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GIS-AHP BASED SUITABILITY MODEL FOR COMMERCIAL PROPERTY INVESTMENT IN BIDA, NIGERIA

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ABSTRACT

Geographic Information System (GIS) benefits have been continuously discovered by Estate Surveyors and Valuers. Despite several attempts in adopting GIS in real estate decision making, there is a significant gap in terms of commercial property investment decisions, particularly, commercial property investment. This research applied GIS to commercial property investment decisions in Bida, Nigeria. Data were mainly collected from primary sources. The entire Bida town built-up area was considered for the study. The commercial rental data for the study area was based on the 2014–2023 collected occupants of commercial rental properties in the study area. Using the street map, the study area was divided into 214 different submarkets. Across the submarkets, a total of 340 blocks of commercial properties, including 284 blocks of shops, 11 office blocks, and 45 combination shops and office blocks, were sampled. Some basic Key Performance Indicators (KPIs) were used as a measuring criterion for commercial properties in the study area, which are: occupancy rate, rent index, tenant turnover, rental growth rate, eviction rate, and lease renewal. The collected data were analysed using the Hotspot spatial analytical technique and the Analytical Hierarchy Process (AHP) in a GIS environment. The study generated a suitability map for commercial property investment. The findings of the study indicate that the closer a location is to the city centre, the more suitable it is for commercial property investments in the study area, and the farther from the city centre, the less suitable it is for commercial property investments in the study area. This research recommends that Estate Surveyors and Valuers adopt GIS to aid their decisions in commercial property investment.

KEY WORDS GIS, Analytical Hierarchy Process, Commercial Property Investment, Real Estate Decision-Making, Spatial Analysis

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1. INTRODUCTION

Geographic Information System (GIS) is a unique application which has overtime been used by estate surveyors and valuers in assessing location of properties in real estate (Dauda et al., 2021). Its application across board has become a veritable tool for effective planning, projection and communication in commercial property studies (Kucera, 2020; Patra et al., 2018). Majorly, it has been accepted and adopted for studying spatial distribution of commercial properties. GIS is a tool that can be utilized to find suitable location for any real estate investment (Astafiev & Guo, 2018; Del Giudice et al., 2019). Studies have shown that there is a growing interest in the adoption and implementation of GIS in different real estate sectors (Droj et al., 2024; Sisman & Aydinoglu, 2022; Arcuri et al., 2020). This is due to its ability to analyse, visualize and interpret spatial data by displaying information in maps thereby revealing patterns, trends and opportunities that may not be identified in tabular data alone (Kraak & Ormeling, 2020; Kraak et al., 2018). Campbell and Masser (2020) points out that most private firms and government agencies are gradually depending on GIS based analysis to locate their businesses. This is because GIS is not only capable of managing vast amounts of spatial data but it also allows analysts to have a visual display of the geographic data (Zhu et al., 2021).

Globally, commercial property investments are threatened by various forms of locational risks, as such it becomes pertinent for a pre-investment location analysis to be accurately carried out to ascertain where an investment should be preferably located. The demand by real estate investors of a preferable location for commercial property investment has increased due to the increase in human population. However, several attempts have been made in understanding the locational characteristics of real property investment using GIS (Namangale & Dunga, 2022). For example, De Toro et al. (2020) explores the real estate market dynamics through the integration of a Multi-Criteria Decision Analysis (MCDA) method and GIS. Locurcio et al. (2020) proposed an evaluative model for the corporate market segment, in order to support the investors decisions. Despite this development, only few studies adopt GIS in assessing commercial property investment (Namangale & Dunga, 2022).

