DOI: 10.22616/j.balticsurveying.2022.17.004

MODELLING RESDENTIAL PROPERTY VALUES IN BIDA USING GEOGRAPHIC INFORMATION SYSTEM

Yunusa Dauda, Jibrin Katun Mohammed, Hauwa L. Etsu-Ndagi and Nwoye Isreal Izuchukwu
The Federal Polytechnic Bida, Nigeria

Abstract
Many studies have unveiled the importance of variation in residential property values overtime, but failed to cover different types of residential property value and location. The aim of this research is therefore to model residential property rental value in Bida from 2015 to 2020 with the aid of Geographic Information System (GIS). The study focused on the rental values of the residential property and rental value variation across space. Data collected for this paper includes residential rental values and geographic coordinates from 196 residential properties in the study area, comprising 101 one-bedroom, 80 two-bedroom and 15 three-bedroom apartments. Inverse Distance Weighted (IDW) interpolation tool of ArcGIS was employed in analyzing the data. It was found out that the core areas of the town commands lower rental values while the southern part of the town commands higher rental values. It was also found out that one bedroom apartment is the most dominant residential rental property followed by the two bedroom apartments and three bedroom apartments respectively. Geospatial database was produced for each model in a bid to ascertain the level of changes with time. The benefits associated with the application of GIS technology were established by this research and recommends its application to other property values modeling.
Key words: residential properties, rental values, modelling, geographic information system, inverse distance weighted.

Introduction

Price variations and the cyclical nature of the housing market are risk factors that might jeopardize the stability of the financial and banking sectors dynamics, as evidenced by recent experience and property value crises in emerging countries (Yuan et al., 2018; Olszewski et al., 2017). Valuation of properties, particularly residential properties, was traditionally done manually or based on a current report and site survey, and was largely documented on paper and hardcopies (Sharafat et al., 2021). The current trend in property revaluation is to create a property valuation model that can estimate residential property values on a wide scale and in a short period of time. Geographic Information System (GIS) are one of the tools used to record all information about the value of properties and spatially represented based on the data collected (Mohammed & Sulyman, 2019; Bohari et al., 2015).

GIS are responsible for establishing spatial links between items that can be identified in respect to the earth (Hu et al., 2018). Cichociski & Dbrowski (2013) describe how these systems may be used to analyze the features and relationships of spatially defined objects. All geographic phenomena vary through time, and comprehending geographic processes and events requires both spatial and temporal qualities. In addition, knowledge derived from spatio-temporal data will aid in the better prediction of spatial processes and events (Li et al., 2020).

The rapid growth of cities has put a strain on land, making it difficult to precisely describe property qualities and value (Biozor & Cielak, 2021). GIS and remote sensing data have been widely employed for property appraisal due to their abundant spatial information and robust image processing capability (Zhang et al., 2014). Although, locational influences on property value are often viewed as the most essential, their inclusion in valuation methodologies is frequently assumed (Li & Luo, 2022). The use of GIS-based value maps to depict fluctuations in value at the individual property level is introduced.

General data such as social, economic, planning, and environmental features, as well as specific data such as local market conditions, transaction details such as location, physical and functional form, and legal characteristics, are used in all valuation approaches (Kemiki, 2012). Market data is generally difficult to obtain due to regulatory limits on the release of property data into the public domain; therefore valuers rely on their own expertise and experience. Despite the lack of access to property data, IT and data analysis techniques are fast evolving. Early IT implementations in the real estate sector were simply computerized duplications of human operations (Yang et al., 2018). Property management software, for example, was built on accounting programs, while valuation software transformed old value processes into spreadsheets (Cellmar, 2011). These programs have been developed and polished to the point where they can now effectively replace manual systems. Complex valuations and sensitivity analysis can be carried out using valuation software to a degree that would be prohibitively time demanding if done manually.

Property valuation estimates are crucial in making strategic real estate investment decisions (Ullah & Sepasgozar, 2020). This is due to the fact that real estate stakeholders (including professionals, corporations, and the government) rely heavily on property valuation estimates provided by valuers (Yalpir, 2014). The inaccuracy of such appraisal forecasts could have a negative impact on real estate stakeholders' investments, which could eventually undermine a country's economy, as the global financial crisis of 2007 demonstrated (Jiang et al., 2013).

Several methodologies have been employed to estimate property values in the real estate research arena, ranging from traditional to advanced valuation techniques (Assimakopoulos et al., 2015). Traditional valuation methods have been proved to be unreliable and erroneous in studies (Zurada et al., 2006). As a result, there has been a shift toward advanced valuation methodologies, which are more accurate and dependable than traditional methods (Abidoye, et al., 2019). Traditionally, property transaction data was only available through a network of professional connections. The contact established by estate surveyor within the property industry and in the area where he or she practices, the 'jungle telegraph' can be effective (Adegoke et al., 2017). However, it can be difficult to obtain the necessary information in many circumstances, particularly when companies are secretive or the market is slow.

