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Decision Support System for the Location of Healthcare Facilities SitHealth Evaluation Tool



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Decision Support System for the Location of Healthcare Facilities

SitHealth Evaluation Tool

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Foreword

A structured decision process is a key factor to the success of any organization and for bringing benefits to the society, particularly in the context of healthcare. This book entitled *Decision Support System for the Location of Healthcare Facilities: SitHealth Evaluation Tool* contributes to this. The book brings considerations to the complexity in solving problems concerning the location of public services as hospitals, by employing an advanced multi-criteria decision analysis (MCDA) method integrated with geographic information system (GIS).

With GIS, the model proposed provides an integrated knowledge about territory and the explicit consideration of the spatial dimension of the decision problems. By using this approach, the distribution of healthcare facilities within cities is not neglected in healthcare policies.

With the advanced MCDA method, the site selection for urban facilities, especially for healthcare facilities, can be approached solving this crucial topic related to healthcare, handling the side effects produced and dealing with the multiple criteria involved. Therefore, it considers simultaneously with economic issues, other dimensions such as functional, locational, and environmental. Also, with this MCDA method, the vision of different categories of stakeholders can be embraced.

The authors represent an important group in the scientific community of operations research and have received in 2017 the award of the best conference paper by the EURO Working Group on Decision Support Systems, which is related to the work published in this book.

I first met Marta at the 2016 MCDM Summer School. Then, she visited my research group for a short time, when my first contact with her co-authors has been established. Since the first meetings, I could realize Marta's skills for advanced research and the authors motivation for developing unconventional work.

It is with great pleasure that I introduce a book that reports outstanding academic research results that supports the decision process related to issues of the utmost importance to society, particularly in the current days.

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Preface

Today, even more than before, decisions need to be strongly addressed. In the recent years, many infectious diseases have occurred all over the world. Differently from the previous infections, the recently emerged coronavirus disease 2019 (COVID-19) appears to be more aggressive in terms of number of cases, countries affected, and mortality rate.

Actually, COVID-19 cases are almost 3.7 million with a 33.3% hospitalization rate.

The geography of contagion has pointed out some reflection suggestions: Cities and their local and global supply chains and networks can amplify the pandemic risk and diffusion; spatial variables, being the big part of the problem, play a central role as determinants for structuring the response and improving preparedness; the WHO social model of health is on the edge between current threats and new advancements of built environment settings towards public health and safety; managing trade-offs among multiple, overlapping, and conflictual objectives, as in complex and uncertain decisions, requires robust methodologies and reliable data.

Despite the lack of comprehensive and homogeneous datasets across regions as well as the asymmetric governance and policy responses, many hypotheses have been defined about the relationship among territorial conditions and disease diffusion. Climate, air pollution, healthcare system governance and organization, physical hyper-connections, commuting travels, urban density, and social vulnerability are some of the potential drivers that stress the importance of territorial perspective as analytical and strategical framework. By observing the Italian response to the outbreak and especially the Lombardy Region, one of the most affected territories by the pandemic, the location of healthcare facilities network, compared to other regional and international contexts, has been able to cope with the health emergency, managing so far to limit its extent in the areas with the highest population density. Therefore, the location of hospitals can be considered as a precondition for the success of a new facility and an inadequate evaluation can strongly determine the capability to react to infections diffusion and to health diseases.

For understanding how environmental, social and economic features can promote or inhibit disease growth, spatial analysis is essential. This kind of analysis are not new. Before and after the 1792 Finke's medical geography approach and the John Snow's spatial visualization of the London cholera outbreak in 1854, many are the studies that overlaid the location of disease with factors that are considered as its drivers. In addition to the emerging influence of built environment and living conditions on health, maps by combining different layers of information suggest explanations and provide arguments for decision scenarios towards infection inhibiting and preparedness improving.

In the recent years, many geospatial models that combine geographic information systems (GIS) and multi-criteria decision analysis (MCDA) have been defined and applied in several decision fields. The use of GIS together with MCDA has revealed the potentials of spatial decision support tools in the context of complex decision-making with relevant territorial determinants. The current notion of health, being at the centre of several inverse and converse interactions among physical environment and socio-economic conditions as determining factors rather than being anymore the absence of disease, represents a complex decisions problem. In order to address choices towards a balanced trade-off between conflictual goals, multidimensional evaluation approaches are crucial. Furthermore, spatial multi-criteria decision support tools, by considering both geographic data and decision-makers' preferences as inputs, are helpful when the decision problem under investigation involves several stakeholders and government levels and has direct as well as indirect territorial triggers and effects.

Among ill-structured problems, decisions about siting healthcare facilities involves environmental, social, medical, functional, and economic factors, as well as different categories of stakeholders, thus requiring an aiding evaluation framework for authorities to make location choices and to communicate results to the community in a transparent way.

Given the above emerging evaluation issues, the volume proposes a spatial evaluation model for supporting public health policies at two different levels: (i) the location of new healthcare facilities, when a finite number of alternatives has not been yet defined, or to identify the most suitable one among a specific set (ex-ante evaluation) and (ii) to rate the suitability of an already chosen area and, in case of a critical score, to solve or minimize weaknesses and threats (in itinere and ex-post evaluation).

