

Using Gis to find the suitable site selection for hospital in fes city

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ABSTRACT :

One of the most significant healthcare facilities in each community is a hospital. As a result, the locations of these facilities ought to make sense. The current study is to use a geographic information system (GIS) to 1) determine the best sites for new hospital establishments in fes city , Morocco, and 2) evaluate the locations of the current hospitals in fes using a methodology based on Multicriteria Analysis (MCA) and Analytic Hierarchy Process (AHP), integrated into a Geographic Information System (GIS) platform, specifically QGIS. The methodology of this project involves several steps, including defining relevant criteria such as accessibility, proximity to medical services, plot size, infrastructure, and community needs. Subsequently, the relative weights of these criteria are determined using the AHP method to evaluate their respective importance. These data are then integrated into QGIS to generate thematic and spatial maps to visualize potential hospital location zones. Finally, a multicriteria analysis is conducted to rank the sites based on their suitability according to the defined criteria. The results of this study will provide valuable recommendations for decision-makers to select the optimal location for the new hospital in Fes, ensuring maximum accessibility to healthcare services for the local population

Keys word : GIS,QGIS,MCA,AHP,HOSPITAL

INTRODUCTION :

The strategic placement of healthcare centers, such as hospitals, in urban environments is a fundamental element in ensuring equitable access to healthcare services and optimizing their delivery. In fast-growing cities such as Fez, Morocco, where urbanization and population density are on the rise, the need for strategic location of healthcare facilities is becoming increasingly compelling. This presentation opens the way to an in-depth analysis of the process of determining the optimal location for a new hospital in Fez, through the integration

of multicriteria analysis (MCA), the analytical hierarchical system (AHP) and geographic information system (GIS) techniques, mainly facilitated by QGIS.

Fez, one of Morocco's most populous cities and a major cultural and economic hub, faces the challenge of meeting the healthcare needs of its growing population, while ensuring efficient allocation of resources and accessibility to healthcare services. Historically, hospital location decisions have been based on factors such as population density, infrastructure and proximity to existing medical facilities. However, modern decision-making processes increasingly rely on complex analytical methods to take into account a wider range of criteria and weigh up the potential benefits of a given location.

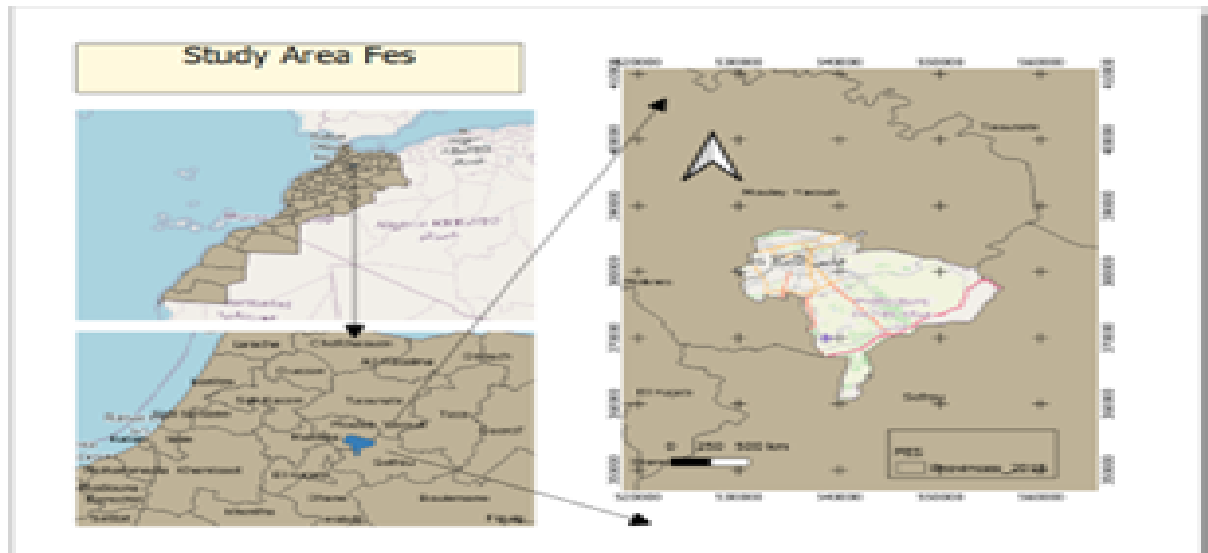
The remainder of this paper will delve into the methodology employed in this study, detailing the process of criteria selection, data collection, analysis techniques, and the integration of findings into actionable recommendations for hospital location selection in Fes. By leveraging the strengths of GIS technology and advanced decision-making methodologies, this research endeavors to contribute to the advancement of healthcare infrastructure planning and resource allocation in urban environments.