In order to examine the drivers of property value, previous research has either disregarded or dealt with location analysis in a very general way (Wyatt, 2013). It's possible that modeling location for the purposes of valuation may be challenging. According to Dabaniyu (2013), valuers infer a great deal about a property from its location, which is based on local experience and knowledge. Acknowledging why a specific location has a particular impact on property value is not the same as attempting to quantify that element (Adetiloye & Eke, 2014). The market value of every asset is the price a potential buyer is willing to pay a willing seller in the presence of all relevant information and acting in their own best interests (Brown & Matysiak, 2017). As a result, the price an occupier is willing to pay determines the value of a property.

It is from the foregoing, that this study attempts to model residential rental properties value with the aid of Inverse Distance Weighting (IDW) interpolation tools of GIS to determine the variation in rental value of residential properties of the study area in 2015 and 2020 respectively.

Methodology of research and materials

The study was conducted in Bida traditional Nupe town in Nigeria. The primary data collected for this study includes the location of residential properties in terms of their coordinates with the use of a Global Positioning System (GPS) receiver to produce a map for residential rental properties as well as rental values for residential property types in the study (see Fig. 1). Questionnaire was administered on occupants of residential properties to ascertain the rental value of varying residential properties for the years 2015 and 2020 to 196 residential properties comprising 101 one-bedroom, 80 two-bedroom, and 15 three-bedroom apartments respectively. Residential rental values collected for each category of properties were used to build the geodatabase in ArcGIS 10.6. The collected information was analyzed using the IDW interpolation technique of GIS using the residential rental values of each category of residential properties (i.e. one-bedroom, two-bedroom, and three-bedroom) as the input field from the attribute table of the geodatabase in the spatial modeling of residential property rental values of the study area.

