An Assessment of the Impact of Public Infrastructure on Residential Property Values in Minna

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ABSTRACT

This study provides evidence on the value capitalization effect of public infrastructure in Minna. It employs rental transactions and datasets constructed from various secondary sources to provide information on geometric and spatial distribution of 4 groups of public infrastructure. Due to aggregation bias in these data sets, we utilize the quartile procedure to construct aggregate indices which capture the effect of the different infrastructure stock component but not infrastructure quality. The quartiles were used to compute location quotients for 12 a priori neighbourhoods, hence providing the basis for grouping and classifying neighbourhoods into low and high infrastructure neighbourhoods. A tenable statistical justification for this neighbourhood split by infrastructure is the Hodges-Lehman point estimate of shift (Δ) at 95.89 confidence level which is (−3.234,−11.072,−0.339) which revealed that the two classified neighbourhoods (low and high) are different . Findings revealed that geometric and spatial distribution of infrastructure is reasonably uneven across the study area. In addition, marked variability exists in quality of infrastructure between low and high-infrastructure neighbourhoods based on respondents' perceptual rating. The conjecture that high-infrastructure neighbourhoods have higher residential property values in contrast with that associated with low-infrastructure neighbourhoods was also found to be plausible. The capitalization effect of public infrastructure is evident in a falling market: high-infrastructure neighbourhoods significantly outperformed low-infrastructure neighbourhoods by N 14470, while in period of soaring property value, high-infrastructure neighbourhoods command N 57305.60 more than the low-infrastructure neighbourhoods. These findings have substantial implications for optimal location of public infrastructure and its capitalization into urban residential property value. To maximize this capitalization effect, policy makers and planners must efficiently allocate public infrastructure across space.

Keywords: Infrastructure Stock, Location Quotient, Neighbourhoods, Property Values, Rents

INTRODUCTION

Public goods such as infrastructure are location-specific and by extension not easily traded across space (Venables, 2009). Against this backdrop, infrastructure has continued to be spatially but disproportionately distributed. Beyond that, urban bias and primate city favouritism due to policy distortions (Henderson and Becker, 2000; Henderson, 2002a, Henderson, 2002b; Saiz, 2006) have further resulted in highly unbalanced infrastructure distribution and quality between urban centres and even within urban neighbourhoods. Majority of research in public economics has however long recognized the connection between public infrastructure investment and economic development. For example, the adequacy of Infrastructure affects quality of life, confers agglomeration benefits and impact on a nation's productivity outcomes and economic competitiveness (See, Röller and Waverman, 2001; Ling and Archer, 2005; Dechant and Finkenzeller, 2013). Globally, infrastructure requirements have been estimated at US$3 trillion per annum, with countries only able to meet one-third (US$1 trillion) of this sum in terms of current spending on infrastructure investment (OECD, 2010; UNCTAD, 2014). Various estimates (AFD and World Bank, 2010; UNDP, 2014) have however shown that, in contrast to the rest of the world, Africa currently has the largest infrastructure deficiency; and would need to invest between US$90-$120 billion annually until 2025 to fill this infrastructure gap. In sub-sahara Africa, expansion of infrastructure stock raises growth rate by 1.20% on annual basis, though reverse causation of infrastructure deterioration concurrently reduces annual net contribution

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to growth rates by 0.50% per year (Calderon and Serven, 2008). Nigeria a country within the sub-sahara region of Africa is not without its fair share of the problem.

Over a long term, passive commitment of public sector to infrastructure investment in Nigeria has precipitated a sharp decline in infrastructure growth in the economy. Further accentuation of this decline is the decrepit condition and benign neglect of existing urban infrastructure (Rioja 2003; Kalaitzidakis and Kalyvitis 2004; Banerjee et al. 2007) with such situations further deteriorating the insalubrious living and housing conditions in most urban centres. Infrastructure however is easily capitalized into house prices. This capitalization phenomenon according to Brueckner (2011) comes from a compensating differential such that increased property value is the resultant effect of urban infrastructure in urban areas where they are adequately provided and efficiently managed.

