School of Environmental Technology International Conference Proceedings

ISBN: 978-978-54580-8-4

Received 19 August 2024; Accepted: 15 October 2024; Available online: 07 November 2024

Volume 1 proceedings

Geospatial Analysis for Optimal Hotel Site Selection in Minna Metropolis

Ekundayo, A. Adesina., S. Chukwu., Oluwatobi, O. Adetunji

Federal University of Technology, School of Environmental Technology, Surveying and Geoinformatics Department, Minna, Nigeria

adesinageoworldsolutions@gmail.com

Abstract

The hotel industry significantly contributes to national economies, particularly in tourism centers. It is a source of employment, generating numerous jobs. However, many African countries, such as Nigeria, face a shortage of hotels due to their spatial distribution. Proper scientific planning, therefore, requires careful consideration of influencing factors before constructing new hotels. This study employed Multi-Criteria Decision Analysis (MCDA) and Geospatial Technologies (GIS and Remote Sensing) to assess hotel site suitability in Minna Metropolis. Based on expert advice and existing literature, the study identified five key factors influencing hotel site suitability: Land Use Land Cover (LULC), Slope, Elevation, the spatial distribution of existing hotels, and Road Network Analysis. These factors were weighted using the Analytical Hierarchical Process algorithm and combined using the weighted overlay tool in ArcGIS 10.8 software to create a suitability map with four classes: Highly suitable, moderately suitable, less suitable, and Not suitable. The study revealed that over 50% of the city (more than 76 square kilometers) is at least moderately ideal for hotel development. LULC, the density of existing hotels, and road networks were the most influencing factors in hotel site suitability. This research is valuable for researchers and professionals in the hodtel industry.

Keywords: Geospatial Analysis, Hotel Industry, Land Use Land Cover (LULC), Hotel Density, Site Selection.

1. Introduction

The hospitality industry is a global sector with significant interest from many nations. The hotel sector is the fastest-growing service industry worldwide, surpassing other service sectors in size (Alberta *et al.,* 2021). Location profoundly influences business profitability, making optimal site selection crucial for hotel investments (Ebru, 2020).

Identifying suitable hotel locations is a pressing issue in hospitality and tourism (Mateusz, 2024). Minna Metropolis, Niger State, is no exception, requiring urgent identification of prime hotel sites to drive development, improve well-being, and attract tourists. Rapid urbanization and population growth in Minna Metropolis make finding profitable locations increasingly challenging.

Geospatial technology offers invaluable tools for addressing the challenges of sustainable urban development, particularly in the context of hotel site selection. By integrating geospatial technologies such as Remote Sensing and Geographical Information Systems with the Analytical Hierarchical Process (AHP), this study aims to identify optimal hotel locations in Minna Metropolis, Niger State. This research is crucial given the growing importance of strategic hotel placement in the hospitality industry and the increasing difficulty of finding suitable sites in rapidly urbanizing areas. The findings of this study will contribute to sustainable urban development and promote the growth of the local tourism sector.

2. Study Area

Minna, located in North-Central Nigeria, is a rapidly expanding metropolitan area, as noted by Ojekunle and Owoeye (2018). As depicted in Figure 1, the city is situated between latitudes 9°31'20"N and 9°41'27"N and longitudes 6°24'59"E and 6°37'42"E. The study area boasts numerous tourist attractions, including the renowned Gurara waterfalls.

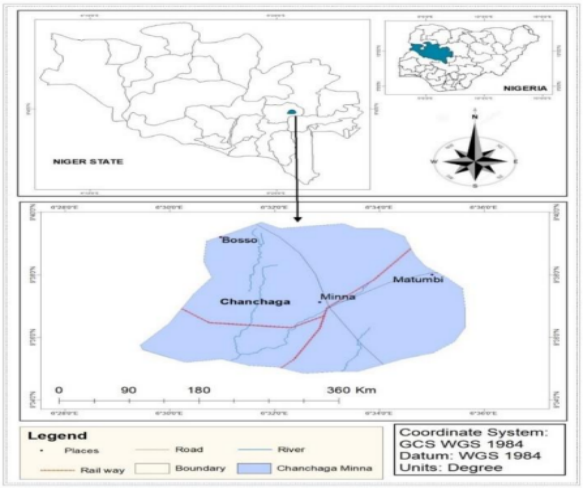

Figure 1: Study Area Map

3. Materials and Methods

This study utilized a methodological approach encompassing data acquisition, data processing, the establishment of the AHP algorithm, and results.