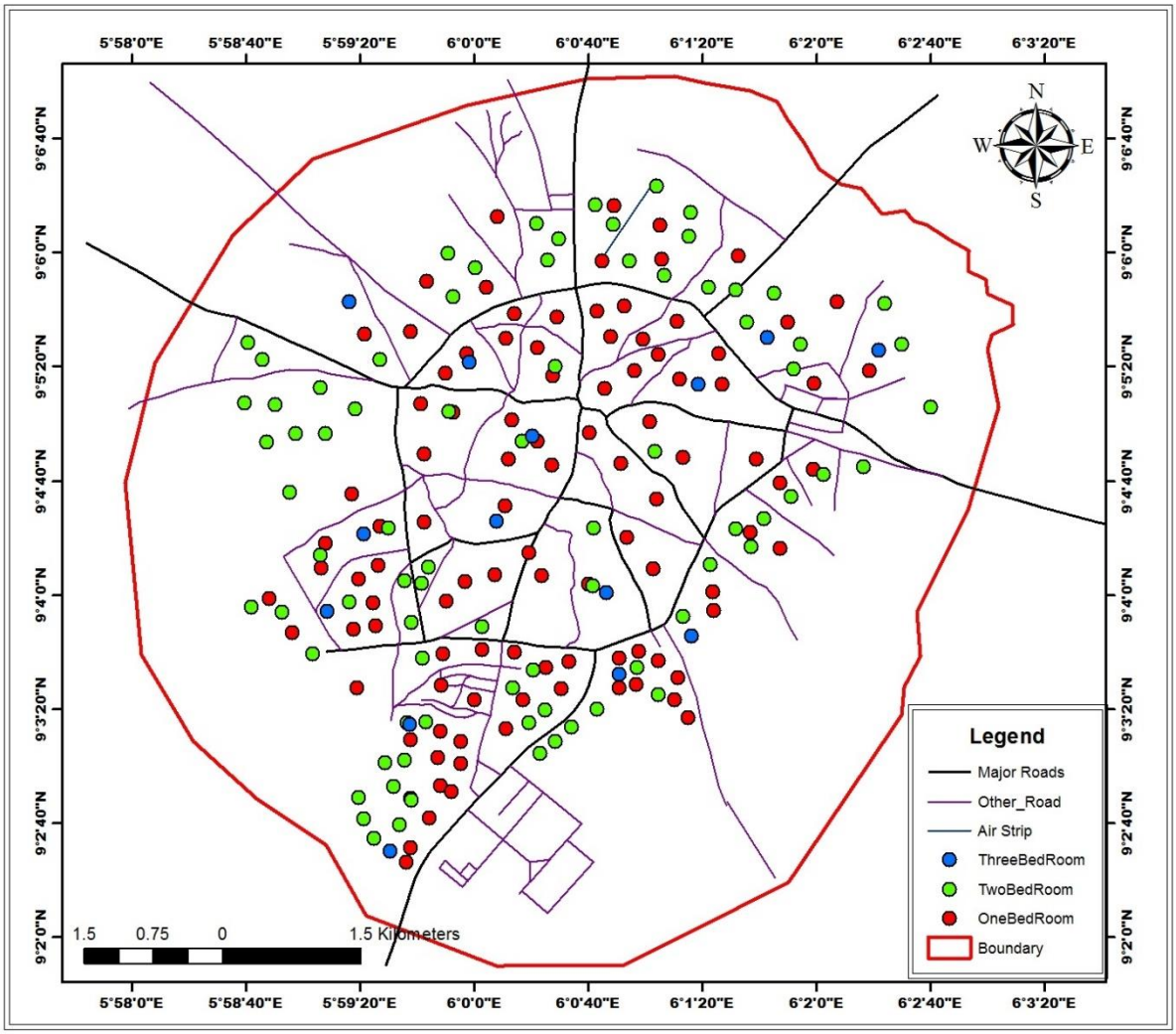

Fig. 1. Location of Sampled Residential Rental Properties in the Study Area

Discussions and results

Model for spatial residential rental value in the year 2015

The rental value of residential properties in the study area as of 2015 is presented in Fig. 2, 3, and 4 respectively. The IDW results show that in 2015 the minimum rental value of a bedroom residential property is thus put within the range of NGN6000 to NGN12000 and NGN61000 to NGN67000 at its peak, while that of two-bedroom residential property was at NGN100000 to NGN107000 and NGN167000 to NGN174000 at the minimum and maximum values respectively. For the three bedrooms' residential property rental values in the study area, the minimum value as of 2015 was between NGN11000 to NGN29000 and the maximum value was around NGN181000 to NGN190000 respectively. The spatial model shows a lower rental value in the central area for one-bedroom residential properties and higher rental values along the southern parts of the region (see Fig. 2). The model indicates decreasing residential rental value with the decreasing distance away from the city center. For two-bedroom rental values, the model shows that the highest rental value is found in southwestern and northwestern areas of the study area, while the city center has a lower rental value for two-bedroom apartments (see Fig. 3). The two-bedroom residential rental property model also indicates the increasing rental value with increasing distance away from the city center. The model for three-bedroom apartments shows a contrasting spatial pattern, although, the city center also records lower residential rental values (see Fig. 4).

