Analysis of Secondary School Infrastructure Distributions in Osogbo Metropolis, Nigeria

Olayode Olayiwola[a*], Ogundahunsi Dele Sunday[a], Gasu Martins Binde[a] Adedotun Samuel Babatunde[a], Olayode Christiana[a]

[a]Urban and Regional Planning, Osun State University, Osogbo, Nigeria

Abstract

This study analysed the geospatial distribution of secondary schools infrastructure in the Osogbo metropolis, Nigeria, with a focus on evaluating accessibility and spatial patterns of school locations. By examining the spatial distribution, travel distances, and clustering of schools, this research offers a novel contribution to the educational planning literature. The data were collected through both primary and secondary sources, utilizing total enumeration for spatial data and a sampling frame of 17,595 students and 452 teachers across 120 public and private secondary schools. Using a balloting approach, at 15%, 19 schools were sampled, followed by a random sampling technique to choose 5% of students and staff, resulting in a total of 906 respondents (880 students and 26 teachers). The analysis, employing Moran's I Index, revealed a value of 0.75 and a p-value of 0.14, indicating a random distribution of schools with a z-score of 1.45, falling within the expected range. The average distance traveled to schools was 1.582 km, reflecting spatial inequities in accessibility. This study provides critical insights for policymakers, emphasizing the need for both public and private stakeholders to ensure equitable distribution and accessibility of secondary schools across Osogbo metropolis.

Keywords: accessibility; geospatial distribution; secondary school

1.   Introduction

Education is a fundamental human right that opens doors to greater social, political, economic, and cultural benefits of human and national development through the available facilities (Akomolafe & Adesua, 2016; Nicolaou, 2023). It is also a prerequisite for the realization of other rights (Akomolafe & Adesua, 2016; Undie & Anake, 2017; Julianti et al., 2021). In view of the transformational attributes and potent nature of education, it therefore, promotes fairness in the society, the rule of law and a reduction in income disparities and inequality, all of which contribute to the creation of equitable societies (Aliu et al., 2012). To advance justice and efficiency, the study of Alimi et al. (2012) emphasized the necessity of improving the educational system by making available adequate educational facilities. However, educational facilities refer to physical structures used for education including primary and secondary schools, colleges, universities, academies, childcare centers, and nurseries (Nicolaou, 2023). They also contain student housing, cafeteria rooms, libraries, and support facilities (Mogea, 2023). As stated by UN member states in 2015, the fourth goal of 2030 for sustainable development is to guarantee that all people have equitable and equal access to high-quality education for the duration of their lives. However, the ability of the educational system to provide every student, regardless of gender, ethnicity or tribe, socioeconomic background, or place of residence, with equal accessibility to get the greatest possible results in terms of academic skills is known as equity in education.

In order to accomplish this goal, it is now crucial to monitor the educational outcome and comprehend the spatial distribution and variation that exist in space. This emphasizes the significance of the large-scale assessments, which can ensure that secondary school students, staff, and other stakeholders have an equitable distance to travel before accessing the

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*Corresponding author. Olayode Olayiwola.

E-mail address: olayiwola.olayode@uniosun.edu.ng.

educational facility (Arinze, 2019; Julianti et al.*,* 2021). The importance of equitable access to education might affect the quality of education in terms of turning influences attendance and academic performances. Secondary school education is a crucial educational stage standing between primary education and higher education or colleges, polytechnic and universities among others, hence, it is a critical stage that requires attention to ensure monitoring of the students' movement to and from their respective schools.

Previous studies have emphasized the role of spatial distribution in the accessibility of educational facilities. For example, Aliyu et al. (2013) and Fabiyi et al. (2015) highlighted the challenges posed by unequal distribution of schools in different regions, noting how long travel distances to educational institutions can hinder access, particularly in underserved areas. Similarly, Ogundahunsi et al. (2018) pointed out that the spatial placement of schools often reflects broader socioeconomic inequities, with public schools typically clustered in certain areas while private schools are randomly dispersed. While these studies provide valuable insights, they fall short of offering a comprehensive geospatial analysis that combines both public and private secondary schools to assess accessibility on another level.

