JOURNAL OF GEOSPATIAL SCIENCE AND TECHNOLOGY

ISSN: 2408-6517 (Print) | 2756-4088 (Online) | www.afrigistjournals.com/jgst

AFRIGIST

GIS-Based Multi-Criteria Site Suitability Analysis for Elderly Care Residential Facilities in Abuja Municipal Area Council, Nigeria

Aishatu Gadzama Dauda and Ozien P. Mamudu

To cite this article: Aishatu Gadzama Dauda and Ozien P. Mamudu, GIS-Based Multi-Criteria Site Suitability Analysis for Elderly Care Residential Facilities in Abuja Municipal Area Council, Nigeria, (2026), *Journal of Geospatial Science and Technology*, 6(1), 18-35, https://afrigistjournals.com/index.php/jgst/article/view/6a2

Link to this article: https://afrigistjournals.com/index.php/jgst/article/view/6a2

Date published online: 02 July 2026.

CrossRef link to this article

Submit your article to JGST

chiefeditor@afrigistjournals.com

Journal of Geospatial Science and Technology, 6 (1): 18-35, 2026
ISSN: 2756- 4088 (Online), 2408-6517 (Print) doi:10.54222/afrigist/jgst/6a2
Received: 8 April, 2026 Accepted: 30 June, 2026

GIS-Based Multi-Criteria Site Suitability Analysis for Elderly Care Residential Facilities in Abuja Municipal Area Council, Nigeria

*Aishatu Gadzama Dauda and Ozien P. Mamudu

Department of Geographic Information Science, African Regional Institute for Geospatial Information Science and Technology (AFRIGIST), Obafemi Awolowo University Campus, Ile-Ife, 220282, Nigeria
*Corresponding Author's email: cadzama@gmail.com

Abstract

The rapid growth of the elderly population, coupled with accelerated urban expansion in Abuja Municipal Area Council (AMAC), has created increasing demand for well-located elderly care residential facilities (ERFs). This study applies a Geographic Information System (GIS)-based Multi-Criteria Decision Analysis (MCDA) to identify suitable locations for ERFs in AMAC. Siting criteria covering accessibility, proximity to healthcare services, environmental quality, safety, and socio-demographic factors were derived from literature, expert opinion, and field-based insights. These criteria were standardized and weighted using the Analytical Hierarchy Process (AHP), and subsequently integrated through a weighted linear combination (WLC). Constraint layers representing incompatible land uses were incorporated to refine the final suitability output. The results show that proximity to healthcare facilities (47.00%) and elderly population density (24.10%) are the most influential criteria. The suitability analysis revealed that though most of the area were not suitable, 29.40% (391.31 km²) are suitable and 5.99% (79.70 km²) are most suitable for siting elderly care facilities in AMAC. The validation of results using existing facility locations further supports the reliability of the model. The study demonstrates the effectiveness of GIS-based MCDA as a decision-support tool for elderly care planning and provides a spatial framework to guide policymakers and urban planners for improved accessibility and quality of life among the elderly population.

Keywords: GIS, site suitability, elderly care residential facilities, MCDA, AMAC, Nigeria.

Résumé

La croissance rapide de la population âgée, conjuguée à l'expansion urbaine accélérée de la zone municipale d'Abuja (AMAC) a engendré une demande croissante d'établissements d'hébergement bien localisés pour personnes âgées (EHPAD). Cette étude est focalisée sur une analyse multicritères (AMCD) basée sur un système d'information géographique (SIG) afin d'identifier des emplacements appropriés pour les EHPAD dans l'AMAC. Les critères de sélection, portant sur l'accessibilité, la proximité des services de santé, la qualité de l'environnement, la sécurité et les facteurs sociodémographiques, ont été élaborés à partir de la littérature, d'avis d'experts et d'observations de terrain. Ces critères ont été standardisés et pondérés à l'aide de la méthode AHP (Analytical Hierarchy Process), puis intégrés par une combinaison linéaire pondérée (CLP). Des couches de contraintes représentant les usages du sol incompatibles ont été intégrées afin d'affiner le résultat final. Les résultats montrent que la proximité des établissements de santé (47,00 %) et la densité de population âgée (24,10 %) sont les critères les plus influents. L'analyse de pertinence a révélé que si la majeure partie de la zone n'était pas adaptée, 29,40 % (391,31 km²) l'étaient et 5,99 % (79,70 km²) étaient optimales pour l'implantation d'établissements d'hébergement pour personnes âgées dans la zone AMAC. La validation des résultats à partir des données d'implantation d'établissements existants confirme la fiabilité du modèle. Cette étude démontre l'efficacité de l'analyse multicritères basée sur un SIG comme outil d'aide à la décision pour la planification des soins aux personnes âgées et fournit un cadre spatial pour guider les décideurs et les urbanistes en vue d'améliorer l'accessibilité et la qualité de vie des personnes âgées.

Mots-clés: SIG, pertinence des sites, établissements d'hébergement pour personnes âgées, AMAC, Nigeria.

1.0 INTRODUCTION

The number of people aged 60 years and above is projected to double by 2050, reaching over two billion worldwide (WHO, 2020). Many nations, including Nigeria, are experiencing a steady increase in the elderly population due to improvements in healthcare, declining mortality rates, and changing socio-economic conditions (Aboderin & Beard, 2015; UNDESA, 2024). The United Nations Department of Economic and Social Affairs (UNDESA) further emphasizes that the pace of ageing in Africa is accelerating, thereby increasing pressure on already constrained urban systems (UNDESA, 2024).

In Nigeria, rapid urbanization has compounded the challenges associated with population ageing (Aliyu & Amadu, 2017). Cities such as Abuja have witnessed significant spatial expansion and population growth, driven largely by rural–urban migration and administrative centralization (UNDESA, 2024; Abubakar, 2014). While this growth has stimulated economic development, studies have shown that urban development in Nigeria often occurs without adequate integration of social infrastructure planning, resulting in uneven access to essential services including healthcare and elderly care support (Aliyu & Amadu, 2017; Abubakar, 2014). Consequently, elderly populations in rapidly growing urban centres face increasing difficulties in accessing appropriate residential care facilities (Aboderin & Beard, 2015; Tanyi *et al.*, 2018).

Elderly care residential facilities play a critical role in ensuring the well-being, safety, and quality of life of older adults, particularly those with declining physical or cognitive abilities (WHO, 2007; Tanyi *et al.*, 2018). The World Health Organization, through the Global Age-friendly Cities Guide, identifies key domains required to create supportive urban environments for older adults, including accessible outdoor spaces, safe transportation systems, and community support and health services (WHO, 2007). Empirical studies have also demonstrated that spatial accessibility to health and social services significantly affects the quality of life of older adults (Carpentieri *et al.*, 2020; Guida *et al.*, 2022; Yu *et al.*, 2022). Despite this, the planning and siting of elderly care facilities in many developing countries remain largely ad hoc and insufficiently guided by spatial analysis (Tanyi et al., 2018; Wang *et al.*, 2023). Consequently, poorly sited facilities can limit accessibility, reduce service utilization, and exacerbate social isolation among the elderly (Tao *et al.*, 2014; Carpentieri *et al.*, 2020).

The application of MCDA allows for the evaluation of multiple criteria such as accessibility, environmental suitability, land use compatibility, and socio-demographic characteristics within a unified analytical environment (Malczewski & Rinner, 2015; Vahidnia *et al.*, 2009). Foundational works by Saaty (1980) introduced the Analytical Hierarchy Process (AHP), which has since been widely adopted in GIS-based suitability modelling (Malczewski, 2006). Subsequent studies have demonstrated the effectiveness of combining GIS and AHP in optimizing the location of healthcare and social facilities (Malczewski, 2006; Malczewski & Rinner, 2015; Tripathi *et al.*, 2021). Tao *et al.* (2014) employed spatial optimization techniques to improve equity in the distribution of elderly care facilities in Beijing, while Yang *et al.* (2023) utilized multi-source spatial data to evaluate land suitability for elderly care development. Similarly, Zhou and Cao (2023) demonstrated the application of spatial multi-objective optimization in enhancing the distribution efficiency of elderly care institutions, while Wang *et al.* (2023) further confirmed the usefulness of GIS-based assessment for elderly care suitability at the city scale. These studies underscore the growing relevance of geospatial approaches in addressing the spatial dimensions of ageing populations (Yang *et al.*, 2023; Zhou & Cao, 2023).

