Optimum Location for Future Hospital of Sintra

Applying Location-Allocation model in Healthcare Planning

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Introduction

In Portugal healthcare planning is centralized and the local authorities only participate at the last stage of implementation. The planning decisions are prepared without taking into account the potential users, sustainable travelling modes or local area knowledge [1]. However, in a world based on information, decisions concerning territory have to be more substantiated and objective [2,3]. Nowadays planning must be much more about strategy than wills or design. An example is the location of new equipment, specifically a Hospital, since it implies the allocation of a population. This type of decision should result from the application of accurate methods and rigorous analysis. Nevertheless, understanding all location features, catchment area potential and consumers' behavior may reveal a highly complex task [4].

Methodology

This article presents a decision support methodology to assess potential locations for the new Hospital of Sintra (FHS), jointly with *Hospital of Fernando da Fonseca* (HFF), using Geographical System Information methodology and location-allocation models.

The FHS will be a HFF complementary unit, sharing the same catchment area, i.e., Sintra and Amadora Municipalities. The recent 203/2008 decree establishes the need of Sintras' new hospital, defines HFF as a public hospital and creates Amadora-Sintra local health unit.

The methodology defined in this project, that follow the one defined by Gonçalves [5], has four distinct phases (figure 1): 1. We have identified the data to characterize each potential location, namely population and HFF patient distribution, location criterions defined by legislation and the population accessibility; 2. We have

analysed the relevant data and modeled several scenarios; 3. We used a location-allocation tool to select the best location in each scenario; 4. Finally, to identify the best location, we used a single indicator – number of residents for accessibility level and transportation modes – to select the best location among the set of each scenario best locations.

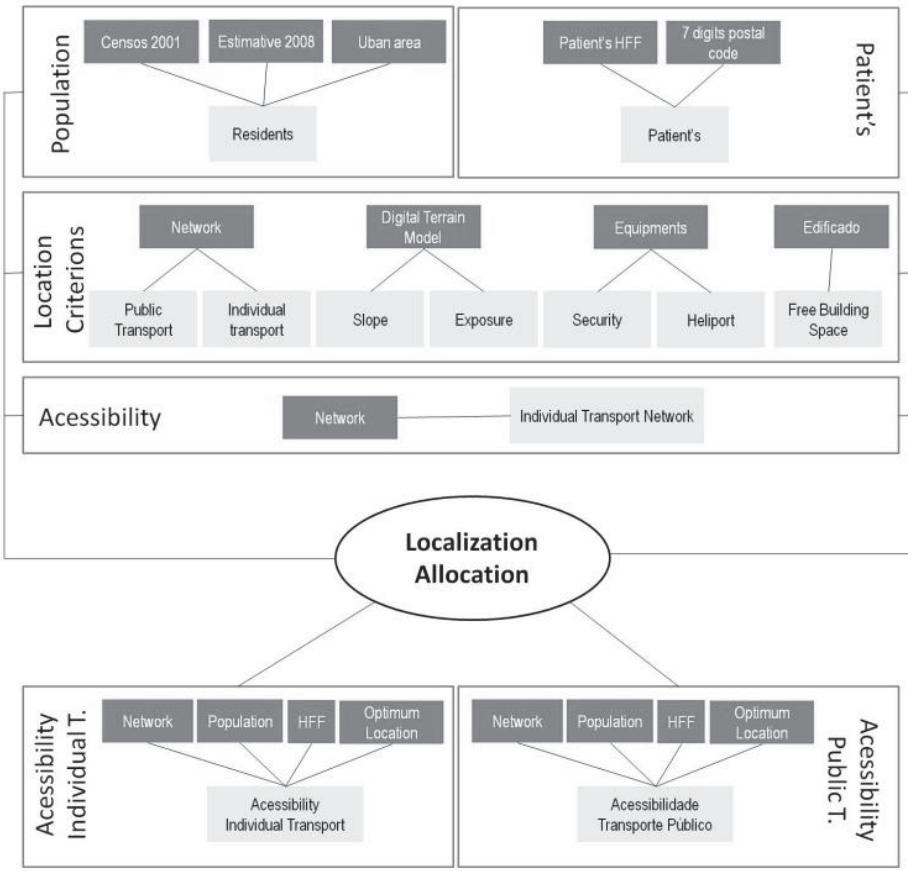

Figure 1: methodology scheme followed in this Project.

In the first phase we have collected data to understand the distribution of potencial and express demand.

Since recent data on population distribution wasn't available at larger scale than municipality (last data is from 2001) and the municipalities of Amadora and Sintra had a growth 14,5% between 2001 and 2008, we use spatial data (as urban area of the Corine Land Cover Project and the requests for new urbanizations) to distribute the population estimation of 2008. This approach allowed us to identify which are the places that will register population growth in next Censos.