In terms of GIS application to commercial property investment analysis, Namangale & Dunga (2022) applied GIS to find optimal location for commercial property investment in Blantyre City, Malawi. The criteria for finding suitable sites were demographics, transportation and competiveness. Yet, critical key performance indicators of commercial property investments such as rental index, tenant turnover, occupancy rate, rental growth rate, eviction rate and lease renewal rate were not considered in the study. Namangale & Dunga (2022) adopted network analysis tool of ArcGIS for weak analytical approach for modelling commercial property investment decision considering property along the major routes. However, the approach is weak and was unable to establish the best locations for commercial property investment which could be best achieved through the Analytical Hierarchy Process (AHP).

AHP is one of the best tool for real estate investment decisions (Aihie et al., 2023; Rodi et al., 2022; Thilini et al., 2021). Rodi et al. (2022) gathered and analysed expert opinions via the AHP method were a good preliminary insight for the real estate industry provided for incorporating the green office building attributes into their conventional buildings. Aihie et al. (2023) opined that AHP can be a useful tool in the appraisal process when faced with the problem of selecting the most appropriate comparable from a list of slightly dissimilar comparables. In contrast, Soussi et al. (2025) suggest that AHP is one of the best tools in prioritising the commercial real estate development risk.

Despite all these attempts in adopting AHP in real estate decision making, there is a significant gap in terms of commercial property investment decisions, particularly, decision on where to invest commercial property. This study seeks to address the gap in commercial investment location decision-making by integrating AHP and GIS to evaluate spatial KPIs in Bida, Nigeria.

2. METHODOLOGY

2.1. Study area

The study was conducted in Bida, traditional, modern and heterogeneous Nupe town in Nigeria. Bida town is located between latitude 9°5'30" - 9°2'07"N and longitude 5°58'30"- 6°3'0"E (See Figure 1). It is one of the largest communities in Niger state and is located in the state's southern area. It is also on the A124 regional highway, which connects Minna with Ilorin and Abuja (Mahmud & Umaru, 2018). According to the last national population census, the town has about 255,008 inhabitants (Mohammed & Sulyman, 2019). The town is highly recognised for activities such as traditional brass and copper goblets, crafts and other metal items, raffia and mats, glass beads and bangles, silk textiles and locally dyed cotton (Mohammed, 2021).

Figure 1: Map of Bida, the Study Area (NIGIS, 2023)

2.2. Data and sampling

The study area was divided into 214 different submarkets for effective and convenient data collection and analysis (see Figure 2). The census sampling technique was adopted, where the entire 340 commercial properties (shops and offices) available in the study area at the time of the survey were sampled, including 284 blocks of shops, 11 office blocks and 45 shops and office blocks combined. Data were collected on Key Performance Indicators (KPI) from property managers, which were used as a measuring criterion for commercial properties investment performance in the study area. The KPIs used are occupancy rate, rent index, tenant turnover, rental growth rate, eviction rate and lease renewal respectively, with their validity supported by established frameworks in real estate performance analysis and KPI modeling (Roubtsova & Michell, 2013; Ogunbiyi & Oladokun, 2023).