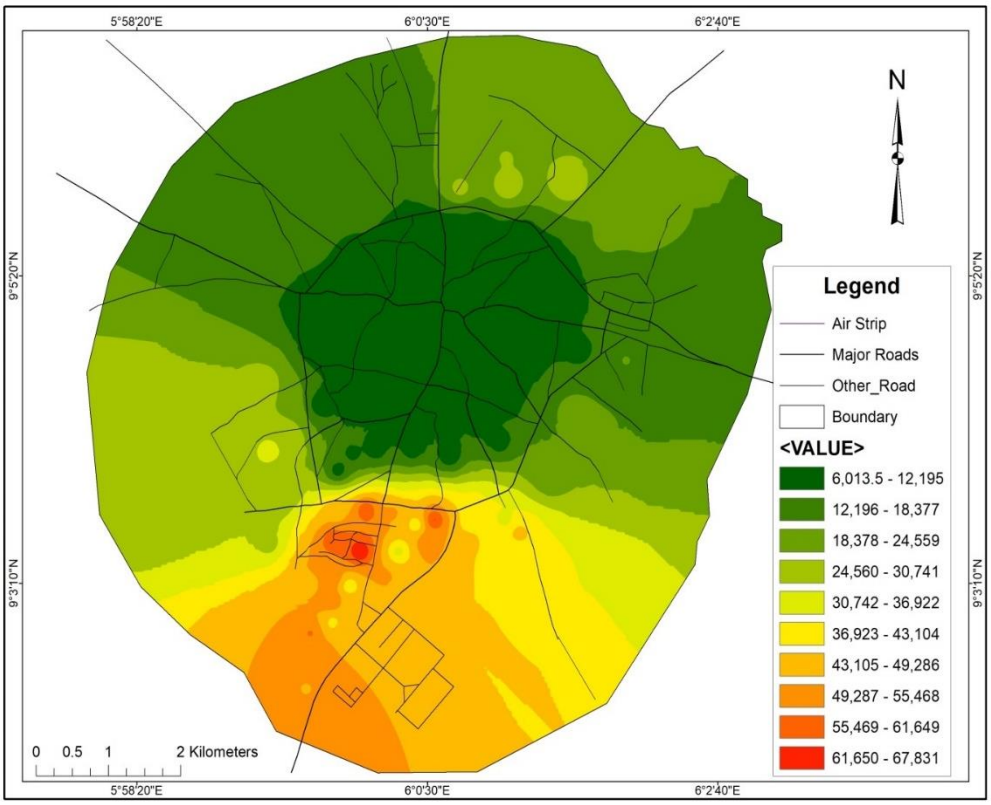

Fig. 2. One-bedroom spatial residential rental value for 2015

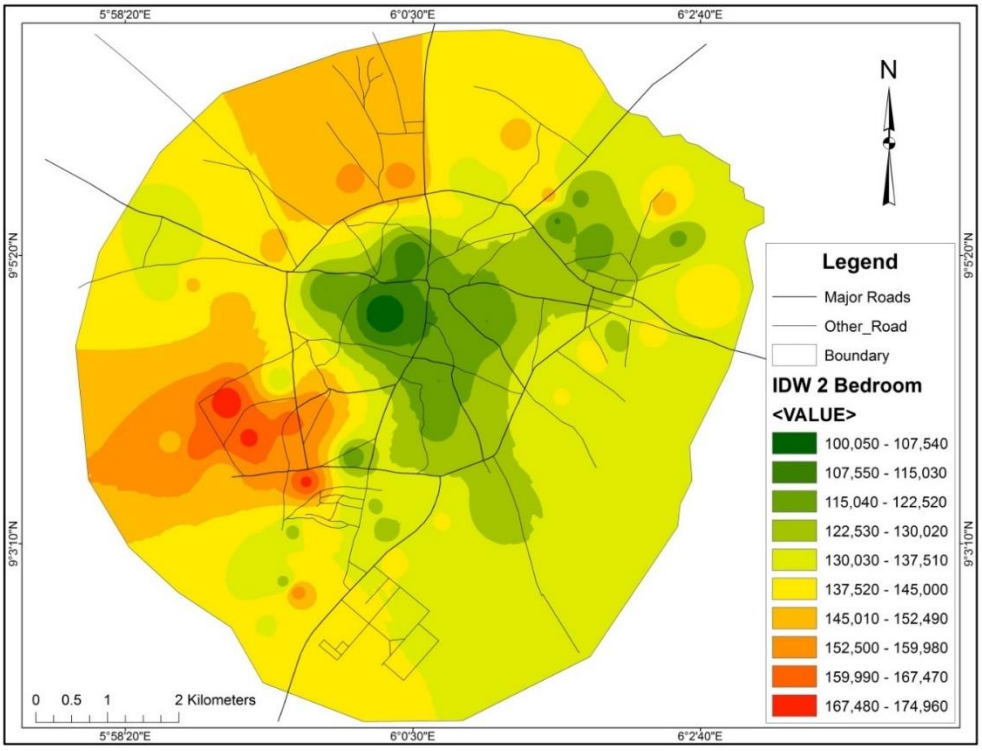

Fig. 3. Two bedrooms spatial residential rental value for 2015

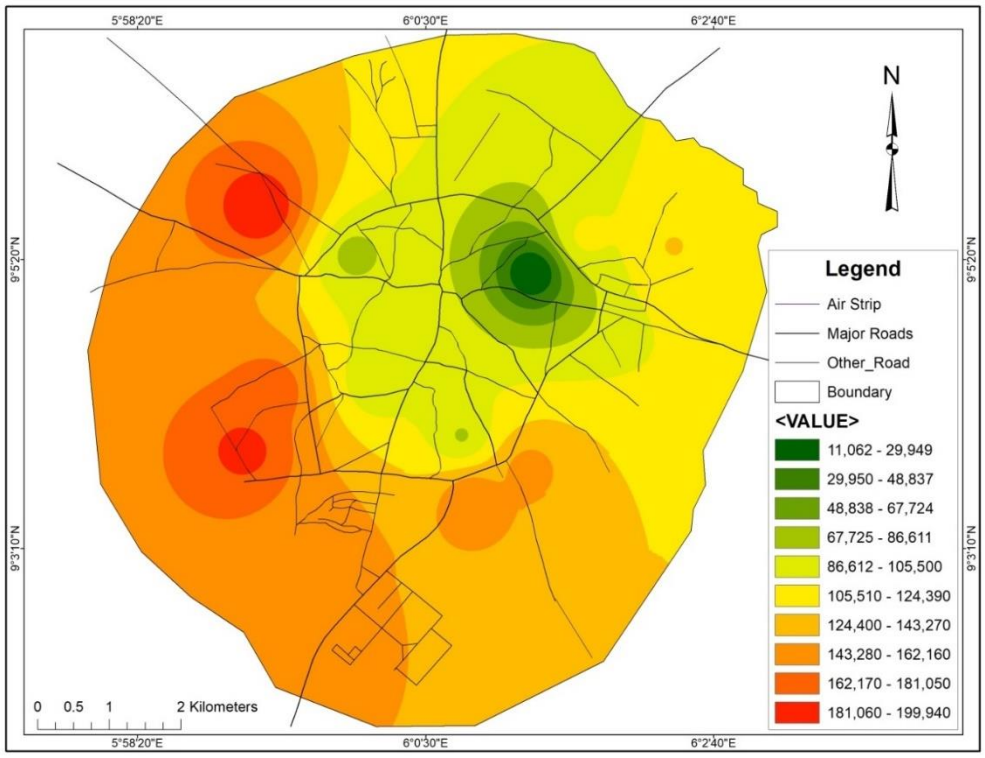

Fig. 4. Three bedrooms spatial residential rental value for 2015

Model for spatial residential rental value in the year 2020

The The IDW analysis presented in Fig. 5, 6 and 7 respectively represents the residential properties rental values for the year 2020 where it was revealed that the rental values for one bedroom residential property was lower in the core areas of the town from NGN14000 to NGN30000 and a bit higher towards the northern part within the range of NGN30000 to NGN50000 while the rental values for a bedroom residential property is considerably high in the south and estimated around NGN60000 to NGN80000 as shown in Fig. 5. Similarly, rental values for two-bedroom apartments were lower at the core of the town estimated around NGN20000 to NGN80000, while other parts of the town commands high values with areas the western axis having the highest values for two-bedroom residential properties estimated around NGN100000 to NGN140000 as presented in Fig. 6. Three-bedroom residential properties command the highest price in the southwestern part of the town with the price ranging from NGN180000 to NGN200000 while the northern part of the study area has a considerably lower rental value of NGN11000 to NGN30000 as shown in Fig. 7. This implies that residential property values in the southern part of the town irrespective of the number of room commands higher value than the core areas and northern part of the town across the time space analysed.