The remainder of this work will focus on the methodology applied in this study, explaining in detail the criteria selection process, data collection, analysis techniques and integration of results into actionable recommendations for hospital siting in Fez. By exploiting the strengths of GIS technology and advanced decision-making methodologies, this research strives to advance healthcare infrastructure planning and resource allocation in urban environments.

Materials and Methods

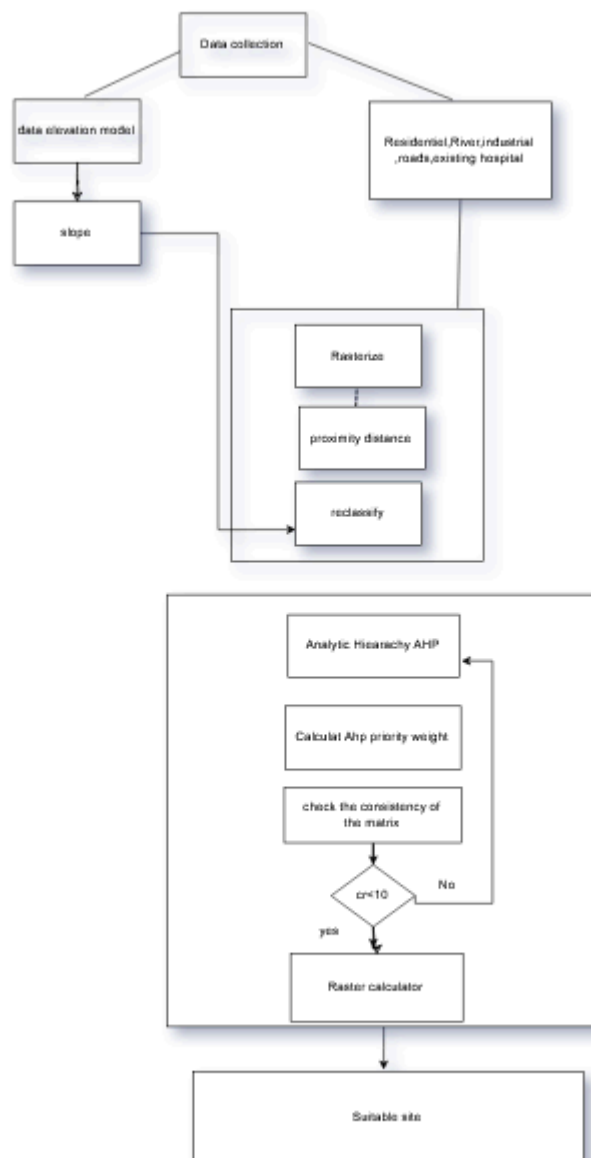
1.Delimitation of the Study Area

The province of Fès, located in northern Morocco at around 34.0182° north latitude and 5.0078° west longitude, is a region characterized by its rich cultural heritage and diverse landscapes. Anchored by the historic city of Fez, a UNESCO World Heritage site known for its medina, the province comprises fertile plains, rolling hills and mountainous terrain. Agriculture, with crops such as wheat, barley, olives and citrus fruits, is the cornerstone of the local economy, which is complemented by a thriving manufacturing sector focused on textiles, ceramics and food processing. The city of Fez, which serves as an economic and cultural hub, attracts visitors with its ancient monuments, traditional crafts and vibrant markets. Ongoing efforts to expand infrastructure and stimulate development ensure the province's continued prosperity as a dynamic center of Moroccan history, culture and economic activity.