The problem of inadequate secondary schools is aggravated by location inequalities in the location of the few available schools. The spatial disparity in the distribution of secondary schools is most severe in conurbated areas like the Osogbo metropolis. Moreover, this metropolis is comprised of three different local governments which might affects different local policies according to accessibility and education needs. Thus, this study analysed the spatial and geo-accessibility of secondary schools in the Osogbo metropolis, Nigeria to determine the school's distribution in the study area. In order to achieve this goal, three objectives were carried in the research study area; (1) identify the spatial location of secondary schools, (2) examine the spatial distribution of secondary schools, and (3) evaluate the distance travels to access secondary schools.

2.   Methodology

2.1   Study Area

The study area in this research is Osogbo metropolis, serves as Osun State's state capital, one of Nigeria's largest cities. It is a metropolitan area that is among the oldest municipalities and is expanding at an extremely rapid pace. The metropolis has experienced economic and physical growth since the state's establishment on August 27, 1991. It sits between latitudes 7°77' and 7°48' north of the equator and between longitudes 4°33' and 4°35' east of the Greenwich Meridian in South-Western Nigeria. The city of Osogbo is located 391 meters above sea level. The city is located roughly 50 km southeast of Ikire and 45 km northeast of the historic Yoruba town of Ile-Ife. According to Osun State Ministry of Education, there are a total of 120 secondary schools in the metropolis, including 28 public secondary schools and 92 private secondary schools. The Osogbo Metropolis map (Figure 1).
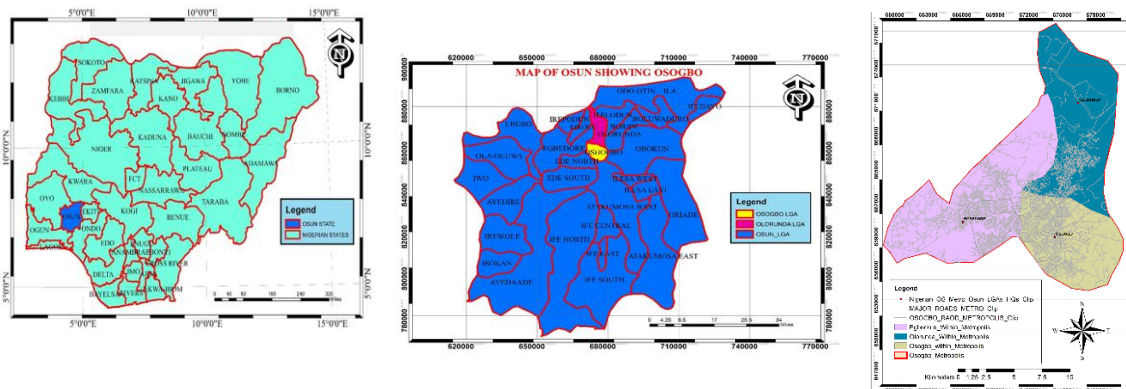

Figure 1. Study Area Map (URP GIS Laboratory UNIOSUN, 2023)

2.2   Methods

This study gathered primary and secondary data. Primary data were collected directly from teachers and students in the sampled schools, while secondary data were obtained from sources such as the Ministry of Education, Osun State, and other relevant publications on spatial planning, accessibility, and school planning. The total population used in this reseaerch consisted of 17,595 students and 452 teachers from 120 public and private secondary schools in the Osogbo metropolis. Balloting approach at 15% was used to randomly select 19 secondary schools from the total population of schools in the Osogbo metropolis, ensuring fairness and randomness in the sample. By using this approach, it helps eliminate bias in the selection process, making the sample more representative. A simple random sampling techniques were then used to choose 5% of the students and staff for data collection, giving a sample size of 880 students and 26 teachers (906 respondents). It is worthy of note that the school selection, students and staff members were rounded up to the next figure where decimal places are encountered. The selection of samples (Table 1)

Table 1. Selections of schools for sample and respondents for questionnaire administration (Ministry of Education, Osun State and Author's computation, 2023).