In AMAC, the provision and distribution of elderly care residential facilities have not kept pace with the city's rapid growth and evolving demographic structure (Abubakar, 2014; Aliyu & Amadu, 2017). Existing planning frameworks rarely incorporate geospatial analytical tools in determining optimal facility locations, leading to potential mismatches between service demand and supply (Abubakar, 2014; Aliyu & Amadu, 2017). Moreover, there is limited empirical research that integrates local socio-environmental conditions, accessibility factors, and expert-informed criteria into a comprehensive spatial suitability model for elderly care facility siting in Abuja. This study therefore addresses this gap by applying a GIS-based Multi-Criteria Decision Analysis to identify suitable locations for elderly care residential facilities in AMAC. Specifically, the study integrates multiple spatial criteria derived from literature, expert knowledge, and local context, and employs the Analytical Hierarchy Process (AHP) to determine their relative importance (Saaty, 1980; Malczewski & Rinner, 2015). The resulting suitability model provides a spatially explicit framework for guiding evidence-based planning and decision-making (Tripathi *et al.*, 2021; Vahidnia *et al.*, 2009). By doing so, the study contributes to the advancement of geospatial applications in urban health planning and supports the development of more inclusive and age-responsive urban environments in Nigeria (WHO, 2007; van Hoof & Marston, 2021).

2.0 MATERIALS AND METHODS

2.1 Study Area

Abuja Municipal Area Council (AMAC) is located between longitudes 7°30′55″E and 7°34′00″E and latitudes 8°22′54″N and 9°31′40″N (figure 1), covering an area of approximately 1,586 km² (Izuegbu *et al.*, 2025). It forms the core metropolitan area of the Federal Capital Territory (FCT) and includes both the central districts and rapidly expanding peri-urban areas of Nigeria's capital city (Abubakar, 2014; Nsu *et al.*, 2024). AMAC shares boundary with Bwari Area Council to the north, Kuje Area Council to the south, Gwagwalada Area Council to the west, and Karu Local Government Area of Nasarawa State to the southeast (Nsu *et al.*, 2024; INEC, 2023).

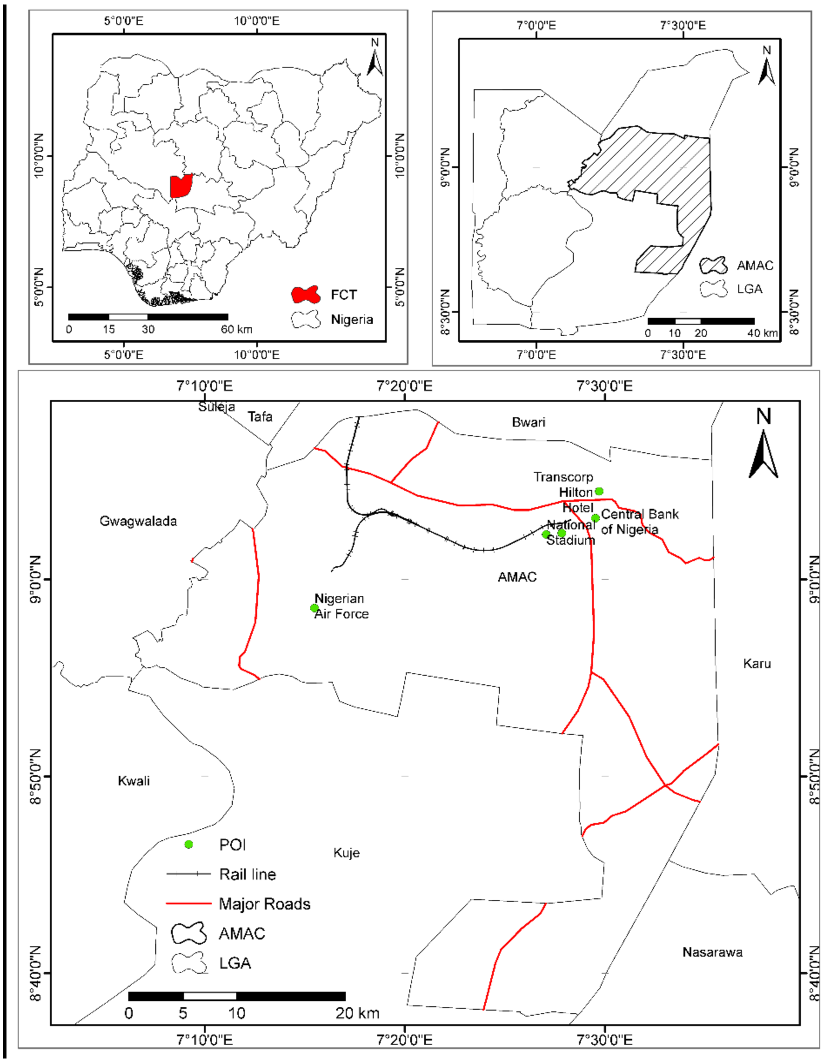


Figure 1: Abuja Municipal Area Council

(Source: Modified from Grid3 Nigeria Administrative Boundaries)

2.2 Data and Sources

Primary data were obtained through field surveys, structured questionnaires, and expert consultation designed to capture public perception, awareness, and expert opinion on elderly care residential facility siting criteria. The perception and awareness survey targeted residents across the 12 wards of Abuja Municipal Area Council (AMAC) using projected population figures derived from the National Population Commission (NPC) 2006 census projected to 2025. A minimum sample size of 400 respondents was determined using Slovin’s sampling formula at a 5% margin of error; however, 451 valid responses were ultimately obtained and analysed. A stratified multi-stage cluster sampling technique with Probability Proportional to Size (PPS) allocation was adopted to ensure adequate representation across the 12 wards of AMAC due to variations in ward population sizes.

The expert survey, administered using KoboToolbox, involved professionals in geriatrics, healthcare, urban planning, architecture, GIS, and related fields whose responses guided the selection and prioritization of suitability criteria. The criteria used for the suitability analysis were derived from literature review, questionnaire responses, expert consultation, and the demographic, infrastructural, environmental, and land use characteristics of the study area. Secondary data such as administrative and ward boundary datasets were obtained from the Grid3 database, which provides standardized administrative units consistent with official ward delineations used for planning and electoral purposes in Nigeria. Other datasets included infrastructure and facility data (roads, railway, healthcare facilities, police stations, parks and recreation, population data (NPC 2006 projected to 2025), and Digital Elevation Model (SRTM). All datasets were processed in ArcGIS Pro and projected to a common coordinate system (WGS 1984 UTM Zone 32N).

2.3 Data Processing

Criteria Selection and Processing

Criteria for the suitability analysis were derived from literature, questionnaire responses, in-depth discussions, and expert consultation. Also, the understanding of the demographics, land use pattern, infrastructure layout and terrain of the study area aided in the criteria selection. Subsequently, six criteria were selected as shown in Table 1. Euclidean distance analysis was applied to proximity-based criteria because it calculates the straight-line distance from each raster cell to the nearest feature and is widely used in spatial accessibility and suitability modelling to evaluate proximity relationships between locations and infrastructure within GIS environments (Malczewski & Rinner, 2015).

Following the selection and validation of the six criteria, each was standardized into a common suitability scale for integration within the GIS-based MCDA framework. Certain land uses and features were treated as constraints due to their incompatibility with elderly care facility siting, and were excluded from the suitability analysis. These include rivers, water bodies, commercial areas, railway corridors, industrial areas, quarries, and airport zones processed independently based on literature. Buffer distances applied were: river (100m), waterbody (50m), commercial areas (200m), railway corridors (100m), industrial areas (500m), and airport (1000m). The individual buffered layers were merged to create the incompatible land use layer, which was subsequently converted into a constraint raster using the raster calculator tool in ArcGIS Pro and used to exclude unsuitable areas from the final suitability output.