3.1 Data

The data used in this study were both from primary and secondary sources. The coordinates of the existing hotels were collected using hand-held GPS and present types of land covers during the fieldwork. The administrative map of the study area (sourced from Diva-GIS: www.diva-gis.org/datadown), Landsat 8 imagery (30 m resolution), SRTM 30 m DEM downloaded from www.earthexplorer.usgs.gov) and Google Earth images are among the secondary data used.

3.2 Influencing factors for siting of hotels

3.2.1 Land Use Land Cover (LULC) Distribution

One factor that influences suitability modelling is the land cover. In this study, the land use and land cover in Minna metropolis, Niger state, were analyzed using the program ENVI 5.1 and the Landsat 8 TM picture of 2021. Different land uses and land coverings were categorized into six groups using the maximum likelihood supervised classification algorithm: built-up, grass, forest, bare soil, wetland, and water. Table 1 shows the LULC classes in the study area and a brief description.

Table 1: LULC classes in the study area

S/No	LULC classes	Interpretation
1.	Built-Up	Areas consisting of residential, commercial, transportation, and facilities.
2.	Water Body	The area consists of streams, tributes, rivers, and lakes
3.	Vegetations	This consists of leaves (broad and scanty), and also includes any form of green plantations that can not be associated with food or economic crops.
4.	Agricultural Land	This consists of regions where crops are grown for food or economic purposes. These locations are identified by their closeness to built-up regions, having a depiction of ridges in them, etc.
5.	Bare soil	Involves mineral properties and bare soils where reefs dominate the ecosystem

3.2.2 Elevation Map

It is necessary to know where industrial sites make better choices. The SRTM 30 m DEM, an open-source data, was obtained from the USGS website and divided into classes depending on the elevation. The area's water level is a crucial consideration when choosing possible sites. Elevations above sea level are more expensive to transport, but

below sea level are vulnerable to flooding. The DEM by ArcGIS 10.8 software determines the study area and proximity to highways, water bodies, and several existing hotels.

3.2.3 Slope Map

Large constructions are more suited for locations with a moderate slope. SRTM DEM was used to create a slope map of the study area. The slope was divided into classes and estimated in percentages based on the degree of steepness of the research area: 0-2 as leveled area or nearly leveled, 2-6 as very softly sloppy, 6-12 strongly sloppy, 12-20 moderately steep sloppy, and over 25 as steep sloppy. ArcGIS 10.8 software formats the slope map to make it usable for AHP implementation.

3.2.4 Kernel Density Analysis of Existing Hotels and Road Network Analysis

Kernel density analysis is a widely employed spatial analysis technique that estimates the density of point or line features across a study area. By applying a smoothing kernel to each feature, the technique calculates the density within a specified unit area. Common applications include analyzing the density of residential areas, crime statistics, transportation networks, or utility infrastructure.

In this study, the kernel density analysis tool in ArcGIS 10.8 software was utilized to create a kernel density map of existing hotels within the study area. This map facilitates the identification of clusters of hotels within the region. Also, to evaluate accessibility to hotels in the study area, road network analysis was performed. This was done by implementing a line density algorithm in the ArcGIS environment to evaluate the volume of available roads.

3.2.5 Multi-Criteria Evaluation

In a GIS-based multi-criteria decision-making (MCDM) framework, objectives are established, criteria and factors are identified and standardized, weights are assigned to each component, criteria are aggregated, and the results are validated. This study employs the Analytical Hierarchical Process (AHP), a widely used criteria-based decision-making technique. The AHP involves the relative weighting of influencing factors based on their impacts on the decision objective. To ensure reliable and consistent weighting, existing literature and expert input were consulted.