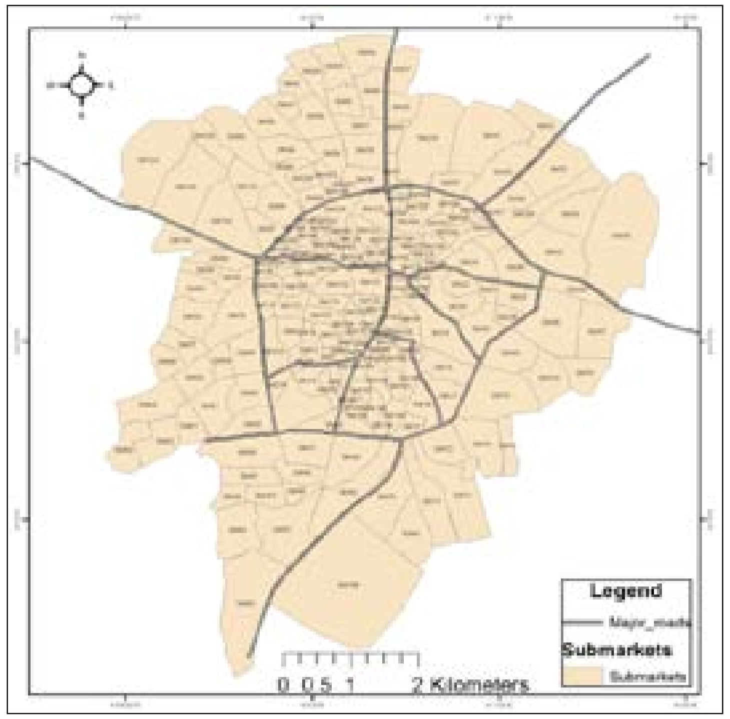

Figure 2: Demarcations of commercial property submarkets in the study area

2.3. Data analysis

Data collected on KPIs were structured separately and analysed using equations for measuring each of them. The equations are presented as follows:

Occupancy Rate

$$Occupancy\ Rate = \frac{Total\ Unit\ Rented}{Total\ number\ of\ Units} \times 100$$

Rent Index

$$Rent\ index = \frac{Current\ Rent}{Base\ Rent} \times 100$$

Tenant turnover

$$Tenant\ turnover = \frac{Number\ of\ units\ turned\ over}{Total\ number\ of\ units} \times 100$$

Rental Growth Rate

$$Rental\ Growth\ Rate = \frac{Current\ Rental\ Price - Initial\ Rental\ Price}{Initial\ Rental\ Price} \times 100$$

Eviction Rate

$$Eviction\ Rate = \frac{Number\ of\ Evictions}{Number\ of\ units} \times 100$$

Lease Renewal Rate

$$Renewal\ Rate = \frac{Number\ of\ Extended\ Contrscts}{Total\ Number\ of\ Renewable\ Contracts} \times 100$$

The KPIs results of each of the submarkets were computed in to the attribute table of the submarkets polygons in the ArcGIS environment and were analysed and presented in thematic maps. This allows spatial visualisation of the performance of the individual KPI.

2.4. AHP

The AHP was employed to determine the relative importance of each parameter in identifying suitable commercial property locations. The process began by defining the goal (to identify the best rental property locations) and the criteria (rent index, occupancy rate, eviction rate, lease renewal rate, tenant turnover rate, and rental growth rate). Each criterion was standardized to a common scale (0 to 1) to enable comparison and combination. All spatial data layers representing the KPIs in ArcGIS were converted to raster and reclassified. Finally, the weighted layers were summed to create the final suitability map, highlighting areas within the study area that are most suitable for commercial property investment based on the integrated analysis of the six criteria.

The analysis of the pairwise comparison matrix using the AHP for the criteria (KPIs) revealed a Consistency Index (CI) of 0.0815 and a Consistency Ratio (CR) of 0.0657. Since the CR is less than the threshold of 0.1, the comparisons are considered consistent, indicating that the judgments used to compare the criteria are reliable. This consistency validates the derived criteria weights, making them suitable for application in a GIS-based multi-criteria decision-making process, ensuring that the spatial analysis reflects the true importance of each factor.

Table 1: Pairwise Comparison Matrix

Criteria	Occupancy Rate	Rent Index	Tenant Turnover	Rental Growth Rate	Eviction Rate	Lease Renewal Rate
Occupancy Rate	1	3	5	7	9	5
Rent Index	1/3	1	3	5	7	3
Tenant Turnover	1/5	1/3	1	3	5	3
Rental Growth Rate	1/7	1/5	1/3	1	3	1/3
Eviction Rate	1/9	1/7	1/5	1/3	1	1/5
Lease Renewal Rate	1/5	1/3	1/3	3	5	1

3. RESULTS AND FINDINGS

3.1. Criteria for measuring commercial property investment in the study area

The findings of this study revealed in Figure 3 that the major ratio of the rate of occupancy of commercial properties in the study area is within the range of 96 to 133 and is mostly located within the Central Business District (CBD), the western and northern areas of the town. This is followed by submarkets ranging from 84 to 95, which are located in the eastern part of the town, while the lowest rate of occupancy is ranging from 15 to 42, located in the southern part of the town. This implies that the areas with the lowest rate of occupancy are located within the eastern part of the town, and the areas with the highest rate of occupancy are located within the C.B.D., northern, and western parts of the town.

