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Dual-Level Location Suitability Index for Optimum Site Selection

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ABSTRACT

COVID-19 pandemic has spread rapidly affecting the entire world. During the fight against the pandemic, hospitals are insufficient to meet the needs. This study aims to set the basis for optimal site selection of quarantine hospitals. Further, to determine the critical factors influencing this selection. The Dual Level Location Suitability Index (DLLSI) proposed methodology provides decision maker with the optimal city and the optimal sites in the selected city for hospital construction. Analytical Hierarchy Process approach is implemented as a part of this study with 14 criteria used to evaluate the alternatives. Safety, accessibility, and availability criteria are also influencing the site selection. The results of DLLSI proposed methodology implementation show the optimal city and the optimal potential sites. It is observed that potential optimal sites located in optimal city. This is considered as self-evaluation, one of the contributions for the proposed methodology. Furthermore, the results of the proposed model are robust, realistic, and supportive for decision makers.

KEYWORDS

Analytic Hierarchy Process, Geographical Information Systems, Health Care, Optimum Site Selection, Quarantine Hospital

INTRODUCTION

Humanity, throughout history, has faced many types of disasters, whether natural or human-caused, such as earthquakes, tsunamis, volcanic eruptions, landslides, nuclear blasts, and epidemics. These types of disasters affect limited areas; however, a pandemic affects larger geographical areas. The COVID-19 outbreak was declared a pandemic by the (World Health Organization, 2020). COVID-19 can be considered the largest multifaceted crisis the world has recently faced. There were more than 770 million confirmed COVID-19 cases and 6.9 million deaths as of 27 August 2023 (WHO Team Emergency Response (WRE), 2023). The COVID-19 pandemic placed a "crushing burden" on most of the world's health systems. Governments around the world made every effort to ease this overwhelming burden but faced challenges due to a lack of available physical resources, especially intensive care units (ICUs). Therefore, in addition to resource allocation, increasing the capacity of

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intensive and supervised care beds (semi-ICU), and reducing the risk of infection are of primary importance when it comes to hospital facilities in the event of a pandemic.

Hospitals must also maintain a level of safety to operate in an emergency amid disastrous conditions. Therefore, like in other disastrous conditions, the selection of the appropriate location of a pandemic hospital would have a direct effect on the survival and/or rapid recovery of the affected population; having a medical building that could accommodate pandemic conditions would have the same effect. Location, as well as capacity, would also have a direct effect on the costs and other potential benefits for post-pandemic use (Ağaç & Şimşir, 2022).

In addition to that, decisions regarding hospital location may depend on personal testimony rather than objective analysis of required criteria and constraints (Soltani & Marandi, 2011). A wrong decision to not conduct the analysis of required criteria would increase investment and operation costs and would influence the lives of affected communities in the management of pandemic's circumstances. On the contrary, the right decision made after the analysis of the hospital site selection would have a positive impact on different parties such as optimizing the allocation of medical resources by combining health care services with economic and social needs, coordinating urban and rural health services for development, and alleviating social conflicts at the government level, increasing access to health care by reducing rescue times, meeting the medical needs of patients, improving citizens' quality of life, and saving costs for investors and hospital operators (Sen, 2017).

The decision-making process regarding the location of quarantine hospital must involve the identification, analysis, evaluation, and selection of several alternatives. After recognizing the need for additional competencies, a decision should be made about the “best” possible position (Yang & Lee, 1997). In such a process, it is essential to determine the criteria to be considered and the extent of their impact on site selection. In other words, the selection of locations for urban facilities is a strategic issue due to the many risks and conflicting criteria associated with such a decision (Oppio et al., 2016). Therefore, choosing the right location to put a hospital is an important factor in determining the success or failure of the facility (Senvar et al., 2016).

Geographical information systems (GIS) have proven to be an effective site selection tool in positioning selection across different sectors, such as factories, industrial areas, irrigation systems, power plants, and airports, as discussed in (Deveci et al., 2018; Erkan & Elsharida, 2020; Merrouni et al., 2018; Neissi et al., 2020).

One of the crucial parameters for selecting an optimal locations is determining its geospatial potential (Eastman, 1999). GIS can help decision makers with spatial data needed for proper site selection and provides automated functions for managing and analyzing spatial data types. In combination with multiple-criteria decision analysis (MCDA), GIS helps to identify potential construction site projects (Malczewski, 2006). Kapilan and Elangovan (2018) combine GIS with Analytical Hierarchy Process (AHP) in a GIS-AHP method to study solid waste disposal location selection. Also, Al Garni and Awasthi (2017) used GIS-AHP to select a construction site for a solar power plant. In addition, this method was used for the selection of other types of sites of facilities such as factories and industrial areas (Deveci et al., 2018), irrigation systems (Neissi et al., 2020), power plants (Merrouni et al., 2018), airports (Erkan & Evans, 2016), farms (Teniwut et al., 2019), charging stations (Kaya et al., 2020), dams (Arabameri et al., 2018), municipal facilities (Nyimbili & Erden, 2020), and residential areas (Shao, 2019).

Many multi-criteria decision-making (MCDM) tool have been applied in healthcare. AHP is an MCDM tool that decomposes a complex multi-criteria decision problem into a hierarchy (Saaty, 1980). According to a review of the literature, site selection problems are well-known, though, there are many different approaches to solving them. Table 1 summarizes various problems in applying a similar methodology in different fields.