GIS-based Site Suitability Analysis for the Development of Healthcare Facilities in Tacloban City

Maria Cecilia R. Paringit[1], Marian Stephanie R. Lao[2], *Stephen Ross L. Roleda[3]

[1,2,3] *De La Salle University (DLSU),*
2401 Taft Avenue, Malate, Manila, 1004 Metro Manila, Philippines,
maria.cecilia.paringit@dlsu.edu.ph
marian_lao@dlsu.edu.ph
stephen_roleda@dlsu.edu.ph

Abstract: The uneven distribution of healthcare facilities, not only in the Philippines but in other countries as well, causes issues of inequity in access and sufficiency. Health inequity is caused by systemic injustice that results in the variation of health outcomes in a group. Particularly in Tacloban City, Philippines, there are areas that had been identified as underserved due to physical distance to the healthcare facilities (HCF). Notably, 127 barangays out of 138 have access to all seven hospitals in the city considering a 30-minute travel time threshold. Meanwhile, two barangays have access to six out of seven HCFs. The remaining nine barangays, however, were determined to be limited to only five or less HCFs within the predetermined threshold. Another factor contributing to the inequity in access is the suboptimal distribution of the HCFs, with six out of seven located within the southern portion of the city. The outbreak of the COVID-19 pandemic had also revealed the vulnerability of the health system in the city as hospitals had already been at full-capacity. Prior to the pandemic, the tripling burden of disease has become an issue due to the rapid urbanization of the city. The burden in medical demand had also increased due to the rising number of patients being referred to one of the city's biggest and best-equipped hospitals; this hospital is the only major healthcare facility that is located in the north. Increased medical demand, inadequate number of HCFs, and suboptimal spatial distribution of HCFs had exacerbated the health system status within the city.

Thus, this study utilized methods that account for the supply-demand ratio between a hospital's capacity and the population as well as incorporating the realistic setting of distance decay and competition among healthcare sites. These variables had been encapsulated within the Modified Huff Three-Step Floating Catchment Area (MH3SFCA) to target the issue of low spatial accessibility to HCFs. The MH3SFCA quantifies the spatial accessibility of each population location given a predetermined time threshold to promote the principle of regional availability. To further address the issue of inequity, site suitability analysis by means of multi-criteria decision analysis (MCDA) was applied within the study area. Utilizing ArcGIS for the MCDA process, candidate sites were determined while considering primary constraints which are the spatial accessibility indices (SPAI) and the city's land use map.

The results of the MH3SFCA had identified areas with low and high spatial accessibility

through a generated SPAI map. The general trend had shown that, for those areas which are typically closer to the city's central business district and had a population which was serviceable in terms of probable medical demand, these are the communities which had higher SPAI. Communities which had a combination of high probable medical demand and increasing distance from the different healthcare facilities are areas which are shown to have decreased spatial accessibility. Due to the concentration of six out of the seven major healthcare facilities within the central business district of the city, the overlapping service areas allow for greater collective medical service provision to the communities within the urban core. The overlap in service areas of the HCFs significantly improves overall medical provision capacity, and ultimately increases the spatial accessibility of the communities within its proximity.

The considerations for the site suitability map include the generated SPAI map and the land use map. For the study, two cases or scenarios were created for the site suitability maps in order to compare the results. The first scenario (i.e., Case A) focused on the combination of low SPAI and the designated institutional land plots in order to find the intersection and generate the site suitability map. For the second scenario (i.e., Case B), this includes the aforementioned criteria in the first scenario with the addition of the designated agricultural land plots within the city. This scenario considers agricultural land since the policy of the local government unit indicates that idle or non-productive agricultural lands may be converted for institutional use. Having considered the generated SPAI map and the land use map, the generated site suitability map had shown that there is a potential of having a more even spatial distribution of HCFs within the city of Tacloban. Despite the resulting suitable areas close to Southern Tacloban, there were more suitable sites identified traversing the northern and the middle areas of the city than that in the southern portion. After identifying the most suitable service sites, an HCF test point was plotted on a candidate site to verify the suitability map and essentially, visualize the effect of adding a hospital with a substantial bed capacity. Magnifying further, the test point was added in the northern portion, being the proposed site by the local city health office for future HCFs. The new dataset for the SPAI, considering the test point, had resulted in a significant increase of accessibility for the northern barangays.

The results of the site suitability analysis through MH3SFCA-GIS had allowed for the identification of areas which are most appropriate for the future development of healthcare facilities within the city. Having identified these areas and conducted validation of a suitable site through the addition of a hypothetical healthcare facility, the results of the MH3SFCA (i.e., SPAI) had shown significant improvement in spatial accessibility for the areas within the test facility's proximity. Ultimately, the results validate and align with the current direction of the local city health office to locate future HCFs in the northern area. Since the city's southern communities had already been sufficiently developed, future development is rapidly shifting towards the north. Thus, a data-driven approach in healthcare planning could be of great significance in alleviating the inequity in access and availability within the city of Tacloban.

Keywords: Health Care, GIS, Spatial Accessibility, MH3SFCA