3.3 Weighted Overlay

The relative importance of each factor map was assessed to determine its corresponding weight. A pairwise comparison matrix was constructed to assign standardized relative weights. The weighted linear combination technique was employed to combine the standardized components. Each factor was multiplied by its weight, and the resulting values were summed to generate a multi-criteria solution, which represents the hotel site suitability map. Table 2 presents the influencing factors considered in this study and their calculated AHP weights.

Table 2: Influencing factors considered in this study and their calculated AHP weights

S/No	Factors	Weight
1.	Land Use Land Cover	46.88
2.	The density of existing hotels	25.81
3.	Road network	11.94
4.	Slope map	7.86
5.	Elevation map	7.51

Obtained consistency ratio (CR): 0.09

3.4 Hotel Suitability Map of Minna Metropolis

Before weight assignment, each influencing factor was reclassified based on its contribution to hotel site suitability. For example, the slope map's classes were ranked according to their suitability for hotel development. Steeper slopes were assigned lower weights, reflecting their reduced influence on site suitability. The weighted factors served as input maps for the creation of a hotel suitability map using the ArcGIS environment. This was achieved

byimplementing the weighted overlay algorithm. The resulting map visually represents the distribution of suitability across the study area. To provide a textual representation, the map classes were reclassified as follows: 6 = Highly Suitable; 2 = Suitable; 3 = Less Suitable and 4 = Not Suitable

4. Results and Discussion

4.1 Land Use Land Cover Distribution Analysis of Minna Metropolis

Figure 2 illustrates the Land Use Land Cover (LULC) map of Minna Metropolis, while Figure 3 presents the percentage distribution of each LULC class in the area for the year 2020. As an urban area with a significant land expanse, Minna is characterized by a predominance of bare ground, covering approximately 59.8% of the total area. Built-up areas account for 34.44% of the total land area, followed by vegetation cover at 4%. Agricultural land comprises 1.9% of the study area, while water bodies constitute the smallest land cover category, occupying only 0.061% of the total area.

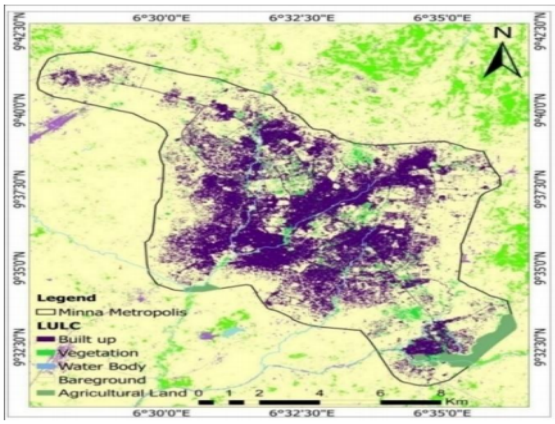

Figure 2: Land Use Land Cover map of Minna

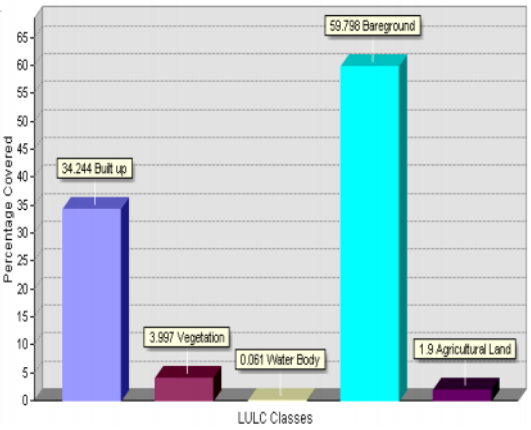

Figure 3: LULC distribution chart

4.2 Topography

4.2.1 Elevation Map

Figures 4 and 5 present the elevation maps of the study area, respectively depicting numerical values and textual classifications. The elevation of the study area ranges from 195 meters to 441 meters, with the southern region exhibiting the highest elevation. A reclassification map based on suitability, shown in Figure 5, indicates that hotel site selection becomes less favorable as one moves from the southern to the northern region of the city. The results demonstrate that a substantial portion of the study area falls within the highly suitable elevation range. Owing to the unique and aesthetically appealing nature of these geographical features, higher elevations generally possess greater suitability for scenic attractiveness (Yanxia *et al.,* 2022).