Against this background, we provide evidence in this paper of the residential property value impact of infrastructure stock and quality in Minna, North-Central Nigeria. In passing, we provide explanations for four (4) fundamental research questions: Is there inequality in the distribution of infrastructure stock across neighbourhoods? Suppose the presence of inequality, can neighbourhoods be classified into low-infrastructure neighbourhoods and high-infrastructure neighbourhoods? Perceptually, does infrastructure quality vary between low and high-infrastructure neighbourhoods based on residents' opinion? How do residential property values differ between high-infrastructure neighbourhoods and low- infrastructure neighbourhoods? Prior studies which used data on stock and quality of infrastructure have employed either principal component analysis (Calderon and Serven, 2004; Calderon and Serven, 2008; Seneviratne and Sun, 2013) or quartile approach (Hulten, 1996; Chong and Calderon, 2001) to construct aggregate indices which capture the effect of such infrastructure. Our paper utilize the quartile approach proposed by Hulten (1996) for only infrastructure stock component, due to paucity of robust data on infrastructure quality. This quartile approach avoids any aggregation bias and non-linear problem as it allows aggregate index to be constructed from data of different infrastructure. Previous studies in this area (Van de Walle, 2002; Duflo and Pande, 2007; Gonzalez-Navarro and Quintana-Domeque, 2010) have shown that selection bias may arise in infrastructure placement, as simple comparison of places with and without infrastructure in observational data might be misleading. Unlike those prior studies, we adopt a simple but intuitively plausible approach by employing location quotient to group and classify infrastructure into high-infrastructure neighbourhoods and low-infrastructure neighbourhoods. The Wilcoxon-Manny-Whitney rank sum test for inequality of samples is then used to compare whether the two groups of neighbourhoods are different. With this result we further conjecture that the distribution of residential property values should vary between high-infrastructure and low- infrastructure neighbourhoods.

LITERATURE REVIEW

Determinants of Urban Location and Property Values

A starting point in assessing the residential property value impact of public infrastructure is the theoretical construct of some underlying theories of urban dynamics. Central to theoretical discussions on location of urban infrastructure is the development of urban residential location choice theory. A useful insight into urban location theory, for instance, was the integration by Hurd in 1903 of Von Thunen theory of agricultural land use with the theory of land rent as formulated by David Ricardo for the analysis urban location activities. The highpoint of Hurd (1903) work was the application of the theory of economic competition to provide explanation for spatial variation in land value across urban landscape. Hypothetically, Hurd surmised that "since value depends on economic rent, and rent on location and location on convenience(infrastructure), and convenience on nearness......by eliminating the intermediate steps it can be concluded that value depends on infrastructure and nearness'' Given the assumption of market equilibrium, the optimal location of individual enterprise lies where the net profit is greatest (Losch, 1954). Intuitively, this implies therefore that location is the engine that drives real estate activities and values.

An understanding of the central role of neighbourhood location preference for public infrastructure comes from space-access (bid-rent) theory as postulation by Alonso. The standard access-space model formulated by Alonso (1964) for the analysis of urban land and property markets posits that housing and accessibility are jointly purchased and that it is only abstracting location specific activities, that households would lower their bid price for housing as commuting cost increases from the city centre. A simple modification of the standard access-space model to incorporate infrastructure is to define neighbourhood as the immediate area at any given distance to the centre (Straszheim, 1987). Suppose public infrastructure is exogenous at all locations and available without any charge, the hypothesis that rent gradients decline away from the centre may no longer hold. In such case, the utility function yields equilibrium rents, such that households are indifferent to locations. With better public infrastructure at more distant locations, the infrastructure effect may exceed the cost of friction and by extension the land rent gradient will be positive. This implies that urban residents may value distant locations with better infrastructure higher inspite higher commuting costs. The variation in rents and prices for such sites relative to similar sites is offset by the compensating differential in infrastructure.

A large theoretical body of hedonic literature on residential property market has pointed to the determinants of house prices. Several empirical contributions from this literature are deeply rooted in Rosen (1974) work. Studies by Can (1992), Basu and Thibodeau, (1998) and Paetz et al. (2008) suggest that house price is a function of packages of structural (dwelling size and age), neighbourhood and location (accessibility to service and other attractive points) neighbourhood (public utilities, sea view and school quality) attributes of the dwelling. However, quality location and neighbourhood amenities as aptly indicated by Tse (2002) induce better quality properties to be constructed and contribute to variation in price. The relationship between house price and location factors is the result of unobservable variation in shared infrastructure across properties. In his study, Tse further argued that house prices tend to be spatially autocorrelated because neighbourhood residential properties share public infrastructure and amenities. Such neighbourhood effects will be capitalised into the nearby house price in the house price determination process (Can, 1992; Goodman and Thibodeau, 1998; Kestens et al. 2006; Tu et al., 2007; Paetz et al., 2008).

Conceptual Issues in Public Infrastructure

Infrastructure has been variously defined as the collection of social, economic and physical facilities necessary for productivity and well being of economic units (governments, firms and individuals) of a nation (American Heritage Dictionary Editors, 2000; Nubi, 2002). According to Jerome (2006) infrastructure includes all public services as varied as education and public health to transportation, communication, power and water supply, as well as such agricultural overheads in irrigation and drainage systems. Against the background of this inexhaustible list, infrastructure has been classified under different thematic areas. For instance, unlike Obateru (2005) who grouped infrastructure into physical and social infrastructure, RREEF (2005) and Jerome (2006) classified infrastructure purely into economic (utilities, airports, power stations and pipelines) and social (healthcare facilities, education facilities and correction facilities) components.