Figure 4 shows that the majority of property submarkets with the highest tenant turnover rate are within the range of 86 to 136, located within the C.B.D. parts of town. This is followed by submarkets with a range of 48 to 85, which are located close to the eastern parts of the city, while the submarkets with the lowest tenant turnover rate range from 0 to 9, which are mostly located within the southern and western parts of the town. The implication is that the lowest tenant turnover rate was found in the locations within the southern and western parts of the town, and the highest tenant turnover rate is located within the C.B.D. of the town.

Figure 5 indicates that submarkets with the lowest rate of eviction are within the range of 0 to 7 and are mostly located within the northern and southern parts of the town. The highest rate ranges from 81 to 150, which are located within the eastern part of the town. This is followed by submarkets with a range of 44 to 80, which are located within the C.B.D. of the town. This denotes that the lowest eviction rate was found in the northern and southern parts of the city, while the highest eviction rate was located in the eastern part of the town in the study area.

Figure 6 indicates that submarkets with the lowest lease renewal rate are within the range of 0 to 50 and are mostly located in the C.B.D. and the southern part of the town. The highest lease renewal rate ranges from 501 to 867, which are located within the inner parts of the town. This is followed by submarkets with a range of 287 to 500 and located close to the inner parts of the town. This finding shows that the highest lease renewal rate was found within the inner parts of the city, while the lowest lease renewal rate was located at the fringe of the town in the study area. Figure 7 revealed that the highest rental growth rate of commercial properties in the study area is within the range of 81 to 233 and is mostly located in the C.B.D. and northern parts of the town. This is followed by submarkets ranging from 51 to 80, which are located in the eastern part of the town, while the lowest rental growth rate ranges from 0 to 11, located within the western and southern parts of the town. This finding indicates that the areas with the lowest rate of occupancy are located within the western and southern parts of the town, and the areas with the highest lease renewal rate are located within the urban fringe (C.B.D.).

Figure 8 shows that the highest rent index of commercial properties in the study area is within the range of 551 to 1000 and is mostly located within the C.B.D. of the town. This is followed by submarkets ranging from 336 to 550, which are located in the northern and eastern parts of the town, while the lowest rent index ranges from 100 to 136, located in the western and southern parts. This implies that the areas with the lowest rate of occupancy are located within the western and southern parts of the town, and the areas with the highest rent index are located within the C.B.D.