2.Methodology :

In this project, the methodology was organized to ensure clarity and efficiency. Starting with data collection from OpenStreetMap, the process included pre-processing of the data to ensure accuracy through cleaning . Next, a multi-criteria analysis, using the Analytic Hierarchy Process (AHP), weighed up factors such as accessibility and population density. Synthesizing the results using a matrix calculator produced a map highlighting suitable hospital sites. Finally, on the basis of this analysis, a recommendation for the optimal hospital location was formulated, making a significant contribution to informed decision-making on urban planning and public health initiatives.



3.Data Collection

3-1.Site Selection Criteria

For this hospital site selection study, six essential criteria were selected: roads, residential areas, waterways, slope, industrial zones and the presence of existing hospitals. These factors were chosen for their relevance to accessibility, population density, natural hazards and existing infrastructure, all of which are crucial elements in the decision to locate a hospital.

Roads:

High Importance

Roads play a pivotal role in hospital site selection, given their significance in facilitating access for patients, staff, and emergency vehicles. The proximity to well-maintained road networks ensures ease of transportation, particularly during emergencies when swift access to medical care is essential. Hospitals situated near major roads benefit from enhanced accessibility, reducing travel times for patients seeking medical attention and improving the efficiency of ambulance services. Moreover, road connectivity facilitates the transportation of medical supplies and personnel, contributing to the seamless operation of the hospital.

Residential Areas:

Medium Importance

The proximity of residential areas is an important consideration in hospital site selection, albeit with medium importance compared to other criteria. Situating hospitals close to residential neighborhoods ensures that healthcare services are easily accessible to the local population, promoting timely medical intervention in emergencies and routine care. Additionally, proximity to residential areas may facilitate recruitment efforts by providing a potential pool of healthcare professionals living nearby. While not as critical as road accessibility, the presence of residential areas contributes to the hospital's community integration and ensures its relevance to the surrounding population.

Waterways:

Low to Medium Importance

Waterways, although less critical than other criteria, can still influence hospital site selection to some extent. While not directly related to hospital operations, proximity to water bodies may offer recreational opportunities and alternative transportation routes. However, the impact of waterways on hospital site selection varies depending on regional factors such as navigability, flood risk, and environmental considerations. While not a primary consideration, acknowledging the presence of water bodies in the vicinity can inform decision-making regarding disaster preparedness and environmental stewardship.

Slope:

High Importance

The slope of the terrain holds considerable significance in the selection of an appropriate site for the hospital. Steep slopes can present challenges for construction, access, and infrastructure development. High slopes may increase construction costs, impede the efficient layout of hospital facilities, and pose risks of soil erosion and instability. Additionally, steep terrain can complicate transportation routes and emergency access, potentially delaying

medical response times. Therefore, identifying areas with low to moderate slopes is crucial to ensuring the feasibility and safety of the hospital site, optimizing construction efforts, and facilitating ease of access for patients and staff. Integrating slope analysis into the site selection process allows for the identification of suitable locations that minimize terrain-related constraints and promote the efficient operation of the hospital.

Industrial Zones:

Low Importance

Proximity to industrial zones holds limited significance in hospital site selection compared to other criteria. Industrial areas may introduce pollution, safety hazards, and incompatible land uses, making them less desirable for hospital siting. While not a primary consideration, maintaining a buffer zone between hospitals and industrial activities is essential to mitigate potential risks and ensure the health and safety of patients, staff, and visitors. Therefore, while the presence of industrial zones may inform site selection decisions, it holds relatively low importance compared to factors directly related to healthcare delivery and accessibility.