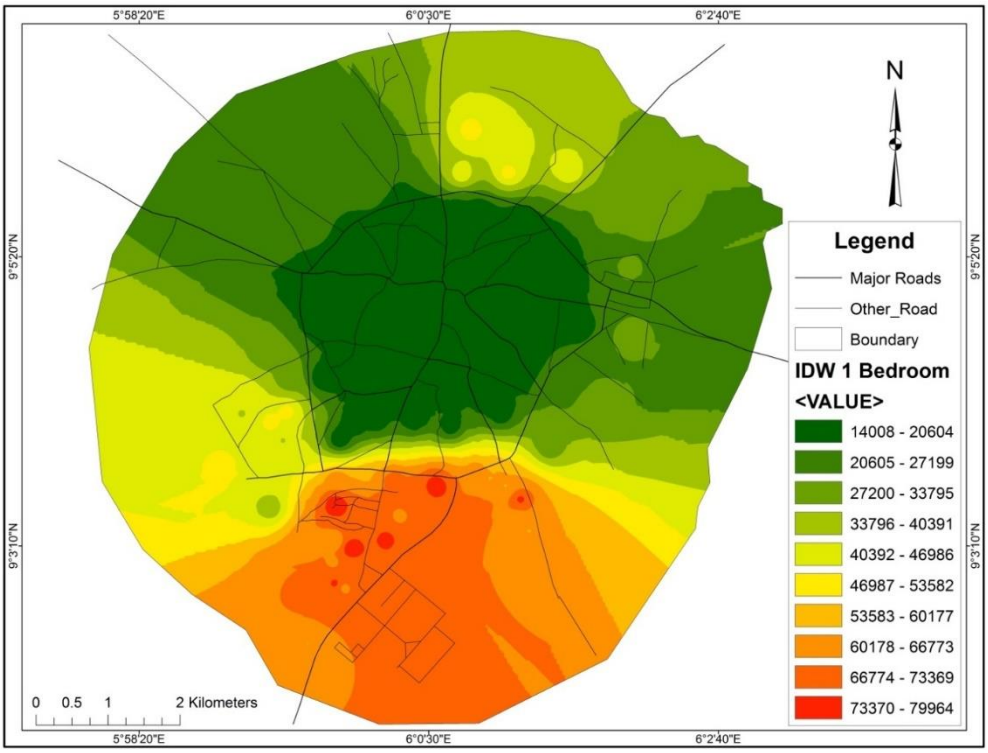

Fig. 5. One-bedroom spatial residential rental value for 2020

Similarly, rental values for two-bedroom apartments were lower at the core of the town estimated around NGN20000 to NGN80000, while other parts of the town commands high values with areas the western axis having the highest values for two-bedroom residential properties estimated around NGN100000 to NGN140000 as presented in Fig. 6. Three-bedroom residential properties command the highest price in the southwestern part of the town with the price ranging from NGN180000 to NGN200000 while the northern part of the study area has a considerably lower rental value of NGN11000 to NGN30000 as shown in Fig. 7. This implies that residential property values in the southern part of the town irrespective of the number of room commands higher value than the core areas and northern part of the town across the time space analysed.