In view of the fact that infrastructure is a congestible and non-excludable capital good that produces services for its users (Laan et al., 2000) public involvement in urban infrastructure provision and management becomes a necessity. In theory, the need for public sector regulation in infrastructure provision is due to the divergence between marginal social benefit and marginal social cost of infrastructure which must not be dictated wholly by the market (Canning, 2006). In the past, governments have employed a traditional approach to infrastructure development by promoting public sector infrastructure monopolies. With this approach, urban infrastructure development has not kept pace with urban population, resulting in infrastructure deficits in most urban settlements (Yan, 2000 and Fay, 2005). Consequently, governments' decision to cut expenditure on public infrastructure in recent times and engage in control of critical infrastructure through variants of privatization schemes has been termed as the contemporary approach to infrastructure development (Canadian Union of Public Employees, 2004).

In spite, the attended level of involvement of government, it is clear that satisfactory solutions have not been found to the deficit of infrastructure services as the governance of infrastructure service features high on the agenda policymakers and economists (Laan et al, 2000). In Nigeria and other developing countries, infrastructure provision and quality have remained a major challenge as a result of government's poor financing and insufficient political will to pull private participation (Otegbulu, 2014). In quest for solution, user groups, workers and the general public have been agitating for renewal and re-investment as public infrastructure crumbles. Most studies have therefore unearthed how communities have been renewing and or improving the dearth and decaying situation of public infrastructure. Jack and Morris (2005) for instance have stressed the concept of community-based networks or organisations; depicting how communities have organized themselves and developed capacity to tackle the complex issues of housing and infrastructure.

METHODOLOGY

The analysis in this study draws on various data sources from Minna Urban. The first is the Niger State Primary Health Care Development Agency, which provides a comprehensive list of public health facilities (hospitals, maternity clinics, primary health care centres and dispensary) and their spread across Local Government Areas (LGAs), political wards and neighbourhoods. The data comprise a sample of 16 health facilities currently owned and managed by the government in Minna. Secondly, Niger State Universal Basic Education Board records data on student enrolment by gender and the number of public primary and secondary schools in Niger State. From this record, an aggregation of 16 primary schools located within the study area was extracted. The data from Parks and Gardens Department of Ministry of Environment and Abuja Electricity Distribution Plc comprise a respective sample of 5 recreation centres and 142 electricity step-down transformers, geographically located across different neighbourhoods. Generally, the data constructed from these sources provide information on geometric and spatial distribution of 4 groups of public infrastructure: primary schools, health facilities, fire service stations and electricity transformers (proxy for electricity distribution capacity) in this study. Finally these datasets, which are mainly secondary in nature, were augmented with 2006 neighbourhood population and household data from National Population Commission. Projection at an annual growth rate of 3.80% (NPC, 2006) was subsequently made for the 9 year time lag covering 2006 to 2015.

Aside the secondary data, a survey based technique involving a designed 11 item structured questionnaire, was employed to obtain primary data on infrastructure quality from household heads (respondents) who are renters in the study area. By adopting cluster random sampling, the study area (consisting of 12 neighbourhoods) for the questionnaire administration was drawn from the *a priori* 25 neighbourhoods in Minna Urban. The selected 12 *a priori* neighbourhoods comprise: Bosso Estate, Tunga Low Cost, Barkin Saleh, Jikpan, GRA, Limawa, Minna Central, Shango, Tudun Wada South, Agwandaji and Dutsekura. The choice of these neighbourhoods for the study was further premised on the availability of robust data on public infrastructure stock in the Minna Urban. The number of questionnaire to be administered was based on 33871 households in the study area as at 2015. 3372 (10.99%) households were initially drawn from the total households in Minna in 2015. Of these, 1 out of every single household of 5 persons (NPC, 2006) is a household head. In passing, 745 household heads represent the active sample size in the study area.

Subsequently, we controlled for bias in the sample size and concluded that we are 95% confident that this estimate from the total population will be ±10.99% the margin of error (in this case, between 6.99% and 14.99% for a 4% margin of error). However, only 463 of the administered questionnaire were retrieved from the 745 household heads. This proportion of questionnaire retrieved gives an approximate total response rate of 62%. This response rate concurred with those reported by Willimack et al. (2002) for primary data collection. Table 1 shows the breakdown of the questionnaire administered, retrieved and the response rate.