S/N	School Category and Status	Number of Selected Schools (15%)	Students Enrolment	Student selection at 5%	No. of Staff	Staff selection at 5%	Total
1.	Public Secondary Schools	28 (5)	11,300	**565**	191	**10**	**575**
2.	Private Secondary Schools	92 (14)	6,295	**315**	262	**16**	**331**
Total		120 (19)	17,595	880	453	26	906

Data were analyzed using cross-tabulation and chi-square to evaluate significant relationships between the sparial distribution of schools and the distance traveled, also geospatial analysis using Moran's I index analysis to examine the spatial autocorrelation of school locations and identifying patterns in the spatial distributions to evaluate patterns expressed by spatial entities that could be culstered, random, or dispersed (Chen, 2013; Yakubu et al., 2019). All the schools' spatial coordinates (x,y) were generated using the Global Positioning System (GPS), integrated into the Geographic Information System environment and performed the Moran Index analysis through the spatial statistics tools. This combination of analytical and geospatial analysis was chosen to provide both numerical and visual understanding of distribution patterns, ensuring a rigorous analysis of school accessibility across the Osogbo metropolis.

3.   Literature Review

3.1   Education and The Importance to National Development

According to Olamiju & Olujimi (2011), in many regions of the world, education has been the catalyst for socioeconomic change. Having access to educational resources is essential to developing the literate population needed to advance a country. According to UNICEF (2010), Nigeria's literacy rate is predicted to be 61.3%. Nigeria must restructure its educational system if it wants to realize its goal of ranking among the world's greatest economies by 2030. To ensure equity in the distribution or provision of these facilities, one approach to achieve this is to have accurate information on the placement and distribution of educational facilities across the nation's political areas. Illiya et al. (2020) state that the public sector advocates for the provision of education as a worldwide social service. The location of such educational facilities

affects how well they are used and function. The decision to look for and use these facilities is also influenced by proximity to them.

3.2   *Spatial Distribution of Educationial Facilities*

The location of educational facilities is related to their spatial distribution. The degree to which facilities are accessible to customers is significantly impacted by their position in space. Christaller (1993) made it quite evident that the location of services affects how often people use and patronize them, as well as how far they are prepared to travel to get there. According to Michael et al. (2008), a facility's level of accessibility increases with distance from its target. This implies that the degree of accessibility is influenced by spatial dispersion. Longer distances created by users of educational institutions in any geographic location, according to Michael et al. (2008), represent hurdles to the accessibility of such facilities.

According to Fabiyi & Ogunyemi (2015), if geographical distribution problems are resolved, the issue of low enrollment in post-primary school education will also be resolved because of the reduced distance. Data from Kucerova & Kucera (2012) provide credence to this conclusion. In the second half of the 20th century, Kucerova & Kucerova (2012) looked at how the spatial distribution of elementary schools changed in Czechia and how these changes affected the way rural communities functioned. They pointed out that a wide range of general processes are connected to and have an impact on the elementary schools' spatial distribution, the configuration of their catchment regions, and the local and regional communities. They discovered a correlation between the type of settlement growth in the communities and both the decline in the number of elementary schools and the rise in the concentration of primary schools in larger population centers.

Fabiyi & Ogunyemi (2015) observed that distance is a factor influencing trade between nations, drawing on the gravity model. Building facilities and making investments in ICT-related infrastructure would be necessary to close this gap in post-primary education and support online learning. According to the status of post-primary education, these communities would first need to determine the gap in facilities that exists at the primary school level. According to Ogundahunsi et al. (2018), accessibility is indexed by distributive equity in infrastructure, such as educational facilities. Essentially, the degree of justice in the spatial distribution of educational facilities determines the accessibility of those facilities. Thus, disparities in the distribution of facilities are extremely important, especially in poor nations where there are two issues: a lack of facilities and low personal mobility (Ogundahunsi et al., 2018; Olayode et al., 2022). These issues would have an impact on primary education accessibility.