Table 1: Criteria and threshold ranges

Criterion	Suitability classes used in this study	Basis for threshold selection	Supporting literature
Proximity to healthcare facilities	Most suitable: 0–500m; Suitable: 500–1000m; Less suitable: 1000–2000m; Unsuitable: >2000m	Adopted to favour short-distance access to healthcare, since elderly care facilities require rapid access to medical services and healthcare utilization declines with increasing distance. The reclassification used in the GIS stage follows the threshold adopted in this study	WHO (2015); Ismaila & Usul (2013); Shuaibu & Kara (2019)

Criterion	Suitability classes used in this study	Basis for threshold selection	Supporting literature
60+ population density	Jenks Natural Breaks classes: 0–3,702; 3,702.001–8,125; 8,125.001–8,561; 8,561.001–119,711.648 persons/km², ranked from unsuitable to most suitable	Treated as a demand-based criterion because elderly care facilities should be located close to areas with higher concentrations of older adults. The Jenks Natural Breaks method was used to capture natural groupings in the ward-level elderly population density surface.	Guida *et al*. (2022); Zhang *et al*. (2019); Malczewski & Rinner (2015)
Availability of police stations	Most suitable: 0–2865m; Suitable: 2865–5297m; Less suitable: 5297–9395m; Unsuitable: >9395m	Used as a proxy for security and emergency response accessibility. The thresholds were retained from an empirical facility and suitability study, and adapted to a four classes suitability framework.	WHO (2007); WHO (2015); Mokhtar *et al*. (2023)
Proximity to major roads	Most suitable: 50–500m; Suitable: 500–1000m; Less suitable: >1000m; Unsuitable: 0–50m	Designed to balance accessibility with environmental safety. Very close roadside zones were excluded because of traffic noise, air pollution, and safety risks, while locations within 50–500m were preferred for access by caregivers, emergency services, and visitors.	Vahidnia *et al*. (2009); Ismaila & Usul (2013); Yuchi *et al*. (2020)
Recreational areas	Most suitable: 0–300m; Suitable: 300–800m; Less suitable: 800–1200m; Unsuitable: >1200m	Based on the importance of elderly access to recreation, green space, and community destinations within walkable distance. The recreational criterion in this study combines parks & recreation, and places of worship to reflect elderly social and mobility needs.	Zhang *et al*. (2023); Shuaibu & Kara (2019); Mahmoud *et al*. (2016)
Proximity to existing elderly care residential facilities	Most suitable: >1500m; Suitable: 1000–1500m; Less suitable: 500–1000m; Unsuitable: <500m	Used to discourage clustering and promote spatial equity in service distribution. Greater separation was considered preferable because it supports wider facility coverage across wards when combined with the other criteria.	Ismaila & Usul (2013); Shuaibu & Kara (2019)

(Source: Author's compilation)

Standardization of Criteria and Suitability Modelling

Standardization is required because the criteria are measured in different units and data formats, including distance, land-use categories, and population density. Each criterion was therefore transformed into a common ordinal suitability scale ranging from 1=unsuitable, 2=less suitable areas, 3=suitable, and 4=most suitable (Oloukoi *et al*., 2022). This transformation ensured comparability among criteria and allowed them to be combined within the raster-based GIS–MCDA framework using the weighted overlay procedure (Malczewski & Rinner, 2015).

The standardized criteria layers were integrated using the weighted overlay method in ArcGIS Pro. Each raster layer was assigned its corresponding AHP weight, and a weighted linear combination was applied using the equation below:

$$S = \sum (W_i \times X_i) \qquad (1)$$

where S represents the suitability score, W_i represents the weight of each criterion, and X_i represents the standardized score.

The Analytic Hierarchy Process (AHP) was used to assign weights to the six criteria. Pairwise comparisons were conducted using Saaty's 1–9 scale, guided by questionnaire findings, expert ranking, literature, and knowledge of the study area. A 6 × 6 pairwise comparison matrix was constructed, and the normalized eigenvector was used to derive criteria weights.

The resulting suitability dataset was classified into four categories: unsuitable, less suitable, suitable, and most suitable. Using the raster calculator, a constraint mask was applied to the weighted suitability raster, thereby excluding all constraint zones from the final suitability map. The resulting Masked_Suitability_Map was reclassified into four suitability categories: unsuitable, less suitable, suitable, and most suitable.

3.0 RESULTS

3.1 Perception and Level of Awareness of Elderly Care Facilities by Residents of AMAC

A total of 451 respondents participated in the public perception and awareness survey. The distribution was relatively balanced, with 52.3% male respondents (n=236) and 47.7% female respondents (n=215), as seen in Figure 2. Majority of respondents (71.2%) were under 60 years of age (figure 3), representing the younger workforce and potential decision-makers for elderly relatives. The remaining 28.8% represented individuals aged 60 and above. The survey population was highly educated, with 87.8% having attained tertiary education. Also, most respondents currently live with family (42.6%) or with a spouse (21.1%). Approximately 15.5% reported living alone. Respondents were spread across various wards in AMAC, with the highest participation from Gwarinpa (16.4%), Garki (14.2%), and Kabusa (10.9%) wards.

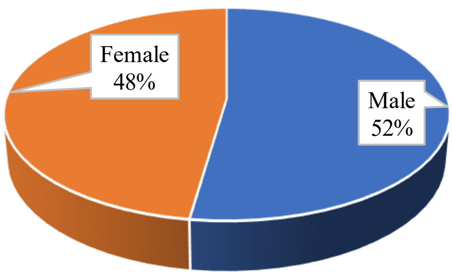


Figure 2: Gender Distribution of Respondents

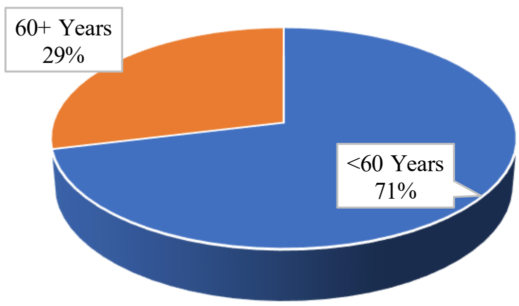


Figure 3: Age Distribution of Respondents

3.2 Perception and Expert-Based Insights

Figure 4 shows that while 63.2% of respondents had heard about elderly care facilities, only 10.4% were aware of any specific facilities currently operating within AMAC. For the responses from willingness to utilize facilities questions, Figure 5 shows that only 35.0% of respondents indicated they would consider living in an elderly care residential facility if necessary. A larger portion (42.1%) explicitly stated they would not consider it, while approximately 22.8% remained unsure. Meanwhile, for those who would consider it, the primary drivers were if the service meets their health and social needs (n=79) and if they had no one to take care of them (n=67).

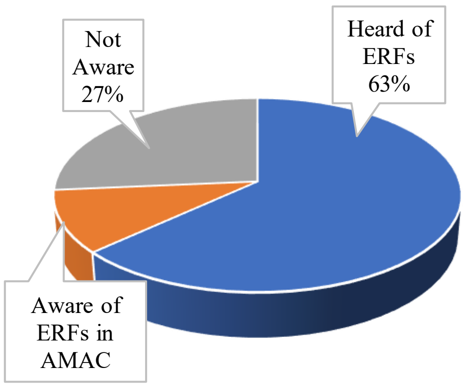


Figure 4: Public Awareness of ERFs

Healthcare services on-site (mean rank: 6.55) was identified as the most critical factor, while, proximity to major roads and eliminating business areas received the lowest mean ranks of 4.58. Although expert rankings were not directly applied as AHP weights, they guided the research-defined ranking used to construct the AHP pairwise comparison matrix.