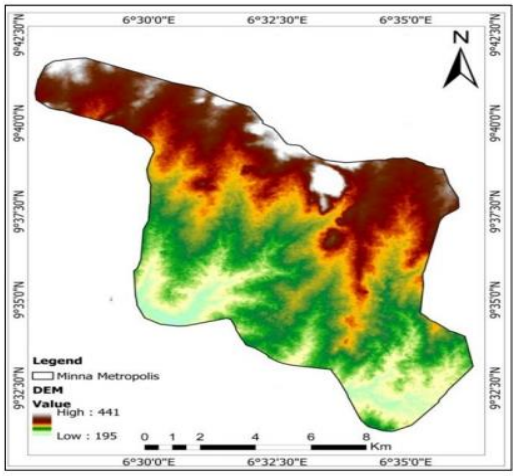

Figure 4: Elevation distribution map of the study area

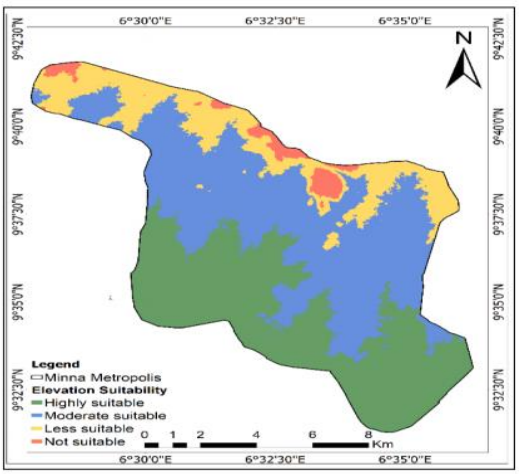

Figure 5: Elevation suitability map for hotel sitting

4.2.2 Slope Map

The slope pattern of a region, formed by intricate landforms, is a critical factor in hotel site selection. Figure 6 presents the slope map (in percentage gradient) of the study area. The slope classes were reclassified into five textual categories for compatibility with the weighted overlay process, as illustrated in Figure 7: "Level," "Very Gently Sloping," "Strongly Sloping," "Moderately Steep Sloping," and "Steep Sloping." Unlike the elevation map, the slope classes in the produced map exhibit a random distribution. However, the study area can be generally characterized as level, as this is the predominant class. Nevertheless, steep slopes are noticeable in the northern and eastern regions, represented in red.

4.3 Distribution and Kernel Density Map of Existing Hotels

Figure 8 illustrates the spatial distribution of existing hotels within the study area, represented by red points. This map served as input for generating a kernel density map of hotels, facilitating the identification of regions with hotel clusters in Minna. As depicted, hotels are clustered in the central region of the study area, while the northern region exhibits a sparse distribution. Conversely, the study area's far north and far south have minimal hotel presence. Figure 9 presents the kernel density map of existing hotels. The red area indicates the highest concentration of hotels, followed by the yellow area with a moderately high concentration. The light green area represents the average number of hotels, while the deep green area signifies the lowest concentration.

4.4 Road Network Analysis and Hotel Accessibility Map

The global hotel industry, in large part, suffers from significant accessibility deficiencies (Chiara *et al.,* 2024). Therefore, a thorough analysis of road networks and hotel accessibility is crucial before site selection. Figure 10 presents the road network density and accessibility map of the study area. This map illustrates four levels of traffic density, serving as an indicator of accessibility. As shown, there is a discernible decrease in road network efficiency and suitability from the central region towards the periphery. The results indicate that a majority of the roads within the study area experience heavy traffic congestion, a common occurrence in urban areas with a high level of economic activity.