The study in view of school mapping is an assessment of the current location of schools and where schools have been absent (Olayode et al., 2023). The main objective of this strategy is to guarantee a fair distribution of schools. The Ministry of Education is in charge of or oversees educational mapping. Government and private schools are commonly considered to be required to adhere to these requirements in order to provide the targeted users, including students and staff, with high-quality and reasonably priced education (Owuamanam, 2015; Mustapha et al. 2016). In order to guarantee fair education for particular groups and raise the quality of their education, Zhang et al. (2020) research indicates that it is critical to assign schools in a manner that is suitable for the relocated children of migrant workers.

4.   Results and Discussion

4.1   *Spatial Analysis of Secondary Schools in Osogbo Metropolis*

Based on the Moran's Index calculation, it shows that the overall distribution of both public and private secondary schools in Osogbo metropolis were randomly distributed. The randomness result could be traced to the involvement of private individuals, groups of individuals and religious organisations among others supporting the effort of the government in the establishment of schools in the study area. Moreover, a threshold distance of 1.582 km distance covered by secondary school staff and students in the study area is a reflection of random distribution which established the germane contributions made by private individuals, groups of individuals and organisation in the provision and establishment of secondary schools in the study area to reduce and ameliorate the risk involved in the distance traversed before having access to secondary school education in Osogbo metropolis. Hence, the effort of private providers of educational facilities supporting and complementing government efforts by making education accessible to prospective candidates cannot be jettisoned but regulated and encouraged to ensure further delivery of quality education to all. The distance threshold for each secondary school type (Table 2)

Table 2. Moran's Index of Secondary Schools Distribution is Osogbo Metropolis (Author's Fieldwork, 2023)

School Type	Moran's Index	Expected Index	Variance	Z-score	P-value	Distance Threshold
Public	0.398646	-0.037037	0.016340	3.408	0.000	3723.039
Private	0.790546	-0.010989	0.446399	1.199	0.230	1582.300
Study Area	**0.460832**	**-0.005319**	**0.017892**	**3.484969**	**0.000**	**3541.744**

The table explains that public schools tend to be located close to each other as is statistically significant clustering. On the other hand, private schools also show some clustering, even it is not statistically significant. Overall, the combined distribution of both public and private school threshold shows that public public schools users travel further on average than private school users.

4.1.1   *Public Secondary Schools in Osogbo Metropolis*

Spatial location of public secondary schools in Osogbo mteropolis identified by mapping the distribution. There are 28 public schools that found in the study area (Figure 2).
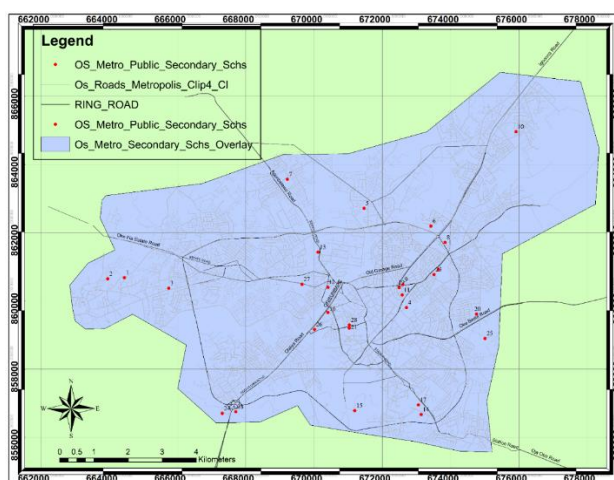

Figure 2. Geospatial Map of Public Secondary Schools in Osogbo Metropolis (Author's Fieldwork, 2023).