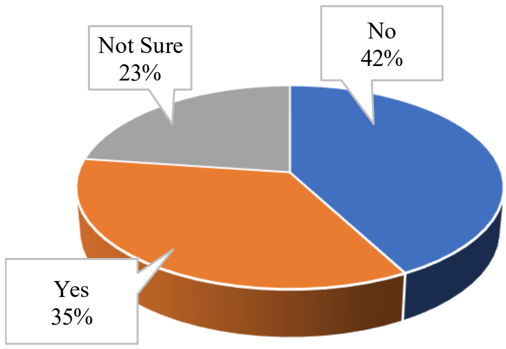


Figure 5: Willingness to Utilize Facility

3.3 Land use, Infrastructure and Terrain overview of AMAC

Residential and service-related land uses are concentrated in central wards, while peripheral areas have limited infrastructure coverage. This spatial concentration provides a favourable foundation for suitability, as central areas already exhibit infrastructural characteristics required for elderly care facility siting. Also, road networks, healthcare facilities, and police stations are more developed in central areas. Terrain conditions also vary, with relatively stable environments in central wards and more vulnerable low-lying areas in peripheral zones. These variations influence accessibility, environmental suitability, and service delivery, and are reflected in the spatial distribution of the criteria used in the analysis (Figures 6, 7, and 8)

3.4 Standardized Suitability Criteria

The standardized criteria maps (Figures 9-16) show the spatial variation of suitability across the study area based on individual factors. Areas closer to healthcare facilities and major roads exhibit higher suitability due to improved accessibility. Wards with higher elderly population density represent areas of greater demand. Availability of police stations and proximity to recreational areas further enhance suitability, reflecting safety and social wellbeing considerations. The reclassified map of existing facilities highlights areas where new facilities are required to reduce spatial concentration and improve coverage.