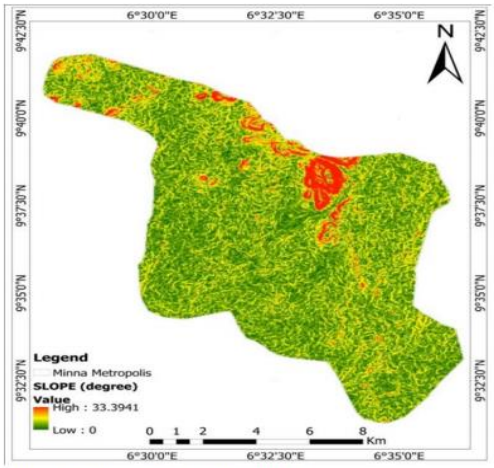

Figure 6: Slope map of the study area

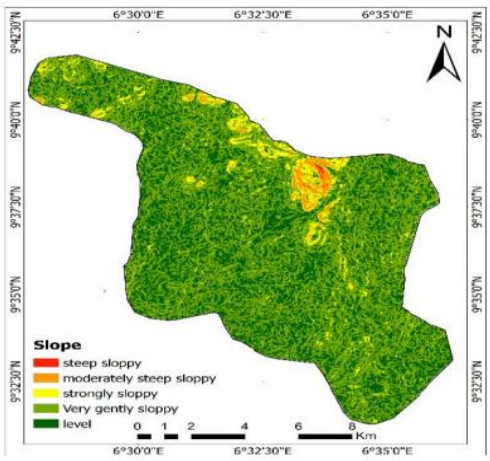

Figure 7: Reclassified slope map

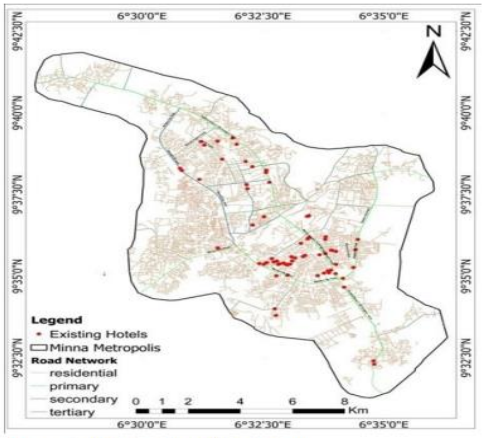

Figure 8: Existing hotels in Minna

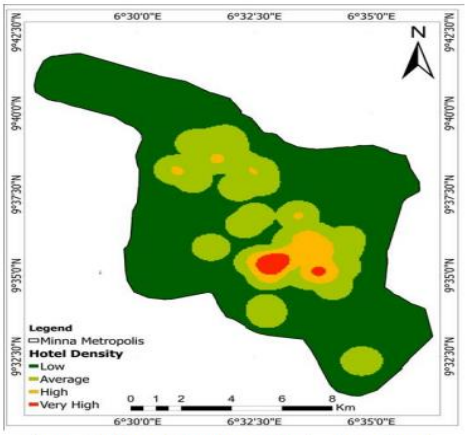

Figure 9: Kernel density map of existing hotels

4.5 AHP Results

This study employed five influencing factors to assess hotel site suitability: Land Use Land Cover (LULC), existing hotel density, road accessibility, slope, and elevation. Table 2 presents the calculated weights of each factor, derived from the Analytical Hierarchical Process (AHP) algorithm. The table reveals that LULC is the most influential factor, accounting for approximately 46% of the overall weight, while elevation is the least relevant, contributing approximately 8%.

4.6 Hotel Site Suitability Map

Figure 11 illustrates the four suitability grades for hotel siting in Minna Metropolis. reveals that the central region and far north of the study area are classified as "most suitable" for hotel development, encompassing approximately 54.24 square kilometers. Approximately 22.60 square kilometers are deemed "moderately suitable" for hotel siting, primarily located in the southern and northern regions. Areas marked as "less suitable" (in orange) cover 17.98 square kilometers, concentrated in the central region. The "not suitable" areas, represented in red, extend over 46.89 square kilometers and are predominantly found in the central region, where hotels are currently clustered and built-up areas are prevalent. Overall, the suitability map indicates that over 50% of the study area is at least moderately suitable for hotel development.