Refers to public schools distributed above, then the spatial autocorrelation was conducted. Analysis of pattern distribution of public secondary schools in the Osogbo metropolis (Figure 3).
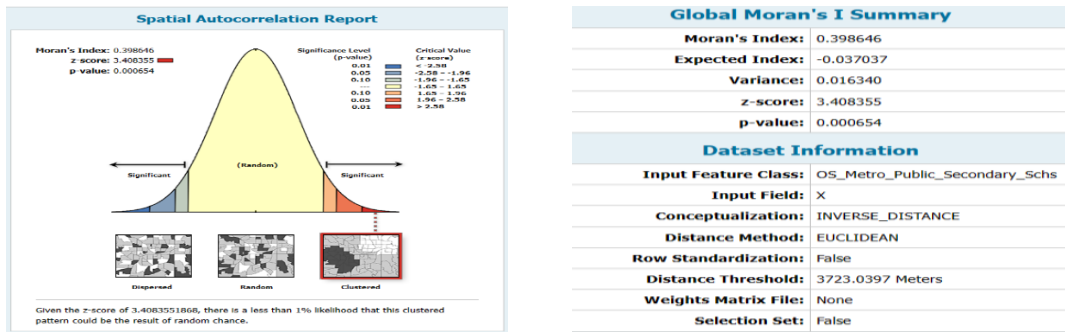

Figure 3. Spatial Autocorrelation Report of Public Secondary Schools in Osogbo Metropolis (Author's Fieldwork, 2023).

Based on Figure 2 above, yielded the Moran's Index of 0.398 and p-value of 0.00, the result is significant as the p-value is less than 0.05. The findings thus, imply that the distribution of public secondary schools in the Osogbo metropolis is clustered rather than randomly dispersed. The z-score of 3.40 falls above >2.58 as a result of a p-value of 0.000, (denoting +0.0 standard deviation away from the mean) which is less than 0.05 critical levels; hence the likelihood that this clustered pattern could be the result of random chance. Therefore, the distribution of public secondary schools in the Osogbo metropolis is clustered and gives several implications for educational accessibility in the region. The clustering pattern indicates that certain areas of Osogbo metropolis are better served with public schools, while other regions may be underserved or completely lacking in such facilities. Moreover, the clustering of schools in some spesific areas might contribute overcrowding and leads to other urban challenges.

4.1.2 *Private Secondary Schools in Osogbo Metropolis*

As well as public schools, spatial location of private secondary schools in Osogbo metropolis identified by mapping the distribution. There are 92 of private secondary schools that found in the study area (Figure 4).
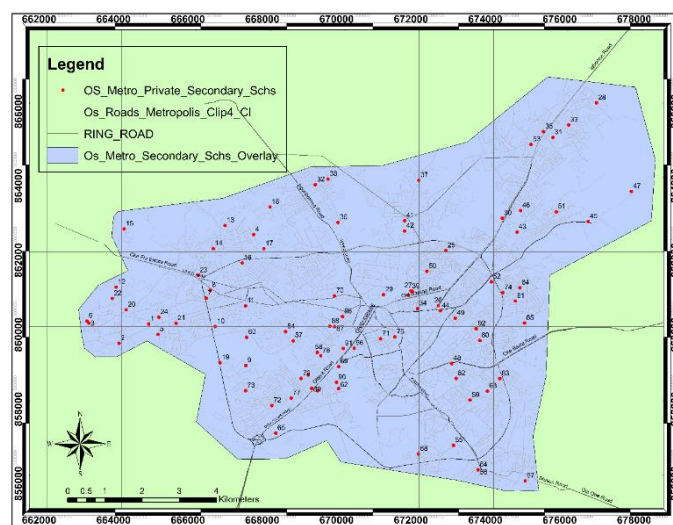

Figure 4. Geospatial Map of Private Secondary Schools in Osogbo Metropolis (Author's Fieldwork, 2023).

