Primary care clinic location decision-making and spatial accessibility for the region of Thessaly

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PRIMARY CARE CLINIC LOCATION DECISION MAKING AND SPATIAL ACCESSIBILITY FOR THE REGION OF THESSALY

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Abstract

The prospect for establishing a General Clinic at the Thessaly Region was examined. The new facility aimes to provide full medical care by qualified scientists (permanent personnel, shareholders or associates), by experienced, trained and skilled nursing personnel, fully organised with sophisticated technological equipment, in a hospitable and pleasant environment, with easy and fast access. The main aim of this study is the determination of the optimum location for the construction of the proposed medical centre for providing high level services in the Thessaly region, by implementing quantitative methods of Spatial Analysis of GIS technology. Spatial Analysis focuses on evaluating existing and proposed models of spatial organization, while GIS, provide the necessary informational tools for the elaboration and management of the relevant information and all in all in the support of the relevant decision making process.

Keywords: GIS, spatial analysis, SDSS (spatial decision support system), health care accessibility

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Introduction

According to current experience from similar approaches, the benefits form the synergy of the methods and techniques of Spatial Analysis and GIS are the database management, the procedures automatization and the testing of alternative scenarios which as a result lead to quicker elaboration, study, and analysis of spatial phenomena and the presentation of results through qualitative maps. Relevant literature is extensively presented in Koutelekos et al, in 2007, and evades the aim and the available space of the present paper.

The location decision study aims to determine the optimum location, which will

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ensure the success of the business plan. Under the framework of the above study, the suitable, according to criteria under evaluation, best locations are calculated so that after the procedure is completed, the solution that arises, serves simultaneously accessibility, effectiveness and efficiency. The selection for the locations is accomplished by equilibration and crosschecking of the businesses requirements (e.g. equal distance for all doctors) and the special characteristics of that area (e.g. population, road network). Basically an examination takes place which under comparison of the businesses requirements and the special characteristics of the location of installation, so that the location which serves best is selected.

After collecting all the above data, the methodological framework which was applied in the present study was formed. Afterwards, the application of the method is described in detail. The data used as well the collection and elaboration procedures are described. The extensive analysis according to the qualitative and quantitative criteria set is followed, as well as the selection of the optimum solution. Then, results are mapped and finally the basic data of the study are summarized and the specifications and characteristics of the following levels are allocated, as well as the business development prospects according to the conclusions of the study.

The region of Thessaly

The region of Thessaly is geographically situated centrally to Greece. The biggest percentage of the areas which are integrated in the directorial borders of the region has access to main road networks of the country. The region of Thessaly situated in the middle of the Athens – Thessalonica network, the two main urban centers of the country. The geographical integration of the region in that network has unambiguous consequences in relation to various developmental characteristics: transfers, commerce, transportation, national centered infrastructure, industry, e.t.c.

Methodological Approach

Geographical study is a process for analyzing the formation of spatial patterns, the interdependence of its elements and its changing procedures. The proposed methodological diagram, in which the steps which must be followed for facing the problem are described, as follows:

Defining the location – allocation criteria: According to the way the problem was expressed, the criteria which are going to be used for its justified and thorough solution are defined. These criteria are correlated with the level of analysis in question and therefore are differentiated according to whether a microscopic or macroscopic solution is selected. The criteria is divided into two categories a qualitative and a quantitative manner, and their gradual implementation leads to the selection of the ones not suitable and at the same time to the determination of the suitable locations. They refer either to critical values which have to be valid, or to indexes and parameters whose prices should be evaluated and compared with the alternative locations.

Data Collection – Database creation: The second step is the data collection and the design of a spatial database. In every process of geographical analysis, the data are on the one hand geographical (points, lines, polygons) that refer to corresponding ontologies and on the other hand descriptive, that include all the additional information regarding the under examination locations. The data used for the current application came from the Laboratory of Spatial Analysis, GIS and Thematic Cartography, University of Thessaly, were updated and corrected (if needed). A database with information about existing hospitals and clinics location, doctors addresses and their speciality.

The research is initially focused on the detection and the illustration of the needs of demand (patients) so as the offer (medical service facility), in order to discover the balance point. Additionally, the overall data elaboration is undertaken in GIS

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software, through the application of methods and techniques of Quantitative Spatial Analysis.

Application

Data Analysis and Elaboration:
1) The formulation of accessibility zones, based on the existing road network, depended on the particular type of each road (Figure 1). The range selected was 5 Km on either side of the highways, and 3 Km on the rest of the network.

Figure 1: Accessibility zones, in case study area

2) Calculation of the diachronic spatial mean of the population settlements and the residence of the clinic doctors.
Spatial mean is equivalent to the mean value:

$$(\bar{x} = \sum^{n} x_i / n)$$

Specifically, if every point i in space is described by its two coordinates (xi, yi), then the coordinates of the spatial mean are given by the following equations:

$$\bar{x} = \frac{\sum_{i=1}^{n} x_i}{n}, \quad \bar{y} = \frac{\sum_{i=1}^{n} y_i}{n},$$

where n is the number of points.
This, without "weight" mean is usually called centroid. In case the points have a specific "weight" (which is the most usual case), like e.g population, then the spatial mean is given by the following equations:

$$\bar{x} = \sum^{n} x_i f_i \;, \quad \bar{y} = \sum^{n} y_i f_i \;,$$

where $f_i = \frac{P_i}{\sum_{i=1}^{n} P_i}$ is the relative weight and Pi the weight of is points i.
A spatial mean of the population and the doctors' residences were calculated and compares so to asses how the population "moves" from 1961 to 2001, including a prediction for 2011.