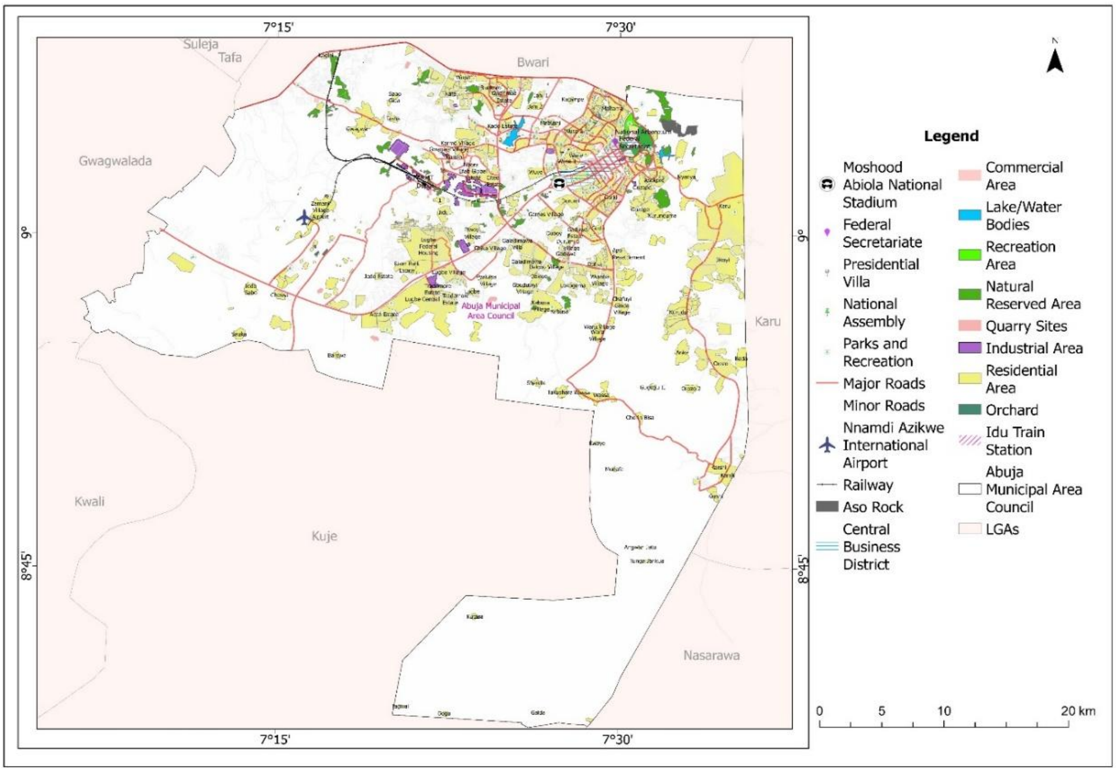


Figure 6: Land use Pattern of Abuja Municipal Area Council

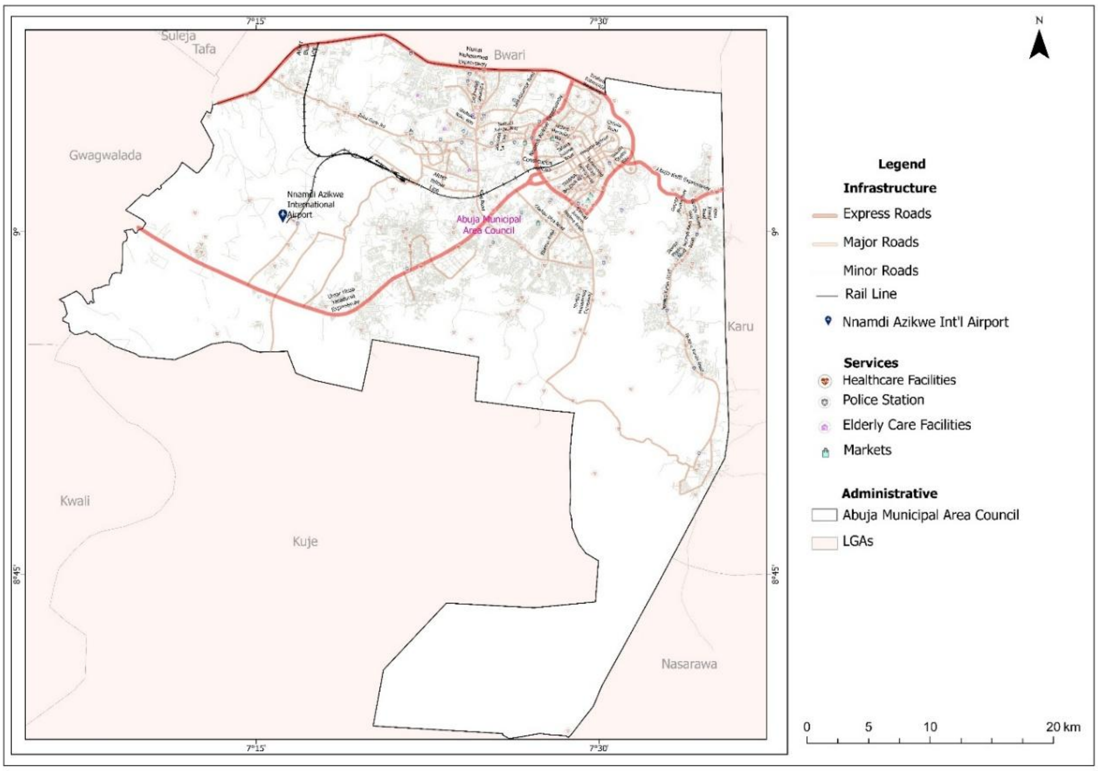


Figure 7: Infrastructure Layout of Abuja Municipal Area Council

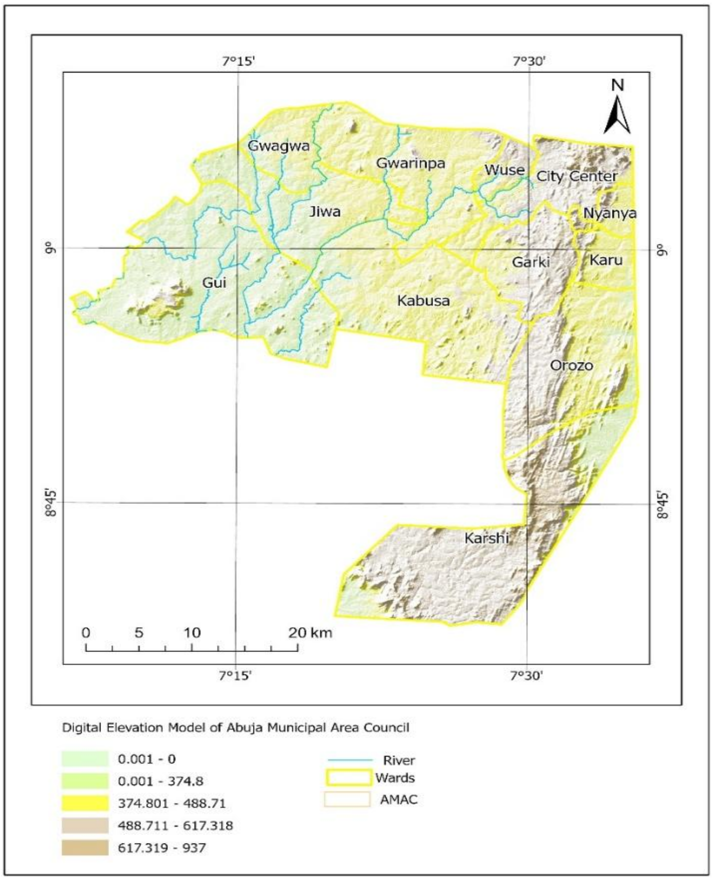
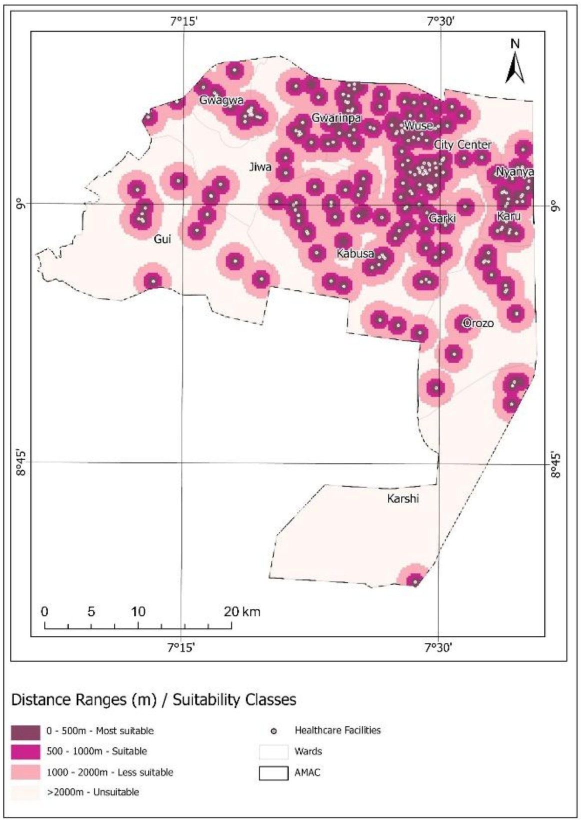


Figure 8: Elevation and Terrain Characteristics of Abuja Municipal Area Council



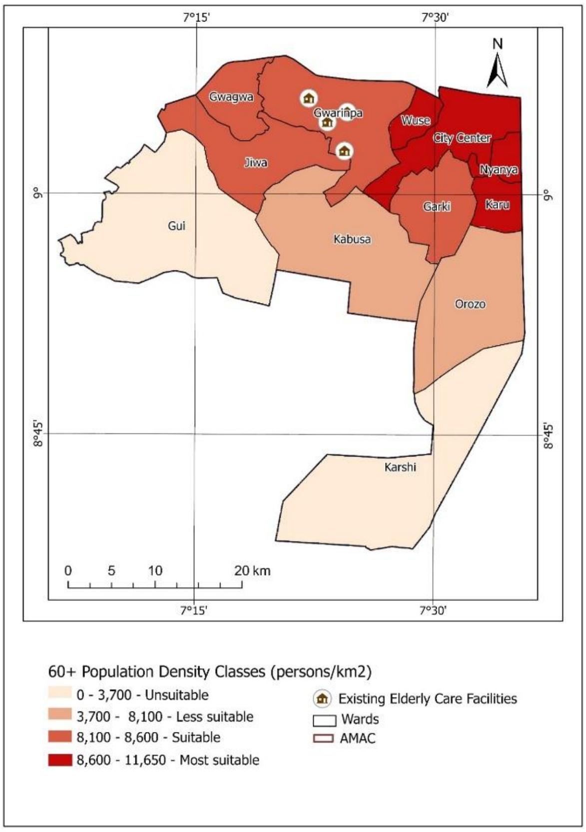


Figure 9: Healthcare facilities reclassified *Figure 10: 60+ population density reclassified*