Analysis of the pattern of distribution of private secondary schools, yielded Moran's I Index of 0.79 and p-value of 0.23. The result is not significant as the p-value is above 0.05. The findings thus, imply that the private primary schools in Osogbo metropolis were randomly distributed. The z-score of 1.19 falls between 1.65 and 1.96 as a result of a p-value of 0.23, (denoting +0.23 standard deviation away from the mean) which is above 0.10 critical levels; hence the pattern does not appear to be significantly different than random. Therefore, the distribution of private secondary schools in the Osogbo metropolis is random as against public secondary school distributions that were clustered.
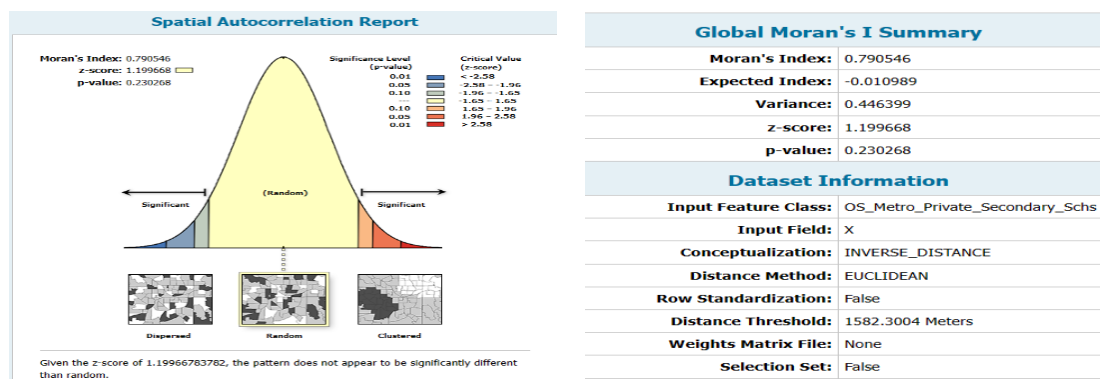

Figure 5. Spatial Autocorrelation Report of Private Secondary Schools in Osogbo Metropolis (Author's Fieldwork, 2023).

More so, findings further established a threshold distance of 1.582km average distance covered by staff and students at private secondary schools in the study area which is evidence of randomness distribution. This implies that private secondary school patrons in the Osogbo metropolis traveled a threshold distance of 1.582km before accessing private secondary schools compared to public secondary schools where staff and students traverse a threshold distance of 3.723km to access public secondary schools.

It can be deduced from the findings that private secondary schools are sited closer to patrons than public secondary schools in the Osogbo metropolis, hence, staff and students at public secondary schools travel farther to have access to educational facilities compared to that of private secondary schools. However, the distance threshold is less than the 4 km maximum distance from home to school as proposed by Vagale (1971).

4.2 *Distance Covered and Maximum Desirable Distance from Residence to Schools*

The distance covered by respondents to public or government owned and privately owned secondary schools in the Osogbo metropolis was examined in kilometers (km) ranging from less than 0.5 km to above 2 km as postulated by Vagale (1971). Findings revealed that the minimum distance covered by respondents was 0.4 km while the maximum was 3 km, where the average distance covered by schools was 1.7 km in the study area. Results as presented in Table 4 revealed that the majority of the respondents covered between 0.5 to 1 km distances with a share proportion of 48.4%, as much as 33.7% of the respondents' travels <0.5 km to public and private secondary schools, 10.1% of the respondents covered the distance between 1.1 to 1.5 km, 5.3% covered the distance above 2 km while the remaining 2.4% of the respondents covered between 1.51 km and 2 km in Osogbo metropolis. The chi-square analysis was also used to test the significant relationship between the distance covered by students to public and private secondary schools in the study area, the result indicates a significant difference in the distance covered by the respondents with $X^2 = = 742.491$; df = 12; p = 0 .000 < 0.05 (Table 3).