3) Calculation of isometric time lines, using as center the point where the services offered exist for each prefecture for a distance of 5, 10 and 20 minutes. Time T is calculated by the following equation:

$$T = {}^{l}\!/\!_{u} \;,$$

where l is the length and u the mean speed, which is calculated by the type fo the road.
For the calculation the settlement with the largest population from each prefecture was selected. Then isometric lines were mapped for 5, 10, and 20 minute service, integrating the different types of the road network (Figure 2). The common space of the 4 isometric lines, define the possible areas of location.

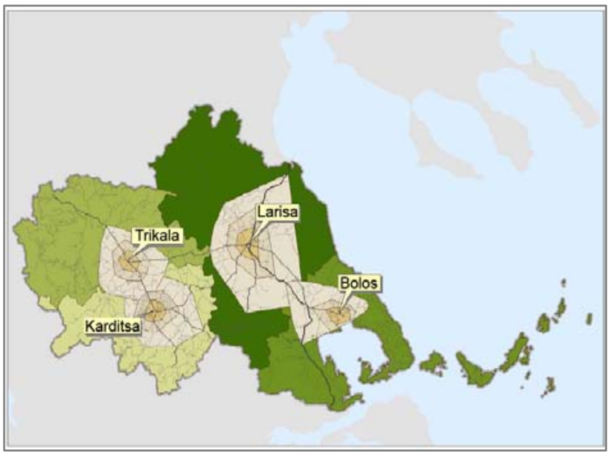

Figure 2: Isometric time lines for distance of 5, 10 and 20 minutes.

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4) Detection of the suggested areas that constitutes the intersection of steps 2 and 4, which is the areas that are characterized by high accessibility and at simultaneously are equally distanced from the most important point in each prefecture.

5) Comparative analysis of the possible solutions, according to the overall transportation, which is defined by the product value of the distance traveled and the population points that were selected from each prefecture. (Figure 3)

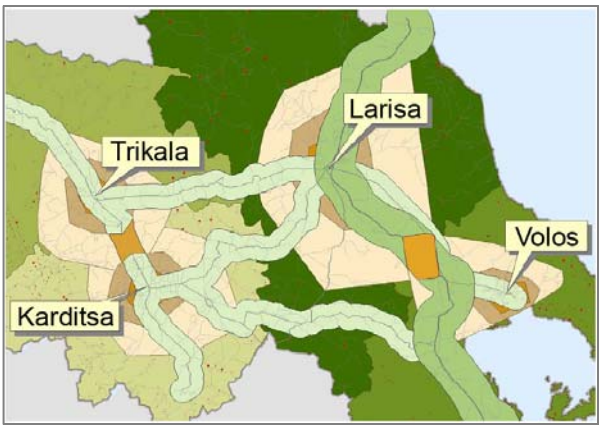

Figure 3: Proposed areas' view.

6) Travel – Cost assessment: Total distance traveled is calculated for the transportation from each settlement (with population over 2000 inhabitants) towards settlements that are within or close to the potential location –allocation area.

7) Spatial interaction of the best location with the depiction of the point of balance between offer and demand. The point of balance is calculated by the equation:

$$d_{iy} = d_{xy} / \left[1 + \left(Pop_x / Pop_y\right)^{1/2}\right],$$

where i is the point of balance between the settlements x and y. Popx and Popy are the corresponding population, dxy, the distance between them and diy, the distance of the settlement y from the point i. The balance point of the offer is calculated by the following equation:

$$d_{iy} = d_{xy} / \left[1 + \left(kl_x / kl_y\right)^{1/2}\right],$$

where i is the point of balance between settlements (x) and (y), klx and kly the number of clinic beds, dxy the distance in between and diy, the distance of the settlement y from the point i.

Possible areas located so far, have common characteristics, and for some additional calculation were needed. So, the overall population transportation time and distance was calculated from the capitals of the prefectures, and then from each settlement separately. The output is mapped the next section.

Best Solution

After having integrated all of the above steps, an examination followed of the overall transportation infrastructure of the area (distance from airports, harbors, railway stations) and the possibility of attracting other population, outside the case study area. So the final suggested area is presented in Figure 4. The wider area between Volos and Larisa is a strong pole not only for the population from other prefectures, but also for the tourists (during the summer season). So the selection of the above area plays also a national role for health infrastructure.

Figure 4: Map of the final area suggested.

Conclusions

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The development prospects of location-allocation plans, are increasing in international level, because as Clarke (1998) states: "Businessmen have realized the benefits from suitable location, and are willing to pay the cost for it." In Greece most enterprises don't use such methods of location –allocation, fact that leaves several development options. (Kaukalas, 1999). This development can be accomplished only by the collaboration of tertiary sector and research laboratories.

The overall approach that was adopted, integrates several theoretical frameworks, specialized techniques and state of the art software. Contemporary literature has similar examples and cases studies, proving not also the significance of this kind of research, but also the different approaches. Initially, a GeoDataBase was built integrating all the data that was collected, and elaborated in a GIS software system. Then after multivariate analysis was performed, possible solutions were revealed, which were cross-examined with other factors, like the general national infrastructure of the region. This was a macroscopic approach, meaning that the actual area selected is far larger, than the land parcel that the clinic will be built. For a more precise location, specific data are required, such as land parcels availability, land prices, legislation situation, etc. Additionally to the presentation of the best location, the research will suggest the development of a wider service network, which will cover the whole region.

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