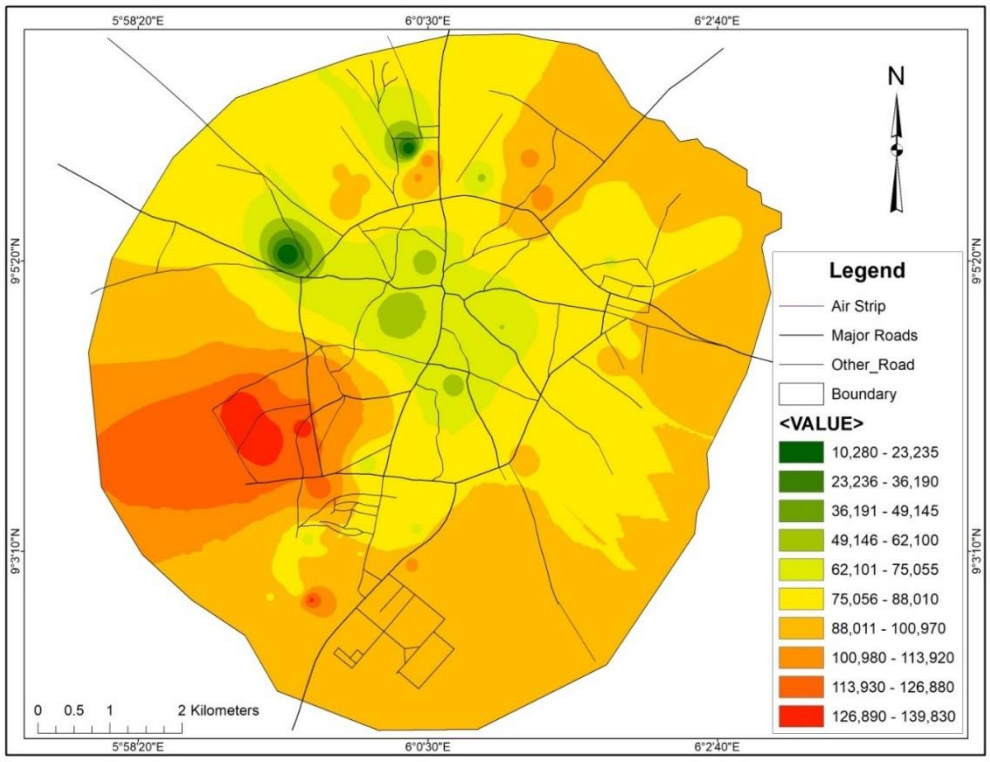

Fig. 6. Two bedrooms spatial residential rental value for 2020

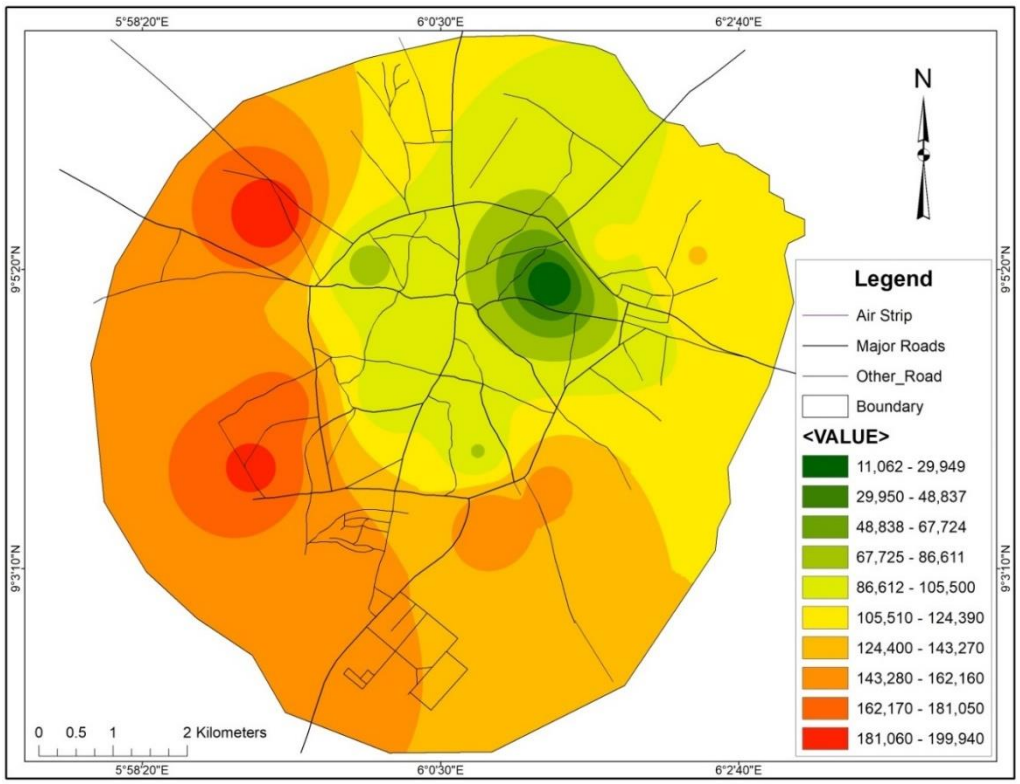

Fig. 7. Three bedrooms spatial residential rental value for 2020

The various analytical tools of GIS present an easier medium of processing, manipulating, understanding, and presenting environmental, social, and economic-related data (Mohammed et al., 2021; Kuller et al., 2019; Grekousis, 2020). As revealed by the findings of this study in 2015, three-bedroom residential rental properties commanded the highest rental value which agrees with the finding of Ciu et al. (2018) in a study conducted in Beijing, China, that residential properties with a higher number of rooms

has more economic return than the lower ones. Similarly, it was observed that residential properties closer to the central business district (CBD) had relatively lower rental values compared to other farther locations from the city center which conforms with the findings of Hussain et al. (2019) in a study conducted in Islamabad region of Pakistan and Nepal et al. (2020) in a study conducted in Nepal. This is due to the organic nature of the city (Mohammed et al., 2021). The model revealed a pattern that shows that all residential rental properties command lower value with proximity to the city center and higher rental value towards the suburb. This is in line with a study conducted by Delventhal et al. (2022), Miessner (2021), and Olowu et al. (2019) indicating that the closer a property is to the city center, the higher the rental value of the such property.