To understand the HFF utilization profile, we applied a methodology already used in some studies [6] in other countries but quite recent in Portugal, which consists on geocoding all the patients, at the seven digits postal code, that had an episode in 2008 HFF database. This method allowed the identification of the distance role in the utilization of HFF (higher travelling distances implies less visits to the Hospital) and the ratio of patients by resident population (which is less than 50% in all the

analysed wards and less than 20% in Lisbon suburbs wards) using anonymized patient data.
We have identified on the legislation, a regulatory document from the Health Ministry [7], with the 36 location criterions for a new hospital. Analysing all the location criterions would be to complex. So, we identified the most important as the availability of free building space, the proximity to security equipments (fireman and police forces), heliport, main road network and public transport network, a good solar exposition and a low slope terrain.
We used two types of point data to identify the best location: the centroids of the statistic subsections, which represent the potential demand of both hospitals, and the centroids of the seven digits postal code, which represent the actual HFF express demand.
By crossing this two themes with the location criterions analyzed, we could identify the number of location-candidates (table 1).

Criterions	**Potential Demand**	**Express Demand**
	Statistical subsections	7 digits postal code
Without taking into account any criterions	5440	6567
All the criterions	28	138
Free building space	1034	2842
Acessibility to main road network	4247	5206
Proximity to Heliport	1156	1809
Low slope terrain	3972	4689
Solar exposion	2231	2906
Accessibility to public transportation	5152	6319
Proximity to security equipments	3413	4899

Table 1: Number of location-candidates when analysed taking into account the criterions.

Based in the distribution of the population and patients of the Municipality of Amadora and Sintra – potencial and express demand, respectively - and in the location criterions, it was possible to model several options and find the best location in each one. In the end, 22 distinct scenarios were modeled. For each scenario an optimum location have been found. However, most of them gave the same location so from those scenarios result 10 optimum locations for new Hospital of Sintra construction (figure 2).

The Optimum Location for Sintra Future Hospital

Through the analysis of the population distribution by accessibility levels, by public or individual transport, to each one of this location solutions it was possible to identify the optimum location: solution E. This solution – located on Agualva ward - results from a scenario where the demand was taken as the distribution of HFF patients in 2008, and the supply by the postcode area that had 4ha of building terrain. In terms of the location criterions analysed, this solution fulfils all of them, except the proximity to a heliport.

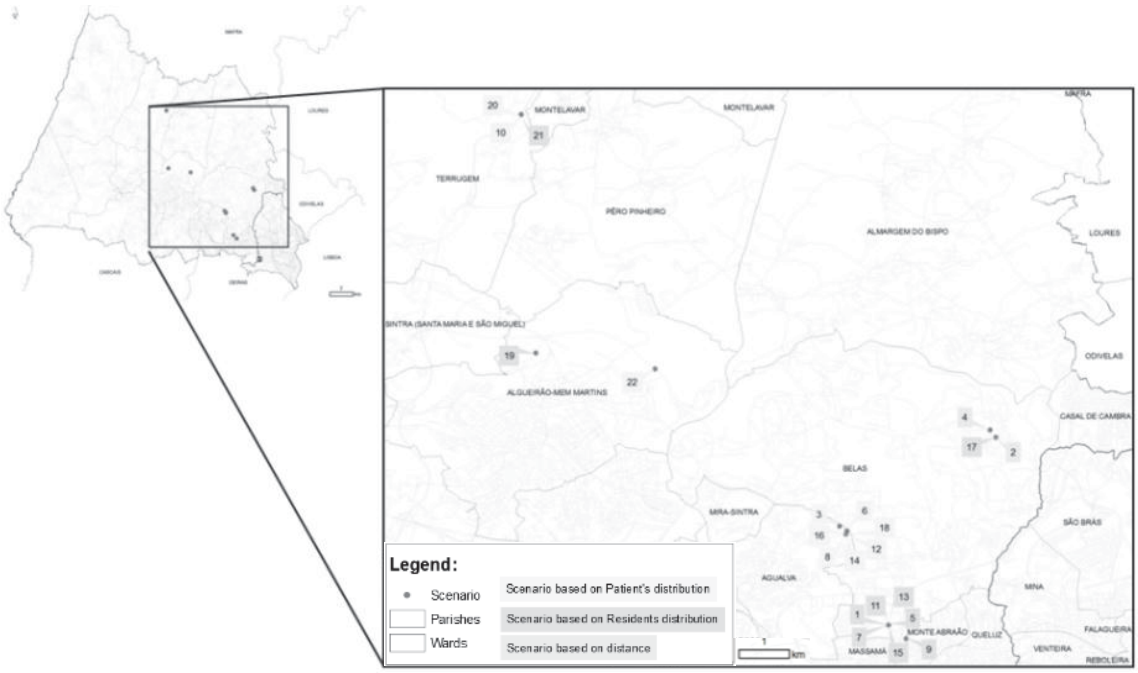

Figure 2: Solutions identified in each scenario as best location to the new Hospital of Sintra.

Choice for this solution is due to the improvement of less than 20 minutes accessibility, to 26,3% for individual transport and 7,6% for public transport; while actually those values are 12,5% and 4,1%, respectively. This solution also benefits 60.598 residents that currently are nearer other hospitals which aren't HFF, implying that 90,2% of Amadora and Sintra councils population will have health care coverage (figure 3).