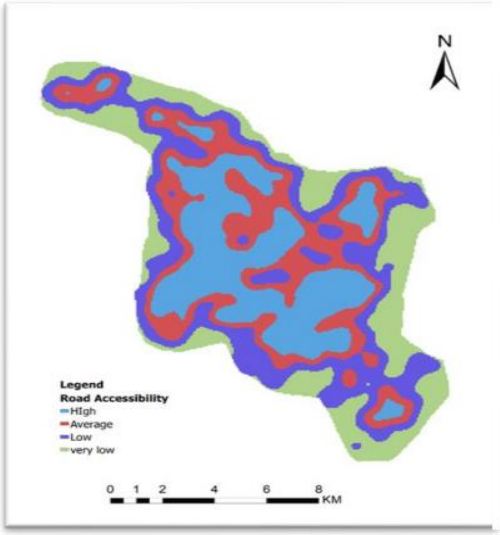

Figure 10: Road Network Analysis

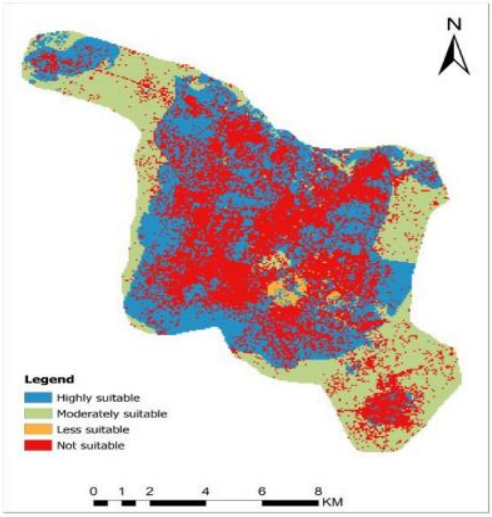

Figure 11: Hotel Site Suitability Map

5. Conclusion

This study utilized the Analytical Hierarchical Process (AHP) within a Multi-Criteria Decision Analysis (MCDA) framework and integrated GIS methodologies to identify suitable hotel locations in Minna Metropolis. This research is crucial to address the growing demand for accommodation from tourists and immigrants visiting the capital city of Niger State. The study findings reveal that the city's central region (core urban area) is already densely populated with hotels, making it the least suitable location for new hotel development. Conversely, regions located away from the core central area, particularly the far northern and southern regions, are identified as most and moderately suitable for hotel siting. These suitability classes encompass over 54% of the entire Metropolis. The AHP analysis determined that Land Use Land Cover (LULC) is the most influential factor in hotel site selection, followed by the density of existing hotels. Researchers and experts in the hotel industry should prioritize these factors to ensure optimized hotel development and maximize economic benefits.

References

Alberta T, Idriz K, Bislim L. & Aziz R, 2021, Tourism and Hotel Industry: Definition, Concepts and Development – The Case of Kosovo, Journal of Quality Management, Volume 22, No. 182, pp.1-6

Chiara Di Nolfo, Eva Martin-Fuentes and Juan Pedro Mellinas, 2024, Analysing the level of accessibility of hotels, The INC International Conference on Tourism, Hospitality and Events, 15th June, 2024, Amsterdam, p. 183.

Ebru U, 2020, The Hotel Site Selection: Determining Locational Factors by Fuzzy TOPSIS, European Journal of Tourism Hospitality and Recreation, Volume 10 (3), pp. 213-228

Mateusz B, 2024, Hotel Industry: Choosing the Right Location <https://aithor.com/essay-examples/hotel-industry-choosing-the-right-location> accessed on: 17th July, 2024

Ojekunle J. & Owoeye A.S., 2018, Spatial pattern of Household Travel in Minna Metropolis, Nigeria, International Journal of Research, Volume 6(5), pp. 276-289

Yanxia Mu, Lin W, Diao X, Zhang Z, Wang J, Lu Z, Guo W, Wang Y, Hu C, Zhao C., 2022, Implementation of the visual aesthetic quality of slope forest autumn color change into the conFigureuration of tree species, Science Repository, Jan 20;12(1):1034. doi: 10.1038/s41598-021-04317-1.