Conclusions and proposals

The spatial models of the residential rental value of the study area show a variation in the spatial structure of the city. However, the uniqueness of the model is that all the residential rental property values depict lower rental values in the central area of the study area. In conclusion, the study revealed a spatial pattern that is contrary to the monocentric city models. The study revealed a spatial pattern that depicts a decreasing rental value with decreasing distance from the city center. However, there is a slight variation in the spatial pattern of two-bedroom rental values for the years 2015 and 2020, yet, the city center commands lower rental values. It was therefore concluded by the study that the IDW interpolation tool of GIS is a unique tool to predict and model property value. The adoption and application of this tool are therefore recommended to estate valuers and managers as an important valuation tool that will aid the processing, analysis, and presentation of valuation-related data efficiently than the traditional approach.

References

1. Abidoye, R. B., Junge, M., Lam, T. Y., Oyedokun, T. B., & Tipping, M. L. (2019). Property valuation methods in practice: evidence from Australia. Property management.
2. Adegoke, O. J., Aluko, B. T. & Adegoke, B. F. (2017). Determinants of Market Value of Residential Properties in Ibadan Metropolis, Nigeria. Journal of Economics and Sustainable Development, vol. 8(4), Pp: 178-188
3. Adetiloye, K. A. & Eke, P. O. (2014). A Review of Real Estate Valuation and Optimal Pricing Techniques. Asian Economic and Financial Review, 4(12):1878-1893
4. Assimakopoulos, V., Makridakis, S., Litsa, A., & Pagourtzi, E. (2015). The advanced forecasting information system PYTHIA: An application in real estate time series.
5. Biłozor, A., & Cieślak, I. (2021). Review of Experience in Recent Studies on the Dynamics of Land Urbanisation. Land, 10(11), 1117.
6. Bohari, S. N., Saad, S. N. M., Marzukhi, F., Rahim, A., &Darim, A. D. A. (2015). Residential property valuation using GIS. In 2015 IEEE 11th International Colloquium on Signal Processing & Its Applications (CSPA) (pp. 131-134). IEEE.
7. Brown, G. R. & Matysiak, G. A. (2017). Real estate investment. A capital market approach. FT, Prentice Hall, Financial Times, Pearson Education Limited. pp: 12-89.
8. Cellmer, R. (2011). Spatial Analysis of the Effect of Noise on The Prices and Value of Residential Real property. Geomatics and Environmental Engineering. 5(4) 13-28.
9. Cichociński, P., &Dąbrowski, J. (2013). Spatio-Temporal Analysis of the Real Estate Market Using Geographic Information Systems. Real Estate Management and Valuation, 21(2). https://doi.org/10.2478/remav-2013-0019.
10. Cui, N., Gu, H., Shen, T., & Feng, C. (2018). The impact of micro-level influencing factors on home value: A housing price-rent comparison. Sustainability, 10(12), 4343. doi:10.3390/su10124343.
11. Debaniyu, I. F. (2013). Price Integration of Cowpea Retail Markets in Niger State, Nigeria. Academic Research International, 4(3), 264–277.
12. Delventhal, M. J., Kwon, E., & Parkhomenko, A. (2022). JUE Insight: How do cities change when we work from home?. Journal of Urban Economics, 127, 103331. https://doi.org/10.1016/j.jue.2021.103331.
13. Grekousis, G. (2020). Spatial analysis methods and practice: describe–explore–explain through GIS. Cambridge University Press.
14. Hu, H., Gu, J., Zhang, Z., Dai, J., & Wei, Y. (2018). Relation networks for object detection. In Proceedings of the IEEE conference on computer vision and pattern recognition (pp. 3588-3597).
15. Hussain, T., Abbas, J., Wei, Z., & Nurunnabi, M. (2019). The effect of sustainable urban planning and slum disamenity on the value of neighboring residential property: Application of the hedonic pricing model in rent price appraisal. Sustainability, 11(4), 1144.
16. Jiang, H., Jin, X.-H., & Liu, C. (2013). The effects of the late 2000s global financial crisis on Australia's construction demand. Australasian Journal of Construction Economics and Building, 13(3), 65–79.
17. Kemiki, O. A. (2012), "Geospatial Analysis of the Effects of Pollution from a Cement Factory on Property Rental Value in Ewekoro, Ogun State Nigeria". Journal of The Nigerian Institution of Estate Surveyors and Valuers. Vol. 36. 160 – 169