The resulting survey, in addition to sourcing data on rental transactions (proxy for house price) for different residential property types (tenement, bungalow, flat and duplex) as well as demographic characteristics of the respondents, provided a perceptual rating of infrastructural quality in their immediate neighbourhoods. Respondents were requested to rate quality on a 5 point scale (with very poor assigned a score of 1; poor rated as 2; fair as 3; good as 4 and very good rated as 5). Table 2 provides a summary statistics which describe the characteristics of these 643 respondents for the study.

Table 1: Questionnaire Distribution to Household heads in the Study Area

S/No	Neighbourhoods	Household size (2015)	Sample size	Proportion of Household Heads	Questionnaire Retrieved	Response Rate (%)
1	Bosso Estate	447	207	42	42	100
2	Shango	747	254	51	38	74.80
3	Jikpan	2,153	326	65	41	62.88
4	Dutsen Kura	2,244	328	66	56	85.37
5	Barkin Saleh	1,436	303	61	45	74.26
6	Tunga Low Cost	1,059	282	56	34	60.28
7	Agwadaji	3,699	348	70	40	57.47
8	Tudun Wada South	5,283	358	72	42	58.66
9	Limawa	6,786	364	73	8	10.99
10	GRA	848	265	53	28	52.83
11	Minna Central	6,560	353	71	46	65.16
12	Tundun Fulani	2,609	335	67	43	64.18
	TOTAL	**33871**	**3372**	**745**	**643**	**62.18**

A starting point in the methodology employed for data analysis in this paper involves the estimation of location quotients on neighbourhood basis for the 4 groups of infrastructure stock. Location Quotient (LQ) is a quantitative measure of the relative allocation or the degree of concentration of a particular activity in a city and in a region as a whole. An infrastructure's LQ for neighbourhood i is given as:

$$LQ_i = \frac{Q_i}{Q_a} / \frac{Pi}{P} \quad (1)$$

Where Q_i is the quantity of infrastructure in neighbourhood i

Q_a is the total quantity of infrastructure in all neighbourhoods

P_i is the population in neighbourhood in i

P is the total population in all neighbourhoods

A $LQ > 1$ indicates that the local area is more heavily concentrated in that activity relative to its average across region. If $LQ = 1$, it means that the local area has its faire share in a particular activity. Although Morenikeji (1995) is one of the few authors in Nigeria, who have empirically demonstrated its application in the study of spatial distribution of social facilities, location quotient has been applied elsewhere in most regional economic base studies (See, Richardson, 1985; Brown et al., 1992; Coulson, 2006).

Before estimating the location quotients, we observe non-linearity and aggregation bias across the measures of infrastructure stock and dealt with this problem by grouping individual measure separately into quartiles. The 1st quartile is ranked 0.25, the 2nd quartile, 0.50 while the 3rd and 4th quartile is ranked 0.75 and 1.00 respectively. With these quartiles, we compute the neighbourhood location quotients for each of the 4 groups of infrastructure stock. In addition, the aggregate index of all infrastructure for a neighborhood is determined by simply averaging the location quotients. This quartile procedure is identical to that employed in Hulten (1996) study, which allows aggregate index to be constructed from data of different infrastructure.

Table 2: Descriptive Summary of Demographic and Socio-Economic Characteristics of Respondents

Variables	Variable Type	Mean	Standard Deviation
PANEL A (Continuous Variable)			
Annual Rent	Continuous	116452.40	**117097.10**
		Ist Quartile	***3rd Quartile***
		30000	***195833.30***
PANEL B (Binary/Categorical)			
		Frequency	**Percentage (%)**
Gender of Household Head:	Binary		
Female		131	**28.30**
Male		318	**68.30**
Missing Response		14	**0.40**
Age:	Categorical		
18-25years		122	**26.30**
26-35years		*171*	***36.90***
36-45years		104	**22.50**
46-55years		35	**7.60**
≥56years		20	**4.30**
Missing Response		11	**2.40**
Length of Stay:	Categorical		
1-5years		26	**5.60**
6-10years		45	**9.70**
11-15years		155	**33.50**
16-20years		193	**41.70**
≥21years		42	**9.10**
Missing Response		2	**0.40**
Occupation:	Categorical		
Artisan		36	**7.80**
Business		56	**12.10**
Farming		46	**9.90**
Civil Servant		266	**57.50**
Professional		39	**8.40**
Student		12	**2.60**
Missing Response		8	**1.70**
	No. of Sample	**643**	

Furthermore, it is plausible to estimate the infrastructure share of neighbourhood i that is excessive (E), since that is the only part of the infrastructure that brings the quotient above 1. This can be expressed as:

$$E = LQ - 1/_{LQ} \qquad (2)$$

Following the logic of the LQ in equation 2, we classify and group the 12 neighbourhoods into low-infrastructure neighbourhoods and high-infrastructure neighbourhoods. With this, we explore further the possibility of whether the neighbourhoods so classified are different because they have different location quotient patterns or that such observed differences are due to random sampling errors in our observations. The Wilcoxon- Mann-Whitney statistic tests the null hypothesis that the shift in location between the distributions of the populations is equal to zero. In other words, do the classified low and high infrastructure neighbourhoods come from population having identical distribution? A rejection of the null hypothesis would suggest that neighborhoods classified as low-infrastructure neighborhoods have more in common with one another relative to those classified as high-infrastructure neighborhoods.