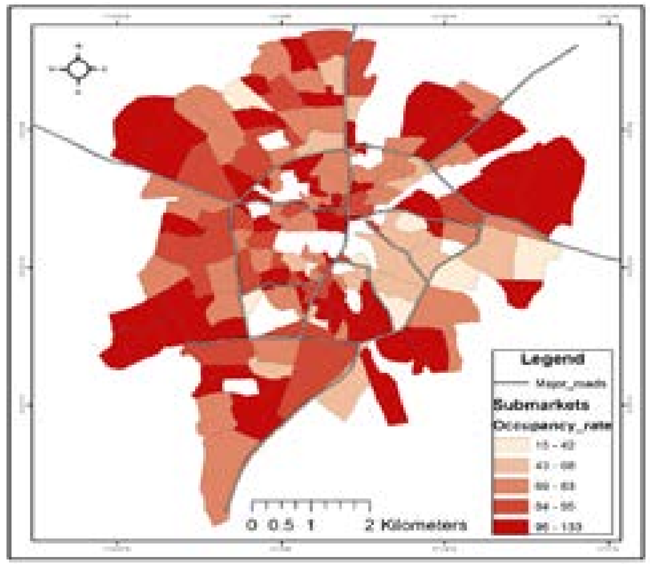

Figure 3: Occupancy Rate of commercial properties across the submarkets

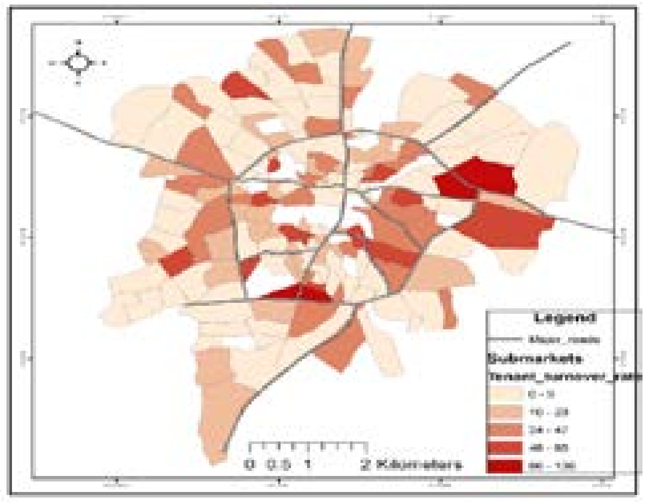

Figure 4: Tenant Turnover Rate of commercial properties across the submarkets

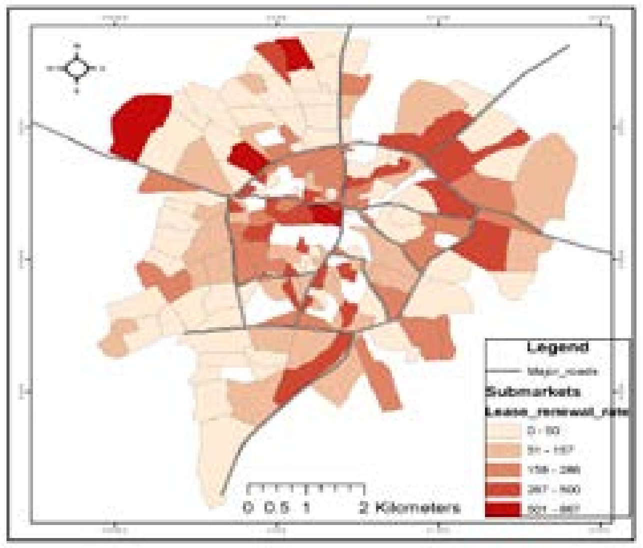

Figure 5: Eviction Rate of commercial properties across the submarkets

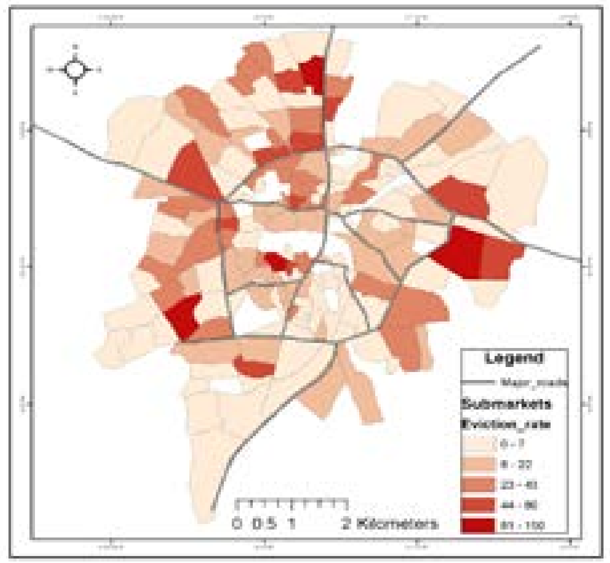

Figure 6: Lease Renewal Rate of commercial properties across the submarkets

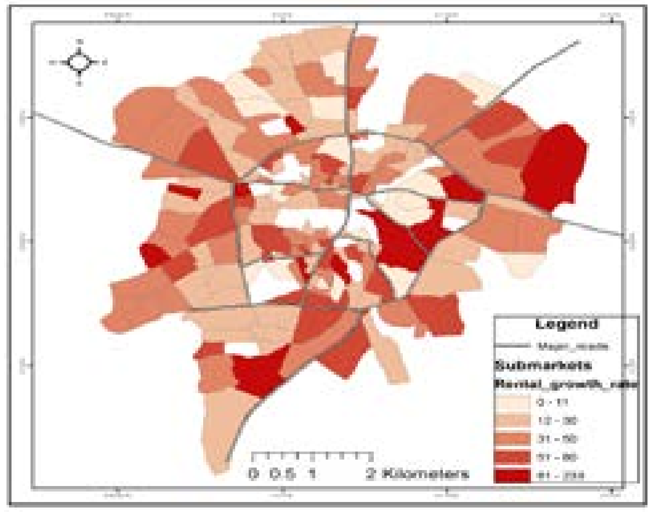

Figure 7: Rental Growth Rate of commercial properties Across the submarkets

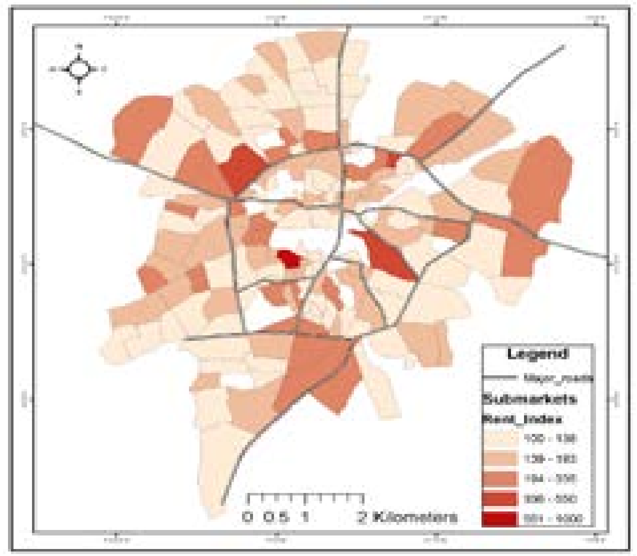

Figure 8: Rent Index of commercial properties across the submarkets

3.2. Suitable Locations for commercial property Investment in the study area

AHP was used to provide a structured map by ranking the suitable locations for commercial property investments in the study area (see Figure 9). It systematically evaluated and prioritised the preferable locations accordingly. The results were ranked from highest to lowest, with the highest ranking being from 176.7 to 212.2 located in the core city centre and the lowest ranking being from 1.001 to 47.38 located on the outskirts of the town. This indicates that the highest-ranked is located in the city's core centre, while the lowest-ranked is located on the outskirts of the town. This finding was able to establish the best locations for commercial property investment; it is one of the areas that previous studies did not explore, which contrasts with the findings of Thilini et al. (2021) where commercial real estate development risk was analysed without the provision of map showing location with potential risks. It also contrasts with findings of Aihie et al. (2023) which was designed to establish the use of the AHP approach as a support tool for deciding property appraisals using property investment comparables, yet, no spatial visualisation of the locations for decision making. One of the major contribution of this current research is the integration of AHP into GIS environment and establishing the best locations for commercial property investment.