Presence of Existing Hospitals:

Low to Medium Importance

While the presence of existing hospitals may provide valuable insights into healthcare infrastructure and service distribution, its importance in site selection is relatively low to medium. On one hand, existing hospitals in the vicinity may indicate established healthcare networks and potential opportunities for collaboration. On the other hand, excessive clustering of hospitals may lead to competition, redundancy, and uneven distribution of healthcare resources. Therefore, while acknowledging the presence of existing hospitals is essential, it is not the sole determinant in selecting an optimal site for a new hospital. Other factors such as accessibility, population density, and infrastructure availability play a more significant role in ensuring equitable access to healthcare services and optimizing healthcare delivery.

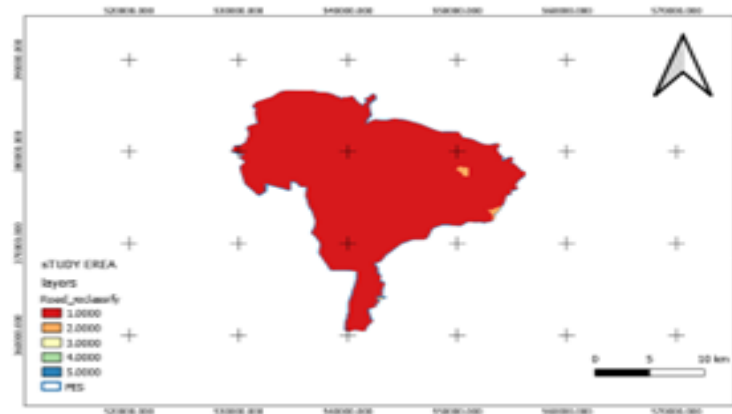
Geographic data was obtained from OpenStreetMap (OSM), an open-source repository of geospatial data. Information regarding roads, residential areas, waterways, terrain slopes, industrial zones, and existing hospitals was extracted from OSM for the province of Fes, Morocco.

4.Data Processing

4-1 Reclassification of Geographic Data

Thematic maps obtained were processed using the reclassification method. Each criterion was reclassified according to a standardized scale, thus enabling effective comparison and integration of the various layers of information.