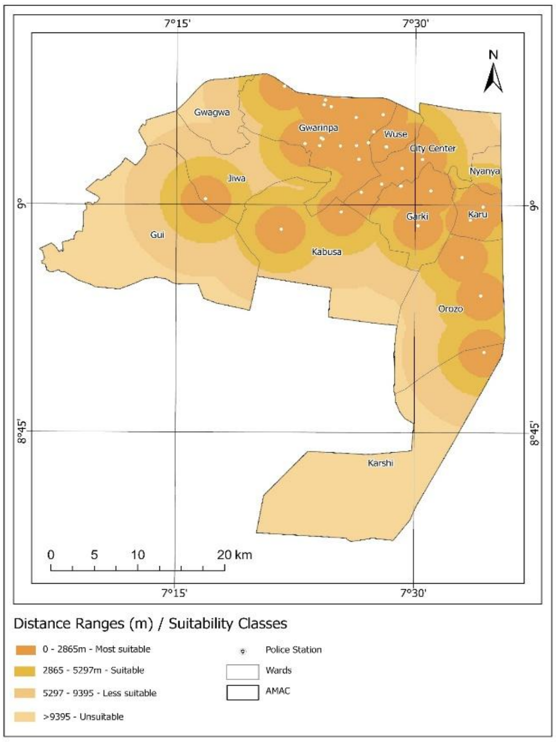


Figure 11: Police stations reclassified raster

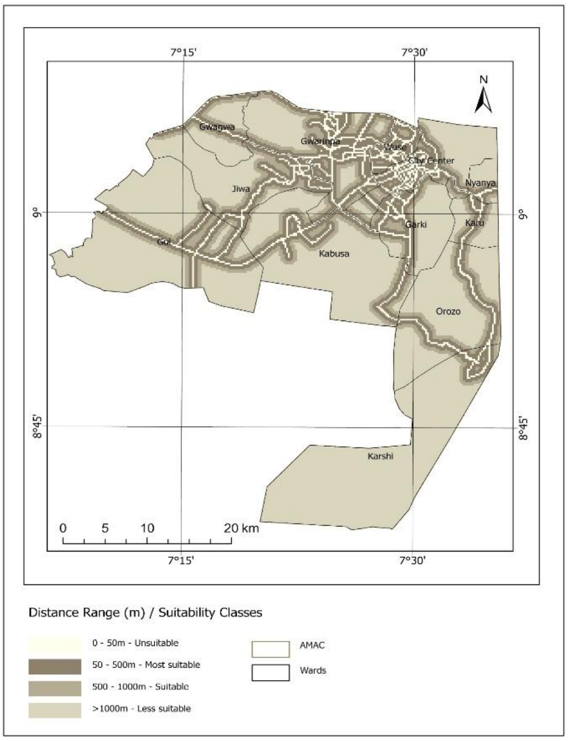


Figure 12: Major roads reclassified raster

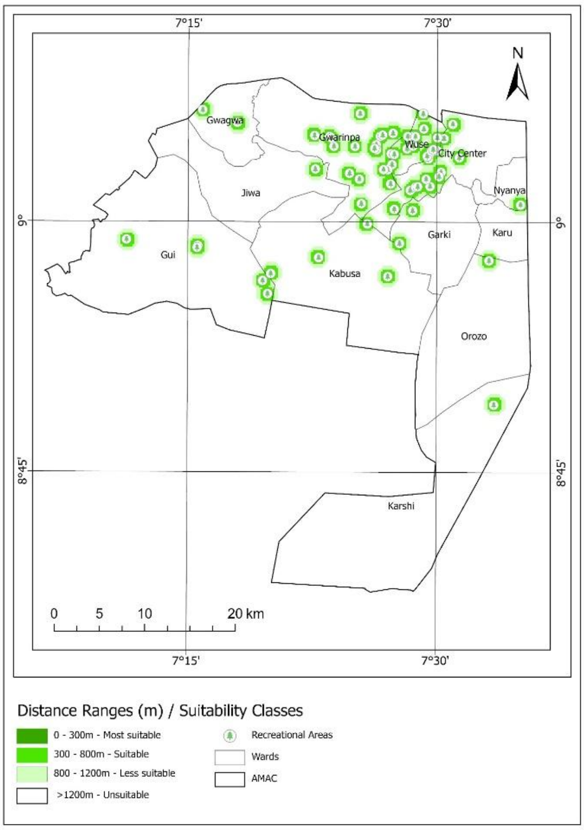


Figure 13: Recreational Areas Reclassified Raster

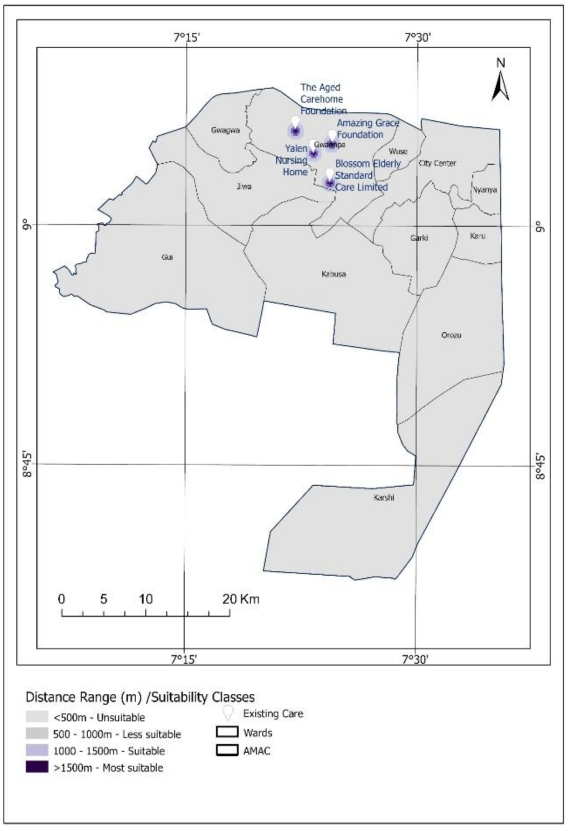


Figure 14: ERFs Reclassified Raster

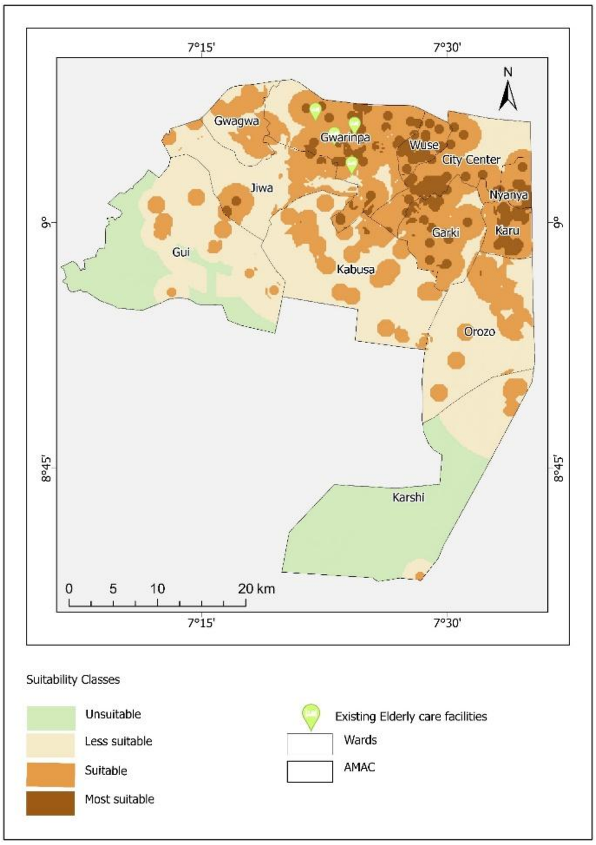


Figure 15: Suitability Map for ERFs

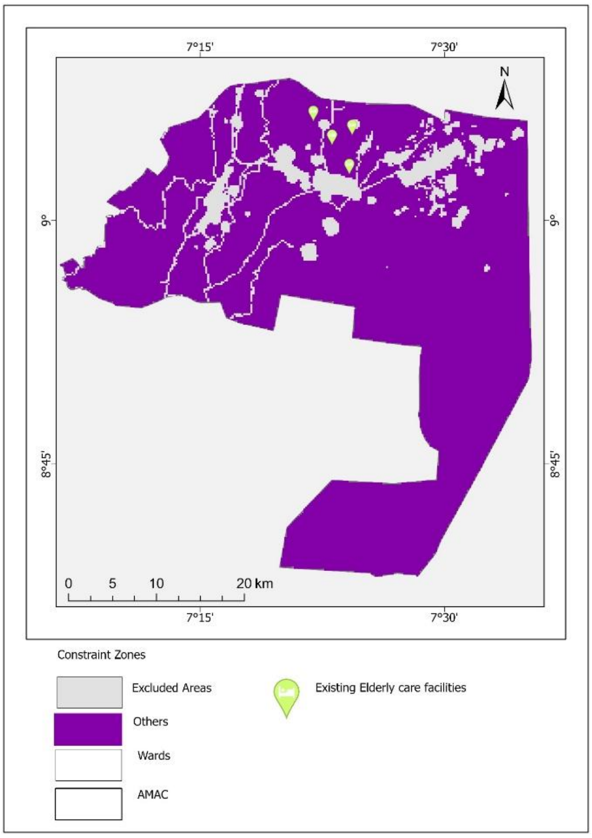


Figure 16: Constraint Mask

3.5 Criteria Weighting Using AHP

The principal eigenvalue (λmax) for the identified criteria was 6.337. The Consistency Ratio (CR) was calculated as 0.054, which is below the acceptable threshold of 0.10, indicating that the pairwise comparisons were consistent. The AHP results show that proximity to healthcare facilities (47.00%) and elderly population density (24.10%) are the most influential criteria. Availability of police stations (14.80%) and proximity to major roads (7.20%) have moderate influence, while recreational areas (4.20%) and proximity to existing facilities (2.80%) have lower influence. The Consistency Ratio of 0.054 indicates that the weighting process is reliable and consistent. Table 2.

Table 2: AHP-derived weights of suitability criteria for elderly care residential facilities in AMAC

S/No	Criteria	Influence (%)	Rank
1	Proximity to Health Facilities	47.00%	1
2	60+ Population Density	24.10%	2
3	Availability of Police Station	14.80%	3
4	Proximity to Major Roads	7.20%	4
5	Recreational Areas	4.20%	5
6	Existing Elderly Care	2.80%	6
	TOTAL	100%	

3.6 Suitability

The masked suitability map (Figure 17) shows that the most suitable areas are concentrated in central wards such as Wuse, Garki, and parts of Gwarinpa. These areas combine favourable conditions including accessibility, population demand, and infrastructure availability. Suitable areas extend into adjacent wards, while less suitable and unsuitable areas are more prominent in peripheral wards such as Gui, Karshi, and Orozo.