Table 3. Distance Covered by Students in The Study Area (Author's Fieldwork, 2023)

Distance Covered (km)		Public Secondary	Private Secondary	Total
			School Type	
<0.5 km	Count	265	32	297
	%	46.9	10.2	33.7
	% of Total	30.1	3.6	33.7
0.5-1 km	Count	187	239	426
	%	33.1	75.9	48.4
	% of Total	21.3	27.1	48.4
1.1-1.5 km	Count	57	32	89
	%	10.1	10.2	10.1
	% of Total	6.5	3.6	10.1
1.51-2 km	Count	15	6	21
	%	2.7	1.9	2.4
	% of Total	1.7	0.7	2.4
> 2 km	Count	41	6	47
	%	7.3	1.9	5.3
	% of Total	4.6	0.7	5.3
Total	**Count**	**565**	**315**	**880**
	%	**100.0**	**100.0**	**100.0**
	% of Total	**30.3**	**16.9**	**100.0**
$X^2 = 742.491$; df = 12; p = 0 .000 < 0.05 (S)				

Based on the table, it is known that different distance covered in both school types reveal the lack of comprehensive planning in the spatial distributions. It suggests that some urban areas may become oversaturated with educational institutions, while others remain underserved as its limited access. Further findings related to respondent's desirable distance established that most of the respondents wished to cover a distance between <0.5 km (57.5%), 0.5 km and 1 km (40.7%) in the study area. Chi-square analysis used to test the significant relationship of the maximum desirable distance from residence to school by respondents to public and private secondary schools in the study area, the result indicates a significant difference in the maximum distance desired to be covered by the respondents of public and private secondary schools in Osogbo metropolis with $X^2 = 402.824$; df = 12; p = 0 .000 < 0.05. This suggests that respondent's has different preferences regarding their willingness to travel to school. The distribution of schools in certain areas are likely influences the preference.

Findings from variance analysis (ANOVA) established that the distance covered by students to both public and private secondary schools in the Osogbo metropolis was statistically varied (0.008). This number explains that the distance students currently cover to reach public schools and private schools is not the same, which define the possible unequal access to educational facilities between two different type of schools. The F-ratios were found to have yielded a p-value that is less than 0.05 (p<0.05) significance level, which implies there are such differences in distances from students' residence to public schools than private schools.

The respondents' maximum desirable distance from home to schools also established a significant variation (0.000) between public and private secondary schools in the Osogbo metropolis with a p-value that is less than 0.05 (p<0.05) significance level. It means students have different preferences regarding how far they should travel to school. Based on the data, public school students may expect shorter travel distances, while private ones may be willing to travel further to school's activity nearby or its quality education. Findings therefore revealed that there is a statistically significant variation in the distance covered by secondary schools, as well as their preferred travel distances, which underlines the importance of school distribution planning and its accessibility in Osogbo metropolis.

5.   Conclusion

This study examined the geospatial distribution of secondary schools in Osogbo Metropolis, Nigeria. The study identified the spatial location of public and private secondary schools, the spatial distribution of the schools and the respondents' distance travels to access secondary school education in the study area. By using Moral's I Index and cross-tabulation, the results revealed that public secondary schools are clustered, while the private ones are randomly distributed, as well as the cumulative analysis for both. The findings showed significant variation over distance covered by students and staffs to reach both public and private schools, with implications for educational accessibility and equity in Osogbo metropolis.

The unequal distribution of schools represents that Osgobo metropolis does not have planning guidlines nor policies in terms of educational facilities distributions. It does not only affects access to education but also impacts broader socioecomonic outcomes, as education is a critical driver of national development. Therefore, the government and other stakeholders need to put the findings of the research into practice in order to successfully fulfill this noble responsibility of providing accessible secondary school education to the targeted users, especially those in undeserved areas. By doing this such research, it underscores the importance of planning guidlines for future educational development to ensure that schools are established in needed area so it minimizes travel distances.

Further research could explore more on spesific factors incluencing the clustering of public schools and the random distribution of private schools, such as land availability, economic conditions, and policiy framework. Additionally, research could focus on the long-term impacts of unequal access to schools on student performance and community development. By addressing these gaps, future studies can provide more targeted recommendations for improving educational equity in similar urban contexts.

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