On the basis of this classification, we examine the conjecture that infrastructure quality should vary between low and high-infrastructure neighbourhoods across the study area. Taking a cue from previous studies by Galster and Hesser (1981) and Ame'rigo (2002) that place users satisfaction at the heart of evaluation of quality of urban environment, respondents were asked to respond on the perceptual quality of their respective neighbourhood infrastructure using a five point likert scale ranging from 1 (very poor) to 5(very good). The frequency of responses for the classified low and high-infrastructure neighbourhoods were then weighted for each infrastructure to arrive at the composite(sum) quality score and subsequently, the weighted mean quality score for each infrastructure. Chi-square (χ^2) test was used to determine the relationship between respondents' responses on infrastructural quality across the classified neighbourhoods.

Finally, we applied one-way Analysis of Variance (ANOVA) with post-hoc comparison to test our expectation that high-infrastructure neighbourhoods are associated with higher house prices (proxy by house rents) than that associated with low-infrastructure neighbourhoods. As homogeneity of variance is one of the stringent assumptions underlying ANOVA, we hypothesized that the population variance for house prices would not hold due to the heterogeneity of the property type employed for the analysis. Brown-Forsythe's test for equality of group variance was therefore conducted to determine whether the house price mean for the classified neighbourhoods are approximately equal. On this basis, we applied Dunnett two tailed t-test to examine the individual comparison in residential property values between high and low-infrastructure neighbourhoods after conducting a standard analysis of variance test.

All analyses were estimated using Analyse-it version 4.20 and SPSS version 20 statistical packages.

FINDINGS AND DISCUSSIONS

Neighbourhood Location Quotients of Infrastructure Stock

The results of location quotients for all the 12 neighbourhoods arranged by infrastructure stock are shown in Table 3. These location quotient patterns have spatial manifestations. The first striking observation is that at a disaggregated level, the wide disparity in location quotients for the 4 groups of infrastructure across neighbourhoods did suggest a close relationship between infrastructure allocation and neighbourhood population. Unlike high-populated neighbourhoods, high location quotients are associated with low- populated neighbourhoods. For instance, with regards to the allocation of primary school, Bosso Estate (4.20), Agwandaji (12.01) and Tudun Fulani (16.81) which are less populated exhibit similar quotient pattern compared to densely populated neighbourhoods like Tunga Lowcost (0.38), Barkin Saleh (0.84), Jikpan (0.74) and Minna Central (0.25). Apparently, the geometric and spatial distribution of infrastructure is reasonably uneven across the study area with severe implications for sustainable urban growth. Unplanned residential location patterns, decentralised urban density and sporadic urban development are some of the spatial dimension to inequality issue in infrastructure distribution

Table 3: Neighbourhoods' Location Quotients for Infrastructure Stock in the Study Area

S/N	Neighbourhoods	Population	Primary School	Health Facilities	Fire Service Station	Electricity Supply	Mean LQ	(E)	Classification
1	Bosso Estate	816	4.20	5.40	16.81	4.54	7.74	0.87	High
2	Tunga Lowcost	9084	0.38	0.97	0.38	1.22	0.74	-0.36	Low
3	Barkin Saleh	8200	0.84	0.54	0.42	0.45	0.56	-0.78	Low
4	Jikpan	9238	0.74	1.43	0.37	1.20	0.94	-0.07	Low
5	GRA	5979	1.15	0.74	0.57	1.24	0.92	-0.08	Low
6	Limawa	5979	1.15	1.47	0.57	1.86	1.26	0.21	High
7	Minna Central	27272	0.25	0.16	0.50	0.41	0.33	-2.02	Low
8	Sango	9084	0.75	1.94	1.51	0.41	1.15	0.13	High
9	Tudun wada south	5979	1.15	1.47	0.57	0.62	0.95	-0.05	Low
10	Agwadaji	856	12.01	5.15	4.00	4.32	6.37	0.84	High
11	Dutsen Kura	9238	1.48	0.95	1.48	1.60	1.38	0.28	High
12	Tundun Fulani	816	16.81	5.40	16.81	9.08	12.03	0.92	High

Secondly, at an aggregated index level, the LQ patterns (third to the last column in Table 3) are nearly identical to the disaggregation. From this, the difference between neighbourhoods with over-concentration and those with less than fair share of infrastructure is straightforward to discern. With this bifurcation, neighbourhoods such as Bosso Estate, Limawa, Sango, Agwandaji, Dutsenkura and Tudun Fulani are tentatively classified as high-infrastructure neighbourhoods. Conversely, Tunga Low Cost, Barkin Saleh, Jikpan, GRA, Minna Central and Tundun Wada South are grouped as low-infrastructure neighbourhoods.