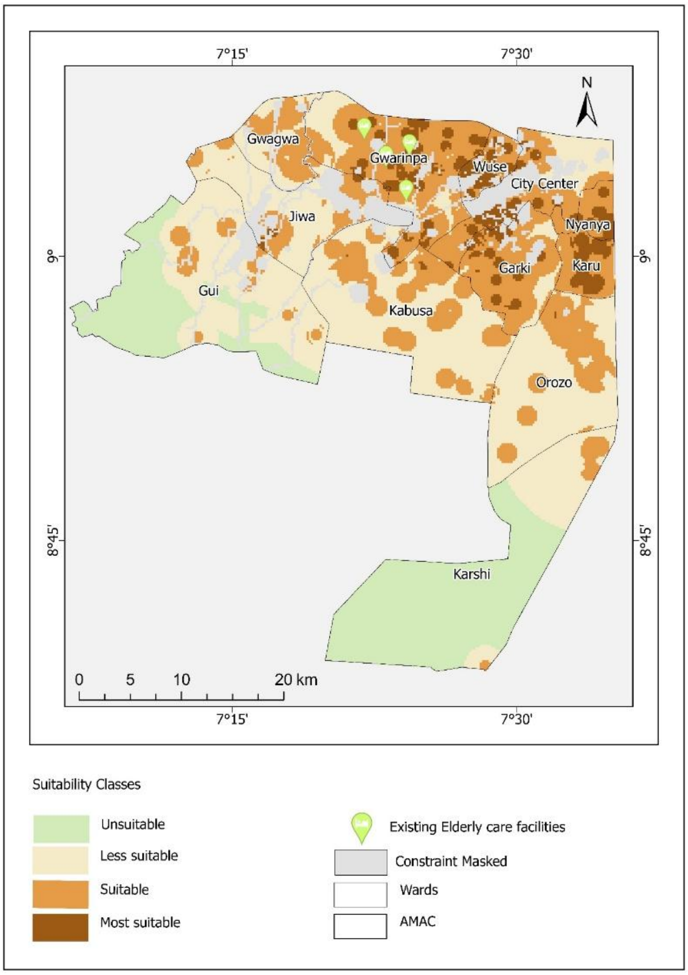


Figure 17: Result of Masked Suitability analysis

As seen in Table 3, the suitability analysis revealed that less suitable areas constituted the largest proportion of the study area, accounting for 41.40% (550.88 km²), followed by suitable areas with 29.40% (391.31 km²). Unsuitable areas covered 23.21% (308.89 km²) of the study area, while the most suitable areas accounted for only 5.99% (79.70 km²), indicating that highly suitable locations for elderly care residential facilities are spatially limited within AMAC.

3.8 Validation of Suitability Model

The degree of correspondence between facility locations and areas classified as suitable and most suitable was used to assess the reliability of the model. Results show that all existing elderly care residential facilities fall within areas classified as suitable to highly suitable. This confirms the reliability of the GIS-based MCDA approach. However, the concentration of facilities within Gwarinpa highlights a lack of spatial equity, indicating the need for redistribution of facilities across other suitable wards.

Table 3: Percentage Distribution of Suitability Classes in AMAC

Value	Suitability Class	Count	Area km²	Percentage (%)
1	Unsuitable	6708	308.88	23.21
2	Less suitable	11964	550.91	41.40
3	Suitable	8498	391.31	29.40
4	Most suitable	1731	79.71	5.99
			1330.80	100.00

4.0 DISCUSSION

The spatial pattern of suitability identified in this study highlights the strong influence of accessibility, infrastructure availability, and population distribution on the siting of elderly care residential facilities in AMAC. The weighted overlay analysis revealed that highly suitable zones were predominantly concentrated within wards such as Wuse, Garki, and parts of Gwarinpa, where there is greater availability of healthcare services, transportation infrastructure, and moderate population density. The most suitable areas accounted for only 5.99% (79.70 km²) of the study area, indicating that highly suitable locations for elderly care residential facilities are spatially limited within AMAC. In contrast, less suitable areas constituted the largest proportion of the study area, accounting for 41.40% (550.88 km²), within wards where infrastructural and service accessibility is relatively limited. This pattern demonstrates the critical role of accessibility in elderly care planning, as proximity to healthcare and essential services directly influences service utilization, well-being, and quality of life among older adults.

These findings are consistent with previous studies that identified accessibility and infrastructure concentration as major determinants of elderly care facility suitability. Tao *et al.* (2014) found that optimized elderly care facility locations in Beijing were strongly associated with areas of high service accessibility and infrastructural concentration. Similarly, Yang *et al.* (2023) and Wang *et al.* (2023) reported that proximity to healthcare services and transportation infrastructure significantly improves suitability for elderly care development. The similarity between these findings and the present study suggests that accessibility-driven spatial planning remains fundamental to efficient and equitable elderly care service provision, particularly within rapidly urbanizing environments.

The incorporation of elderly population density as a major criterion further improved the suitability model by linking facility location planning to potential service demand. The concentration of suitable areas within relatively populated wards indicates that demographic distribution plays an important role in determining optimal facility locations. This finding agrees with Guida *et al.* (2022) and Zhang *et al.* (2019), who emphasized that aligning service provision with the spatial distribution of vulnerable populations enhances accessibility and reduces spatial inequality in healthcare delivery. The integration of demographic and infrastructural variables in this study therefore provides a more socially responsive framework for elderly care planning within the AMAC context.

The study also demonstrates the effectiveness of GIS-based Multi-Criteria Decision Analysis (MCDA) and the Analytical Hierarchy Process (AHP) in integrating multiple spatial factors into a unified decision-support framework. The consistency ratio obtained from the AHP weighting process confirmed the reliability of expert judgement used in criteria prioritization. Similar observations were reported by Malczewski (2006), Malczewski and Rinner (2015), Tripathi *et al.* (2021), and Vahidnia *et al.* (2009), who established GIS-MCDA as a reliable approach for complex spatial decision-making involving multiple competing criteria. The successful integration of accessibility, population, environmental, and infrastructural variables in the present study further demonstrates the suitability of GIS-MCDA techniques for healthcare and social facility planning.

Despite the identification of several suitable locations across AMAC, the validation results revealed a clear imbalance in the existing distribution of elderly care residential facilities, with all identified facilities concentrated within Gwarinpa ward. This indicates that existing facility distribution has not been guided by spatial optimization principles or evidence-based planning approaches. Similar patterns have been reported in developing urban environments where facility development often fails to correspond with spatial demand and infrastructure distribution (Aliyu & Amadu, 2017; Abubakar, 2014). The implication is that without deliberate integration of geospatial analysis into planning processes, inequalities in access to elderly care services may persist, especially within rapidly expanding peri-urban areas. This study demonstrates that GIS-based MCDA provides a reliable and practical framework for identifying suitable locations for elderly care residential facilities. More importantly, the study highlights the importance of adopting structured and data-driven approaches to facility location planning that consider both accessibility and demographic demand in order to promote more equitable and age-responsive urban development within rapidly growing cities such as Abuja.

5.0 CONCLUSION

This study demonstrated the application of a GIS-based Multi-Criteria Decision Analysis framework for identifying suitable locations for elderly care residential facilities in Abuja Municipal Area Council. By integrating accessibility, population distribution, infrastructure, and environmental factors, the study developed a spatially explicit model that supports informed decision-making for facility siting. The findings highlight a clear imbalance in the current distribution of elderly care facilities, despite the availability of several suitable locations across the study area and shows that existing facility development has not fully reflected spatial demand and accessibility considerations.

Overall, the study shows that a GIS-based approach can provide a practical and reliable tool for improving planning decisions. The results can support policymakers and urban planners in making more balanced, data-driven decisions that improve access to elderly care services and promote spatial equity within rapidly growing urban areas.