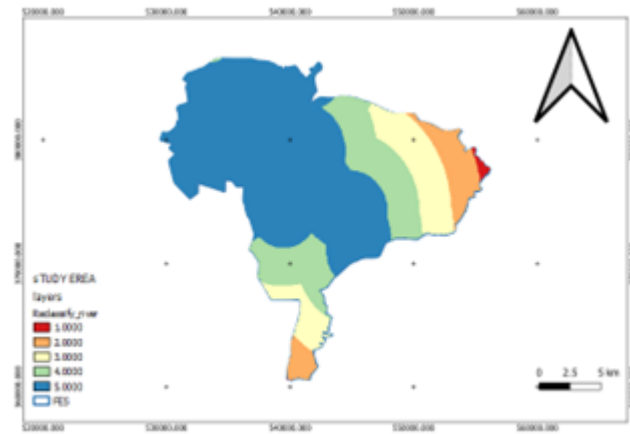
1. Road



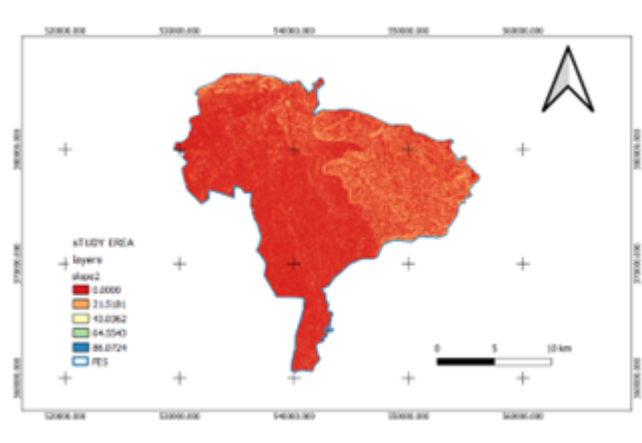
2. Residential areas



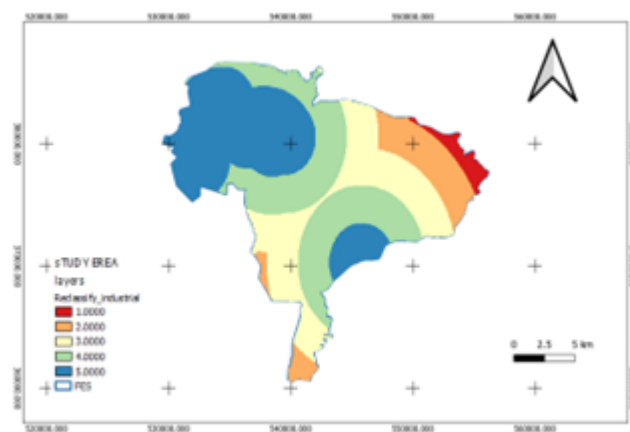
3. Waterways



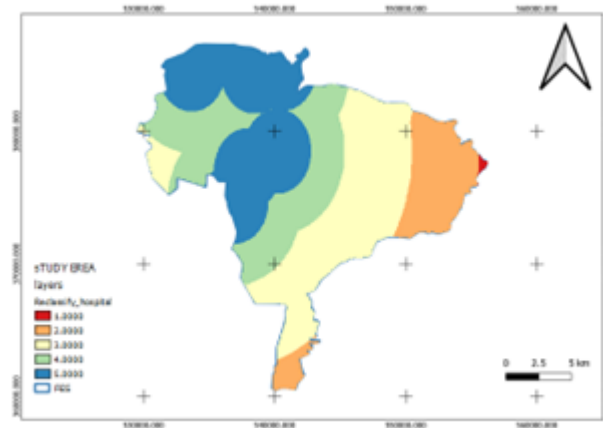
4.slope



5.Industrial zones



6.Presence of existing hospitals



5-2 Analytic Hierarchy Process (AHP) :

An AHP analysis was conducted to prioritize criteria based on their relative importance in the hospital site selection process. Pairwise comparison matrices were developed for each pair of criteria, and the relative weights were calculated using the AHP method.

Priorities

These are the resulting weights for the criteria based on your pairwise comparisons:

Cat		Priority	Rank	(+)	(-)
1	EXISTING HOSPITAL	14.5%	4	6.4%	6.4%
2	RESIDENTIEL	20.0%	2	7.3%	7.3%
3	ROADS	16.4%	3	7.7%	7.7%
4	RIVER	13.8%	5	6.6%	6.6%
5	SLOPE	22.1%	1	10.1%	10.1%
6	INDUSTIRAL	13.1%	6	5.9%	5.9%