The combination of MCDA and GIS could address decisions by considering simultaneously multiple dimensions of the problem under investigation, and the maps could facilitate to interpret and communicate the results, by aggregating and communicating several layers of information and data, thus being a robust support of legitimization and transparency for public authorities and the many stakeholders involved.

Given these premises, the book is divided into five chapters. The first frames the decision problem by focusing on the location of healthcare facilities (Chap. 1). The second introduces a spatial multi-methodological approach as medium to support the development of spatial suitability analysis (Chap. 2). The third deals with the

location of healthcare facilities (Chap. 3). The fourth described the SitHealth evaluation tool, a multidimensional tool for rating the suitability of locations to host hospitals (Chap. 4).

Finally, the book suggests how to support decision-makers within the policy cycle (Chap. 5).

Milan, Italy

Marta Dell'Ovo
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Chapter 1

The Location Problem. Addressing Decisions About Healthcare Facilities



Abstract The location of healthcare facilities is commonly considered as an ill-structured decision problem since characterized by the coexistence of several and sometimes conflictual criteria, the presence of different stakeholders with their own viewpoints and the necessity to find a trade-off among dimensions involved. Given these premises the contribution is aimed at proposing a detailed analysis of the State of the Art (SoA) of the location problem under investigation through a deep review of scientific papers, existing evaluation tools and the researches focused on solving the hospital's site selection. The main purpose of this chapter is to underline existing gaps on this decision problem in order to define an evaluation approach useful to structure a multidimensional framework. In fact, the analysis of the SoA has been developed in order to highlight how previous researches managed the decision problem by pointing out methodologies applied, software used and in particular criteria defined.

1.1 Introduction

Location problems are characterized by a deep complexity due to the coexistence of several and sometimes conflictual factors, interrelated subsystems and externalities. (Capolongo et al. 2020; Lenzi et al. 2020; Azzopardi Muscat et al. 2020). Their solution requires a multidimensional and integrated approach, based on the contribution of different fields of knowledge with respect to the many issues to be considered, both qualitative and quantitative, such as the site layout and characteristics, the stakeholders and the role they play into decision, the capital investment, etc. All of these aspects change according to the different kind of facilities to be located, having each facility its own peculiarity. In addition to the intrinsic characteristics to consider, a special attention should be given to the extrinsic ones, namely the factors influenced by the location, such as the quality of environment, the safety, the security, the accessibility, etc. (Kumar and Bansal 2016). Different steps have to be processed in order to structure a robust decision. Firstly, it is necessary to set the decision problem, then the main objectives and finally the alternatives that contribute to solve it. Moreover, by specifying the values to be satisfied, suggests aspects more relevant to deal with

and could help in identifying the alternative most suitable to meet the values elicited (Keeney 1992; Keeney and Raiffa 1993; Hammond et al. 1999; Keeney 2004).

Within this context, the location of healthcare facilities can be considered as a typical ill-structured decision problem since it involves issues belonging to different fields of research and there are several and sometimes conflicting stakeholders, whose instances should be considered as crucial (Dell'Ovo et al. 2018a).

The objective of the contribution is to propose a detailed analysis of the State of the Art (SoA) aimed at investigating the scientific literature, the existing evaluation tools and the researches focused on solving the hospital's site selection decision problem. In particular this chapter aims at underlying existing gaps on this decision problem in order to define an evaluation approach useful to structure a multidimensional framework. After this introduction, the Sect. 1.2 is focused on the description of the main phases of a decision problem, Sect. 1.3 on facing the location problem considering both public facilities and healthcare facilities, while Sect. 1.4 proposes a deep analysis of the SoA and some preliminary conclusions are presented in Sect. 1.5.

1.2 Problem Statement

The current research is cross-disciplinary between two main different domains: healthcare facilities design and location and Multi-Criteria Decision Analysis (MCDA). As it will be better explained by the analysis of the SoA, it is widely acknowledged the lack of a robust methodology able to solve the decision problem concerning hospitals' location, but more in detail the lack of guidelines capable to support Decision Makers (DMs) on this specific decision problem (Kahraman et al. 2003a, b; Soltani and Morandi 2011). Since the issue under investigation will impact the society as a whole, as well as the natural and the built environment, it becomes important to define a decision support system that can address the site selection of complex constructions such as hospitals.

Many of the scholars who have investigated this topic belong to Operational Research (OR), defined by Ormerode and Ulrich (2013) as "an activity done by people for people", i.e. the final aim is to support people in their activities (Brans and Gallo 2007). In fact, its final purpose is to predict system behaviour and to improve or optimize system performance in the field of complex situation. Within this context the Decision-Making is defined as a multistep process able to guide DMs until the final choice/selection of the most suitable alternative among those available, according to a set of values or elicited preferences (Kersten and Szpakowicz 1994). Decision-Making follows precise steps to support future actions, such as understanding immediately why we care about that action and how it is possible to achieve it by providing different solutions and then validating the result according to robustness tests. Moreover, Decision-Making involves a certain number of stakeholders and it refers to a specific environmental context (Kersten and Szpakowicz 1994).

Already in 1986, Fredrickson, contributed in presenting an overview about how authors, at that time, structured strategic decision processes and in fact, he achieved