In conclusion

The choice of the criterions used to identify the optimum location influences it and not always the analysis of all the criterions reveals to be the best option. For example, if we have taken into account only the scenarios that fulfilled the seven location criterions, the optimum location would bring only benefits for less than 7,2% of the population that used individual transportation (private car). However, it is essential to analyse several scenarios and evaluate them in order to find the best location.

Although the construction of this new unit will improve the population accessibility, mainly in Sintra municipality, and diminish the number of patients at HFF, there are some questions to be taken into account. With this unit, only 7,5% of the population of Amadora and Sintra that actually are nearer another unit than HFF, will stay closer to FHS. Additionally, we cannot forget that the new unit of Sintra will be located near a recent unit – Cascais'Hospital – and a unit already in construction – Loures'Hospital. Nevertheless, both units weren't planned for the almost 60.000 potential patients, residents of Amadora and Sintra.

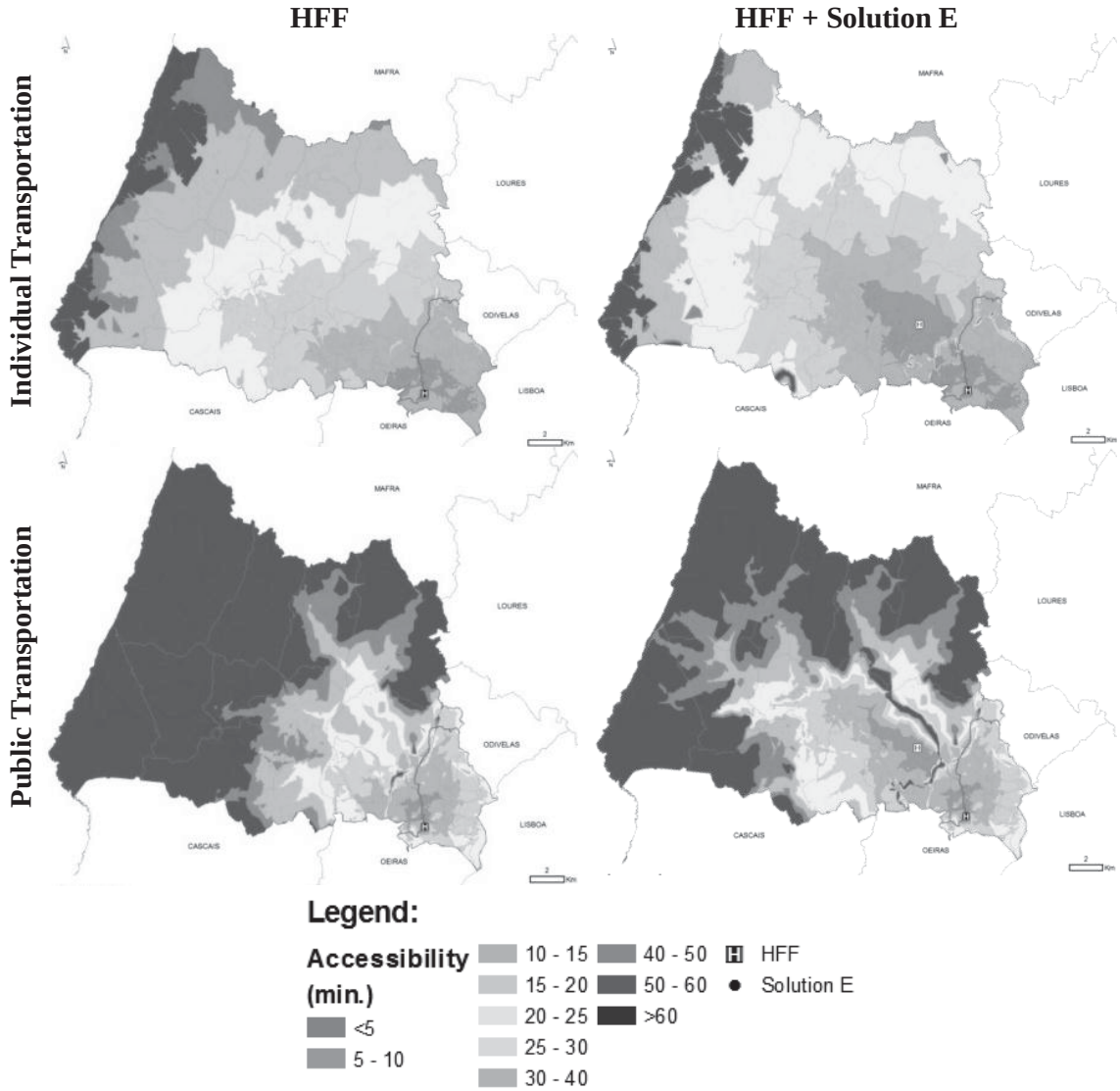

Figure 3: Location solutions identified in each scenario as best location to the new Hospital of Sintra.

These are important questions to be analysed either the Hospital of Sintra is build or not, mainly because, in the actual context of economical crisis and resources rationalization, population still needs and have the right for access to health care.

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