Table 4: Wilcoxon/Manny-Whitney Test of Equality of Means for Location Quotient of Low and High Infrastructure Neighbourhoods

Neighbourhoods	Wilcoxon Statistic	Hodges-Lehman Point Shift	P-Value
Low-High	21.000	-3.234 95.89CL (-11.072 to -0.339)	0.0022

The actual sign of the excess (E) as seen in the second to the last column in Table 3 further provides a tentative support for the classification of neighbourhoods by quotient patterns. However, the results of the Wilcoxon- Mann-Whitney test in Table 4 provide a consistent justification for this neighbourhood split by infrastructure. The Wilcoxon-Mann-Whitney statistic (21.000) with correction for ties indicates that the distributions of location quotients are statistically different between low and high infrastructure neighbourhoods at 5% significance level (P value < 0.05). Since the null hypothesis that the shift in location between the distributions of the populations is equal to zero (H_0: $\Delta = 0$) has been rejected, we extend the Wilcoxon- Mann-Whitney test by estimating the Hodges-Lehman point estimate of shift (Δ median $_{Low}$ - Δ median $_{high}$) to determine the direction and magnitude of such difference. The Hodges-Lehman point estimate of shift (Δ) at 95.89 confidence level which is $(-3.234, -11.072, -0.339)$ further reveals that the median location quotient for low-infrastructure neighbourhoods is stochastically lower than those of high-infrastructure neighbourhoods. Implicitly, the result implies that significant difference in location quotients exist between the two classified neighbourhoods, and by extension, low infrastructure neighbourhoods appears to have considerably low location quotients. This portrays that the two classified neighbourhoods (low and high) are different and therefore their observed LQ differences are not due to any unsystematic oddity in the data. This result sets the stage for the analysis of infrastructure quality as provided in Table 5.

Infrastructure Quality for Classified Low and High-Infrastructure Neighbourhoods

Table 5 shows the frequency of responses on infrastructure quality by neighbourhood class. Aside the evident high response (ranging from 96.33% to 99.57%) in opinion of the 463 respondents, the preponderance of respondents' responses on infrastructure quality oscillate between poor, fair and good perceptual rating.

Table 5: Frequency of Responses on Quality of Infrastructure in Low and High Infrastructure Neighbourhoods

Quality	Very Poor	Poor	Fair	Good	Very Good	Valid Responses	Percentage of Responses
				N=463			
Electricity:							
Low	39	56	95	37	5	232	50.11
High	17	36	100	62	9	224	48.38
Total	56	92	195	99	14	456	98.49
Fire Service:							
Low	36	97	44	29	26	232	50.11
High	28	55	80	42	9	214	46.22
Total	64	152	124	71	35	446	96.33
Public Health Facilities:							
Low	62	69	57	30	10	228	49.24
High	37	55	78	42	11	223	48.16
Total	99	124	135	72	21	451	97.41
Primary School:							
Low	12	36	71	91	26	236	50.97
High	16	21	103	75	10	225	48.60
Total	28	57	174	166	36	461	99.57

With these divergent rating in responses, the weighted means imputed from respondents weighted responses for the classified low and high-infrastructure neighbourhoods, however provide a clear-cut interpretation of respondents' opinion on infrastructure quality as seen in Table 6.

Table 6: Relatedness of Opinion on Quality between Low and High Infrastructure Neighbourhoods

