uno de los enfoques.

Finalmente, también resultaría de interés incluir la variable "tiempo" con el fin de llevar a cabo un análisis dinámico de la distribución espacial de las empresas asociadas a los centros tecnológicos o al sector de la distribución comercial minorista a lo largo de diferentes periodos temporales.

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