References

Aboderin, I., & Beard, J. R. (2015). Older people's health in sub-Saharan Africa. *The Lancet*, *385*(9968), e9–e11.https://doi.org/10.1016/S0140-6736(14)61602-0

Abubakar, I. R. (2014). Abuja city profile. Cities, 41, 81–91.https://doi.org/10.1016/j.cities.2014.05.004

Adama, O. (2007). Governing from above: Solid waste management in Nigeria's new capital city of Abuja. *Habitat International, 31*(3–4), 409–422.https://doi.org/10.1016/j.habitatint.2007.04.001

Adetunji, M. A. (2020). Accessibility of Elderly Citizens to Basic Facilities in Akure Metropolis in Nigeria. *Journal of Architectural Design and Urbanism, 2*(2), 38–52. https://doi.org/10.14710/jadu.v2i2.7641

Aliyu, A. A., & Amadu, L. (2017). Urbanization, cities, and health: The challenges to Nigeria – a review. *Annals of African Medicine, 16*(3), 149-158.https://doi.org/10.4103/aam.aam_1_17

Carpentieri, G., Guida, C., & Masoumi, H. E. (2020). Multimodal accessibility to primary health services for the elderly: A case study of Naples, Italy. *Sustainability, 12*(3), 781.https://doi.org/10.3390/su12030781

Guida, C., Carpentieri, G., & Masoumi, H. E. (2022). Measuring spatial accessibility to urban services for older adults: An application to healthcare facilities in Milan. *European Transport Research Review, 14*, 23.https://doi.org/10.1186/s12544-022-00544-3

Independent National Electoral Commission (INEC). (2023). List of PVC collation centres for ward level collection (6th–15th January 2023), Federal Capital Territory, Abuja Municipal Area Council (AMAC). Independent National Electoral Commission.

Ismaila, A. B., & Usul, N. (2013). *A GIS-based spatial analysis of health care facilities in Yola, Nigeria*. In *GEOProcessing 2013: The Fifth International Conference on Advanced Geographic Information Systems, Applications, and Services* (pp. 46–53). ThinkMind.https://www.thinkmind.org/library/GEOProcessing/GEOProcessing_2013/geoprocessing_2013_3_10_30028.html

Izuegbu, O. U., Sangari, D. U., & Kpalo, S. Y. (2025). Change detection study of Abuja Municipal Area Council Abuja, Federal Capital Territory Nigeria between 2002 and 2023. *International Journal of Research and Innovation in Social Science, 9*(3).https://doi.org/10.47772/IJRISS.2025.90300396

Mahmoud, I. M., Duker, A., Conrad, C., Thiel, M., & Shaba Ahmad, H. (2016). Analysis of settlement expansion and urban growth modelling using geoinformation for assessing potential impacts of urbanization on climate in Abuja City, Nigeria. *Remote Sensing, 8*(3), 220.https://doi.org/10.3390/rs8030220

Malczewski, J. (2006). GIS-based multicriteria decision analysis: A survey of the literature. *International Journal of Geographical Information Science, 20*(7), 703–726. https://doi.org/10.1080/13658810600661508

Malczewski, J., & Rinner, C. (2015). Multicriteria decision analysis in geographic information science. *Springer*.https://doi.org/10.1007/978-3-540-74757-4

Mokhtar, E. S., Md Sharin, N. A. B., Idrees, M. O., Saad, N. M., Astuti, P., Mohd Sidek, N. Z., Mohd Yusoff, Z., & Abdul Wahab, S. M. (2023). Geospatial analysis of sustainable living residential site suitability using analytical hierarchy process. *AIP Conference Proceedings, 2881*, 040011.https://doi.org/10.1063/5.0167596

Nordin, S., McKee, K., Wijk, H., & Elf, M. (2017). The association between the physical environment and the well-being of older people in residential care facilities: A multilevel analysis. *Journal of Advanced Nursing, 73*(12), 2942–2952. https://doi.org/10.1111/jan.13358

Nsu, R. E., Ovye, A. D., Ugal, A. A., & Moses, A. (2024). Healthcare facilities mapping within Abuja Municipal Area Council (AMAC), FCT-Abuja. *International Journal of Social Science Research and Anthropology, 5*(6) https://taapublications.com/tijssra/article/view/236

Oloukoi, G., Akingbade, A. O., Atureta, O. G., & Enaruvbe, G. O. (2022). GIS-based suitable site selection for internally displaced persons' camps in Abuja, Nigeria. Osun Geographical Review, 25(3), 1–14. https://journals.uniosun.edu.ng/ogr/article/view/79

Saaty, T. L. (1980). The analytic hierarchy process: Planning, priority setting, resource allocation. McGraw-Hill.

Shuaibu, J. A., & Kara, C. (2019). Evaluating suitability for sustainable urban growth of Abuja by using MCE and GIS. *International Journal of Advanced and Applied Sciences, 6*(7), 68–76.https://doi.org/10.21833/ijaas.2019.07.009

Tanyi, P. L., André, P., & Mbah, P. (2018). Care of the elderly in Nigeria: Implications for policy. *Cogent Social Sciences, 4*(1), 1555201.https://doi.org/10.1080/23311886.2018.1555201

Tao, Z., Cheng, Y., Dai, T., & Rosenberg, M. W. (2014). Spatial optimization of residential care facility locations in Beijing, China: Maximum equity in accessibility. *International Journal of Health Geographics, 13*, 33.https://doi.org/10.1186/1476-072X-13-33

Tripathi, M., Sahu, N., & Pandey, A. (2021). GIS-based multi-criteria decision analysis for site suitability. *Environmental Monitoring and Assessment, 193*, 1–17.https://doi.org/10.1007/s10661-021-09001-5

United Nations Department of Economic and Social Affairs, Population Division. (2024). *World Population Prospects* 2024.https://population.un.org/wpp/

Vahidnia, M. H., Alesheikh, A. A., & Alimohammadi, A. (2009). Hospital site selection using fuzzy AHP and its derivatives. *Journal of Environmental Management, 90*(10), 3048–3056.https://doi.org/10.1016/j.jenvman.2009.04.010

van Hoof, J., & Marston, H. R. (2021). Age-friendly cities and communities: State of the art and future perspectives. *International Journal of Environmental Research and Public Health, 18*(4), 1644.https://doi.org/10.3390/ijerph18041644

Wang, M., Qi, X., Li, Z., Li, J., & Dong, S. (2023). Evaluation of the suitability of elderly care in prefecture-level cities in China based on GIS. *Heliyon, 9*(6), e16539.https://doi.org/10.1016/j.heliyon.2023.e16539

World Health Organization. (2007). Global age-friendly cities: A guide.https://www.who.int/publications/i/item/9789241547307

World Health Organization. (2015). Measuring the age-friendliness of cities: A guide to using core indicators.https://iris.who.int/handle/10665/203830

World Health Organization. (2020). UN Decade of Healthy Ageing: Plan of action 2021–2030.https://cdn.who.int/media/docs/default-source/decade-of-healthy-ageing/decade-proposal-final-apr2020-en.pdf

Yang, J., Lou, Z., Tang, X., & Sun, Y. (2023). Multi-source data-based evaluation of suitability of land for elderly care and layout optimization: A case study of Changsha, China. *Sustainability, 15*(3), 2034. https://doi.org/10.3390/su15032034

Yu, J., Leung, M., Ma, G., & Xia, J. (2022). Older adults' access to and satisfaction with primary hospitals based on spatial and non-spatial analyses. *Frontiers in Public Health, 10*, 845648. https://doi.org/10.3389/fpubh.2022.845648

Yuchi, W., Sbihi, H., Davies, H., Tamburic, L., & Brauer, M. (2020). Road proximity, air pollution, noise, green space and neurologic disease incidence: A population-based cohort study. *Environmental Health, 19*, 8.https://doi.org/10.1186/s12940-020-0565-4

Zhang, S.-C., Wang, H., Liu, Z., Zeng, S., Jin, Y., & Baležentis, T. (2019). A comprehensive evaluation of the community environment adaptability for elderly people based on the improved TOPSIS. *Information, 10*(12), 389.https://doi.org/10.3390/info10120389

Zhang, Y., Zhu, J., Li, F., & Wang, Y. (2024). Site selection of elderly care facilities based on multi-source spatial big data and integrated learning. *ISPRS International Journal of Geo-Information, 13*(12), 451.https://doi.org/10.3390/ijgi13120451

Zhou, X., & Cao, K. (2023). Spatial multi-objective optimization of institutional elderly-care facilities: A case study in Shanghai. *International Journal of Applied Earth Observation and Geoinformation, 122*, 103436. https://doi.org/10.1016/j.jag.2023.103436