18. Kuller, M., Bach, P. M., Roberts, S., Browne, D., & Deletic, A. (2019). A planning-support tool for spatial suitability assessment of green urban stormwater infrastructure. Science of the total environment, 686, 856-868. https://doi.org/10.1016/j.scitotenv.2019.06.051.
19. Li, S., Ye, X., Lee, J., Gong, J., & Qin, C. (2017). Spatiotemporal Analysis of Housing Prices in China: A Big Data Perspective. Applied Spatial Analysis and Policy, 10(3), 421–433. https://doi.org/10.1007/s12061-016-9185-3.
20. Li, T., Zhang, J., Bao, K., Liang, Y., Li, Y., & Zheng, Y. (2020, August). Autost: Efficient neural architecture search for spatio-temporal prediction. In Proceedings of the 26th ACM SIGKDD International Conference on Knowledge Discovery & Data Mining (pp. 794-802). https://doi.org/10.1145/3394486.3403122.
21. Li, X., & Luo, F. (2022). A Dynamic Econometric Analysis of Urbanization and Ecological Environment in Silk Road Economic Belt. Scientific Programming, 2022. https://doi.org/10.1155/2022/4895213.
22. Miessner, M. (2021). Studentification in Germany: How investors generate profits from student tenants in Goettingen and the impacts on urban segregation. European Urban and Regional Studies, 28(2), 133-154. https://doi.org/10.1177/0969776420934850.
23. Mohammed, J. K. and Sulyman, A. O., (2019). Spatio-Temporal Analysis of Bida Housing Market Using Geographic Information System. Collaboration for Sustainable Development in the Built Environment. International Conference of Environmental Sciences, ICES 2019. University of Ilorin, Nigeria, 29th - 30th April 2019
24. Mohammed, J. K., Sulyman, A. O., & Aliyu, A. A. (2021). A Spatiotemporal Analysis of Urban Densification in an Organically Growing Urban Area. Baltic Journal of Real Estate Economics and Construction Management. Vol. 9: 94–111
25. National Population Commission. (2006). Population and housing census of the federal republic of Nigeria: National and state population and housing priority tables. National Population Commission.
26. Nepal, M., Rai, R. K., Khadayat, M. S., & Somanathan, E. (2020). Value of cleaner neighborhoods: Application of hedonic price model in low income context. World Development, 131, 104965. https://doi.org/10.1016/j.worlddev.2020.104965.
27. Olowu, F. Y., Jaiyeoba, E. B., Agbabiaka, H. I., & Daramola, O. J. (2019). Spatial analysis of the factors influencing housing quality for renters in a traditional Nigerian city. International Journal of Housing Markets and Analysis. https://doi.org/10.1108/IJHMA-04-2018-0027.
28. Olszewski, K., Waszczuk, J., &Widłak, M. (2017). Spatial and Hedonic Analysis of House Price Dynamics in Warsaw, Poland. Journal of Urban Planning and Development, 143(3). https://doi.org/10.1061/(ASCE)UP.1943-5444.0000394.
29. Ononogbo, K. U. (2014). Assessment of Residents' Attitudes Towards Recreation In Bida-Nigeria (M.Sc. Thesis). Ahmadu Bello University, Zaria, Zaria Nigeria.
30. Sharafat, A., Khan, M. S., Latif, K., & Seo, J. (2021). BIM-based tunnel information modeling framework for visualization, management, and simulation of drill-and-blast tunneling projects. Journal of Computing in Civil Engineering, 35(2), 04020068.
31. Ullah, F., & Sepasgozar, S. M. (2020). Key factors influencing purchase or rent decisions in smart real estate investments: A system dynamics approach using online forum thread data. Sustainability, 12(11), 4382. doi:10.3390/su12104382.
32. Wyatt, P. (2013). Property valuation. John Wiley & Sons.
33. Yalpir, S. (2014). Forecasting residential real estate values with AHP method and integrated GIS. Paper presented at the People, Buildings and Environment Conference, an International Scientific Conference, Kroměříž, Czech Republic. 15–17 October.
34. Yang, L., Jin, S., Danielson, P., Homer, C., Gass, L., Bender, S. M., & Xian, G. (2018). A new generation of the United States National Land Cover Database: Requirements, research priorities, design, and implementation strategies. ISPRS journal of photogrammetry and remote sensing, 146, 108-123.
35. Yuan, F., Wu, J., Wei, Y. D., & Wang, L. (2018). Policy change, amenity, and spatiotemporal dynamics of housing prices in Nanjing, China. Land Use Policy, 75, 225-236. https://doi.org/10.1016/j.landusepol.2018.03.045
36. Zurada, J., Levitan, A. S. & Guan, J. (2011). A Comparison of Regression and Artificial Intelligence Methods in a Mass Appraisal Context. Journal of Real Estate Research, vol. 33, pp. 349-387.

Information about authors:
Yunusa, Dauda, MSc. Real Estate Management and Development, M.Tech Estate Management and Valuation, Principal Lecturer, The Federal Polytechnic Bida, Nigeria. P.M.B 55, Doko Road Bida, Nigeria, +2348036297406, yunusasauki@gmail.com. Property Management and Development.
Jibrin Katun, Mohammed, M.Tech Housing and Urban Renewal, Lecturer, The Federal Polytechnic Bida, Nigeria. P.M.B 55, Doko Road Bida, Nigeria, +2348068868547, muhammad.jibrinkatun@fedpolybida.edu.ng. Housing, Urban issues, GIS, ICT.

Hauwa L., Etsu-Ndagi, M.Tech Environmental Management, Lecturer 1, The Federal Polytechnic Bida, Nigeria. P.M.B 55, Doko Road Bida, Nigeria, +2348033555193, hauwabu@yahoo.com. Valuation, Property development and Facility management.
Nwoye Isreal, Izuchukwu, HND Estate Management and Valuation, Graduate, The Federal Polytechnic Bida, Nigeria. P.M.B 55, Doko Road Bida, Nigeria, +2347035519674, divinesons.ni@gmail.com. Real Estate and Spatial Analysis.