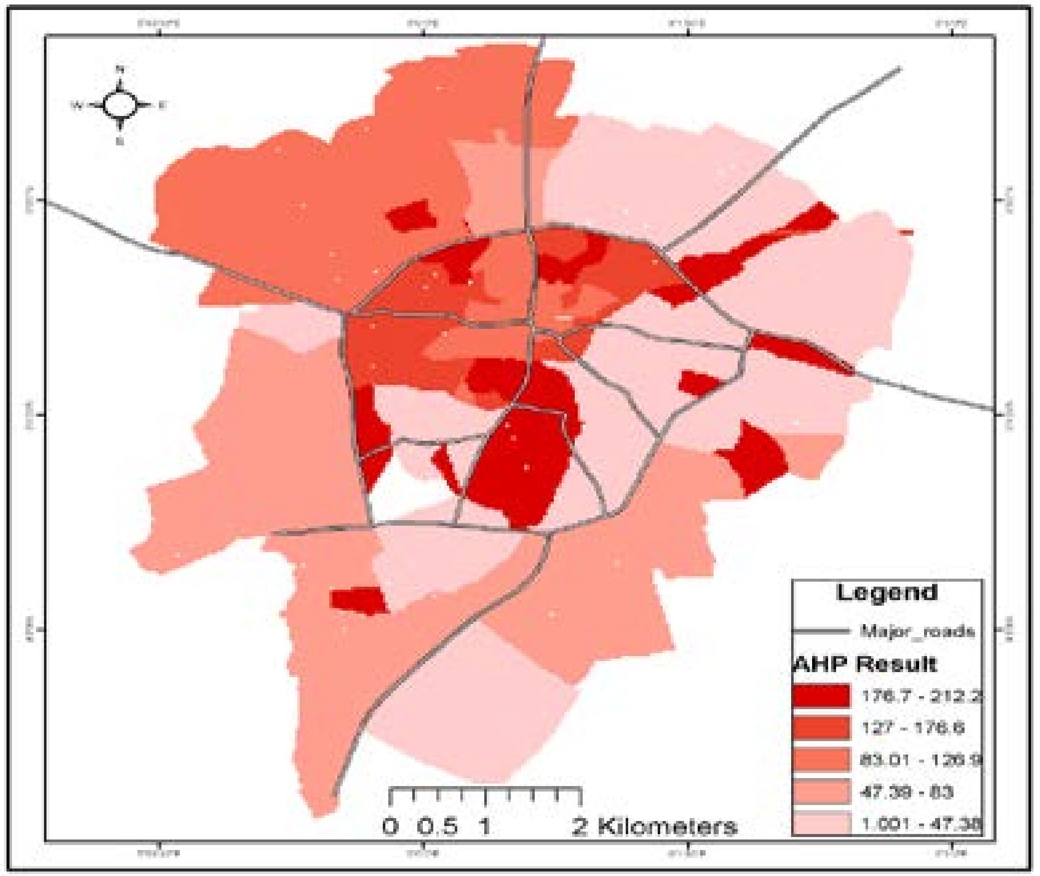

Figure 9: Analytical Hierarchy Process

4. CONCLUSIONS

This study demonstrates the significant potential of GIS in enhancing commercial property investments decisions. By leveraging GIS tools such as AHP, the study effectively identified prime locations for commercial property investments. The study concludes that the best locations for commercial property investments are closer to the central business districts. Also, the ability to visualize the study's results on maps provided clear and accessible insights into where commercial properties can be invested. The findings confirm that GIS is a valuable and applicable tool for identifying suitable locations for commercial property investments, offering a robust approach to decision-making in this field. To generalise the applicability of GIS in commercial property investments decisions, the study recommends that similar studies should be conducted in different geographic regions and market conditions. Comparative analyses can reveal region-specific trends and variations, offering valuable insights into how GIS-based methodologies can be tailored to diverse real estate markets. This can help investors adapt strategies to different locales and improve the robustness of investment decision-making.

However, the study is limited by its focus on a single geographic area, which may constrain the generalizability of the findings. The spatial dynamics and investment factors considered may not fully capture the complexities of other urban contexts or market conditions. The study is also lacks tenant perception data, relying on property managers reports. This study however, presents a GIS-AHP based spatial model that enhances investment decision-making accuracy in under-researched secondary urban markets.

5. ACKNOWLEDGMENTS

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