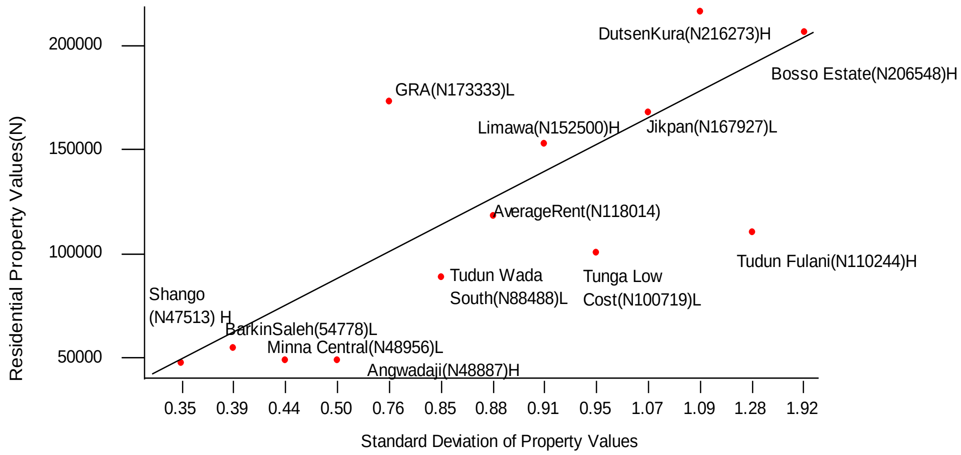
Quality	Very Poor	Poor	Fair	Good	Very Good	Sum	Valid Responses	Weighted Mean	Chi Square (χ^2)	Df	Sig. Level
Electricity:											
Low	39	112	285	148	25	609	232	2.63			
High	17	72	300	248	45	682	224	3.04			
Total	56	184	585	396	70	1291	456	2.83	15.74	20	0.733
Fire Service:											
Low	36	194	132	116	130	608	232	2.62			
High	28	110	240	168	45	591	214	2.76			
Total	64	304	372	284	175	1199	446	2.69	20.89	25	0.699
Public Health Facilities:											
Low	62	138	171	120	50	541	228	2.37			
High	37	110	234	168	55	604	223	2.71			
Total	99	248	405	288	105	1145	451	2.54	26.92	25	0.360
Primary School:											
Low	12	72	213	364	130	791	236	3.35			
High	16	42	309	300	50	717	225	3.19			
Total	28	114	522	668	180	1512	461	3.28	20.92	16	0.182

* The weighted responses are derived from the frequency of responses (with very poor assigned a score of 1; poor rated as 2; fair as 3; good as 4 and very good rated as 5).

A cursory look at the weighted mean of respondents' opinion apparently indicates marked variability in quality of infrastructure between low and high-infrastructure neighbourhoods. For instance, while relatively large weighted mean values are confirmed in high-infrastructure neighbourhoods, all of the weighted means observed in low-infrastructure neighbourhoods are much smaller. We explore whether consensus ratings of these infrastructure as depict by weighted means of the classified neighbourhoods are related in terms of the frequency of responses from the respondents. As evident from Table 6, the reported chi-square (χ^2) values of 15.74, 20.89, 26.92 and 20.92 for electricity supply, fire service, health facilities and primary school have corresponding p-values of 0.733, 0.699, 0.360 and 0.182. Since the p-values in all cases exceed the 5% rejection level, we confidently conclude that there are no significant differences in the respondents' opinion towards infrastructure quality and that respondents in the classified neighbourhoods are largely decided on this issue. Against this background, it can be concluded that infrastructure quality vary between low and high-infrastructure neighbourhoods based on residents percept in Minna.

Distribution and Variability in Residential Property Values for Classified Neighbourhoods

The historical performance of residential property values relative to the average rent and standard deviation across the 12 neighbourhoods is graphically presented in Fig. 1. During 2015 period, property values in 5 residential neighbourhoods (GRA, Limawa, Dutsenkura, Jikpan and Bosso Estate) outperformed the average residential property value (rent) in the 12 neighbourhoods. On the other hand, the average residential property value (₦118014) for all neighbourhoods is far more than the average returns for Shango (₦ 47513), BarkinSaleh (₦ 54778), Minna Central(₦ 48956), Angwadaji (₦ 48887), Tudun Wada South(₦ 88488), Tunga Low Cost(₦ 100719) and Tudun Fulani(₦ 110244).



*Property Values are presented in parenthesis. While L and H signify Low and High-Infrastructure Neighbourhoods

Fig.1: Distribution of Residential Property Values, 2015

Apparently, while residential property values in Shango, Barkin Saleh, Minna Central and Agwadaji are low and subdued, property returns in GRA, Limawa, Jikpan, DutsenKura and Bosso Estate are relatively high and exhibit much more pronounced volatility. This disparity however did not suggest any general pattern or close relationship between property value levels in low and high-infrastructure neighbourhoods. Furthermore, these general observations on property value performance are overly simplistic but can however be given some less hypothetical explanation by employing an empirical test for variability in residential property value across the study area.

The significance of the variability level in property values between the classified low and high-infrastructure neighbourhoods is tested by one-way Analysis of Variance (ANOVA). However, before turning to the ANOVA result, the Brown-Forsythe robust test for null hypothesis of equality of variance shows that the assumption of homogeneity of variance has been grossly violated. This implies that residential property values for the classified low and high-infrastructure neighbourhoods do not have identical population variance as the F-test statistic of 5.79 is greater when compared with a 5%, F(11,440).