Number of comparisons = 15
Consistency Ratio CR = 8.5%

Decision Matrix

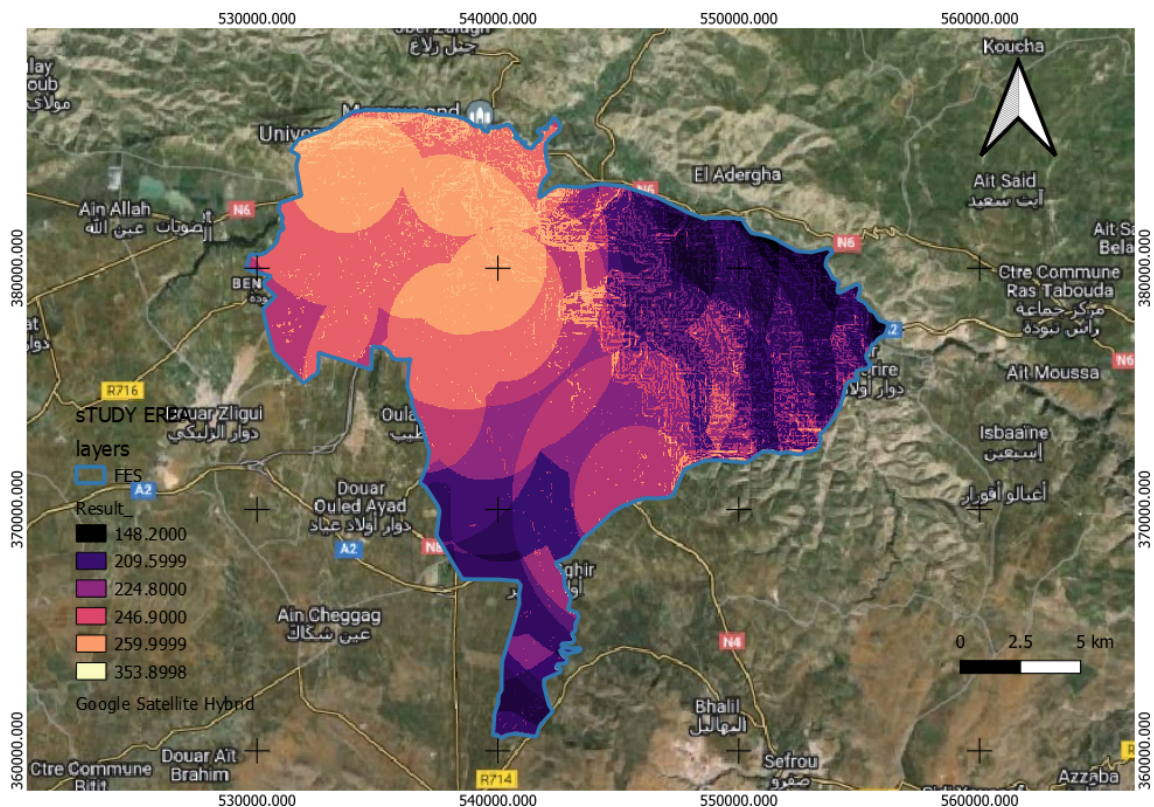
The resulting weights are based on the principal eigenvector of the decision matrix:

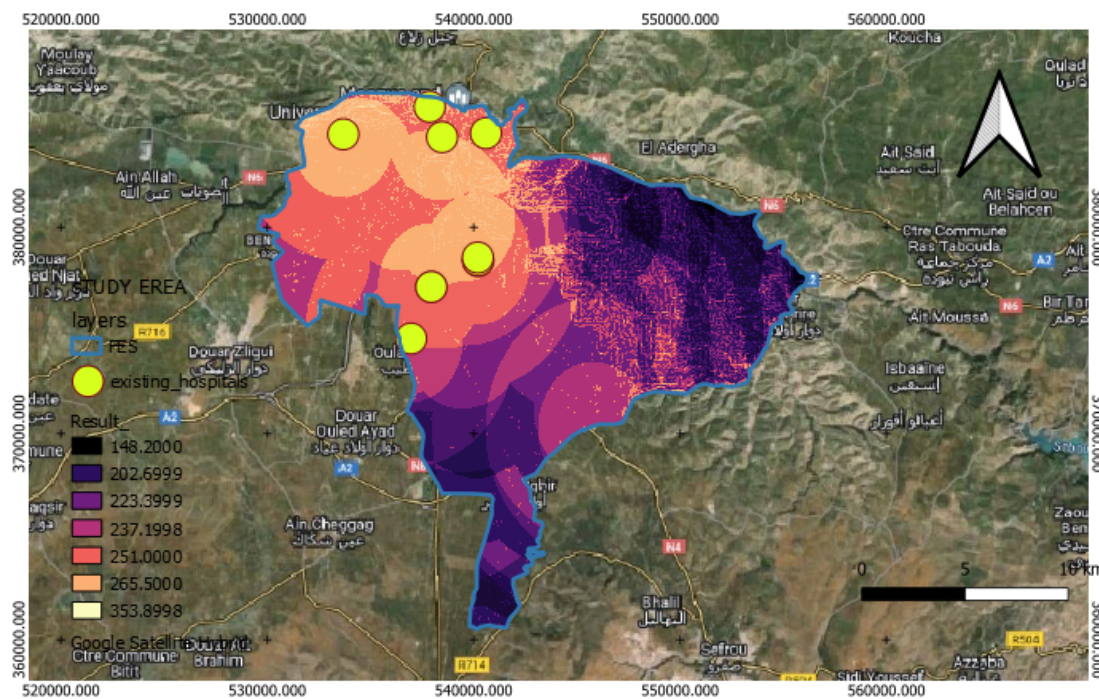
	1	2	3	4	5	6
1	1	0.50	0.50	1.00	1.00	2.00
2	2.00	1	2.00	1.00	1.00	1.00
3	2.00	0.50	1	2.00	0.50	1.00
4	1.00	1.00	0.50	1	0.33	2.00
5	1.00	1.00	2.00	3.00	1	1.00
6	0.50	1.00	1.00	0.50	1.00	1

Principal eigen value = 6.532
Eigenvector solution: 5 iterations, delta = 5.7E-8

Result

Based on the results of the analysis, two areas were identified as being most suitable for the creation of a new hospital in the Fez region, namely Ouled Tayeb and Sidi Hrazm. These areas were chosen for their compliance with pre-established site selection criteria, which include accessibility, population density and potential demand for hospital services. Although the city of Fez already boasts several hospital facilities, our study revealed that these outlying areas have a greater need for medical infrastructure, while still meeting the established criteria for an ideal location. This recommendation is based on a rigorous analysis of geospatial data and selection criteria, providing a sound basis for strategic decision-making in urban planning and public health.





discussion :

The findings of this study underscore the importance of utilizing geospatial analysis techniques in the strategic planning of healthcare infrastructure. By integrating data from OpenStreetMap and employing methodologies such as the Analytical Hierarchy Process, we were able to systematically evaluate potential hospital locations based on a range of factors, from accessibility to existing healthcare services. The identification of Ouled Tayeb and Sidi Hrazm as suitable sites highlights the potential benefits of extending healthcare services to underserved peri-urban and rural areas surrounding Fes.

However, it's important to acknowledge the limitations of our study. While our methodology considered various socio-economic and geographical factors, other aspects such as cultural preferences, land availability, and community engagement were not fully explored. Future research could incorporate stakeholder consultations and more comprehensive data collection to provide a more nuanced understanding of healthcare needs and preferences in the region.

Furthermore, the implementation of healthcare facilities in these identified areas will require careful planning and resource allocation. Infrastructure development, staffing, and ongoing community engagement will be essential to ensure the success and sustainability of new healthcare initiatives. Collaboration between government agencies, healthcare providers, and local communities will be crucial in addressing the healthcare disparities highlighted by our study and promoting equitable access to quality healthcare services across the region.

conclusion ;

In summary, this study demonstrates the effectiveness of geospatial analysis and the methodology of the analytical prioritization process in the strategic selection of sites for the development of healthcare infrastructure. Using OpenStreetMap data and rigorous criteria, we accurately identified priority areas for the establishment of a new hospital in the Fez region. The resulting proposals, highlighting Ouled Tayeb and Sidi Hrazm, offer a strategic roadmap for improving access to healthcare on the city's outskirts.

However, this study has its limitations. Other considerations, such as local cultural preferences and land constraints, may require further analysis in subsequent development phases. Furthermore, the implementation of these recommendations will require close collaboration between local authorities, healthcare stakeholders and communities to ensure the successful and sustainable integration of new infrastructure.

Ultimately, this research provides a sound basis for informed decisions on urban planning and public health. It also highlights the importance of a geospatial approach to managing healthcare resources and promoting equity in access to care, thereby contributing to socio-economic development and improving quality of life in the

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