The ANOVA result for variation in residential property values is shown in Table 7. Since the F-statistic of 18.48 is highly significant at 5% level of significance, this implies that high-infrastructure neighbourhoods have higher residential property values in contrast with that associated with low-infrastructure neighbourhoods. The strength of this contrast can be observed from the confidence interval of the mean difference in residential property value. The mean difference in residential property value which is ₦ 35887.80 (95% CL: 14470 to 57305.60) indicates that the true mean difference is between the lower limit of ₦ 14470 and the upper limit of ₦ 57305.60. Suppose a falling residential property market, high-infrastructure neighbourhoods significantly outperformed low-infrastructure neighbourhoods by ₦ 14470 while in period of soaring property value, high-infrastructure neighbourhoods command ₦ 57305.60 more than the low-infrastructure neighbourhoods.

Table 7: Variation in Residential Property Values in Minna

Contrast	Mean Difference	F-Statistic	Simultaneous 95%CL	P-value
High - Low	35887.80	18.48	14470 to 57305.60	0.0011

Neighbourhoods with strikingly differences in mean property values are revealed by the Dunnett 3T post-hoc test for pairwise comparison of residential property values between high and low-infrastructure neighbourhoods in Table 8.

Table 8: Dunnett Two Tailed T- Test for Individual Comparison of Residential Property Values

High Infrastructure Neighbourhood (I)	Low Infrastructure Neighbourhood (J)	Mean Difference (I-J)	Sig.	95% Confidence Interval	
				Lower Bound	Upper Bound
Angwadaji	GRA	-133012.5*	.000	-199295	-66730
Angwadaji	Jikpan	-124197.87*	.000	-188148	-60248
Bosso Estate	Tudun Wada South	122479.09*	.021	9390	235569
Bosso Estate	Minna Central	156509.32*	.000	47678	265340
Bosso Estate	Barkin Saleh	151912.70*	.001	43455	260370
Shango	GRA	-132075.68*	.000	-196595	-67557
Shango	Jikpan	-123261.04*	.000	-185170	-61352
Dutsenkura	Tunga Low Cost	113656.25*	.000	35262	192050
Dutsenkura	Tudun Wada South	133996.95*	.000	69915	198078
Dutsenkura	Minna Central	168027.17*	.000	113000	223054
Dutsenkura	Barkin Saleh	163430.56*	.000	109227	217634

*Mean Difference is significant at 5% level of significance

Out of the 36 possible contrast cases between high and low infrastructure neighbourhoods, only 11 neighbourhoods showed marked significant differences in their residential property values. From the mean difference of the Dunnett 3T test (column 3) in Table 8, it is evident that property values in high-infrastructure neighbourhoods like Angwadaji and Shango vary from those passing in GRA and Jikpan- which are low infrastructure neighbourhoods. Similarly, property values for such high-infrastructure neighbourhoods like Bosso Estate and DutsenKura differ from low infrastructure neighbourhoods of Tudun Wada South, Minna Central and Barkin Saleh. Property value in Dutsen Kura is also markedly different from that of Tunga Low Cost- a low infrastructure neighbourhood. On the other hand, there are no significant variations in property returns for Limawa and Tudun Fulani when compared with all the 6 low-infrastructure neighbourhoods (Result of the non-significant cases is available from the authors upon request).

CONCLUSION

This study has provided evidence on the residential property value impact of infrastructure by employing location quotient to group and classify infrastructure into high-infrastructure neighbourhoods and low-infrastructure neighbourhoods. Infrastructure provision tends to be unequally distributed across the study area. On the basis of this bifurcation of neighbourhoods, perceptual rating of respondents' opinion equally showed marked variability in quality of infrastructure between low and high-infrastructure neighbourhoods. Relatively large weighted mean quality values for instance are associated with high-infrastructure neighbourhoods compared with low-infrastructure neighbourhoods. Furthermore, property values tend to differ between the classified neighbourhoods: high-infrastructure neighbourhoods have higher residential property values in contrast with that associated with low-infrastructure neighbourhoods. Interestingly, these findings have substantial implications for optimal location of public infrastructure and its capitalization into urban residential property value. It is possible to argue for the existence of capitalization effect of public infrastructure in the study area as renter households tend to exhibit the willing to pay (WTP) higher property values in neighbourhoods with high public infrastructure level than neighbourhoods with low level of infrastructure provision. Although there are exceptions to this capitalization effect across residential space, a tenable justification as aptly stated by Duranton and Puga (2004) is the inefficient sharing of indivisible facilities such as local infrastructure.

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