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Research Article

FACTORIZING RESIDENTS' PERCEPTION AND UTILIZATION OF THE AVAILABLE GREEN INFRASTRUCTURE IN OSOGBO

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ABSTRACT

This work examines the factors of green infrastructure perception and utilization in Osogbo, Southwestern Nigeria. Primary and secondary data were used. Multistage sampling technique was also employed; Osogbo residential area was stratified into core, intermediate and suburban zones, (6) political wards out of (24) were selected across the zones and streets were also identified and systematically selected with the aid of Google Earth. (212) copies of questionnaire were administered on the 10th house head; (10%) of the total number of households). Correlation analysis was used in examining the association among socioeconomic characteristics, spatial, personal/social and economic factors. Kendall (τ) and Pearson's correlations (r) were used in analyzing the categorical and continuous data respectively. The work reveals shortage and uneven distribution of green infrastructure, classified the factors affecting residents' perception and utilization of green infrastructure as socio-economic, spatial, personal/social, level of satisfaction derived and rapid urbanization. It recommends provision and equitable distribution of green infrastructure, design and sustainable enforcement of eco-friendly master plan, collaboration among all levels of government, private bodies as well as environmental education.

Keywords: Green Infrastructure, Residents' perception factors, Utilization, Correlation and Factor analysis

INTRODUCTION

Urban green infrastructure is of strategic importance for human health, well-being and quality of life, especially in areas that have become increasingly urbanized. Having adequate access to green spaces can removes health inequalities, improves well-being, and fast track treatment of mental illness. Studies have also suggests that physical activity in a natural environment removes mild depression and reduce physiological stress (World Health Organization, 2020). Utilization of parks and green space helps residents physiologically and reduces the environmental impacts of the built environment (Van *at al* 2010 and Zhang, *et al*, (2012). Rapid rate of urbanization, limited accessibility to green infrastructure in terms of cost and time and lack of complementary facilities have influenced negatively the perception and utilization of green infrastructure. One of the major determinants of residents' utilization of green infrastructure is the satisfaction derived from it (Madureira *et al*, 2015; Popoola *et al,* 2016 and Ostoić *et al,* 2017). Factors influencing residents' satisfaction according to Madureira *et al.* (2015) are nearness to the respondent's residence, the walking time to reach the nearest public park from the respondent's home and work, and the frequency of using them. Others, as identified by Ostoić *et al.* (2017), are physical attributes, facilities, management, safety, comfort and maintenance as well as behaviour of other users. The study of Karanikola, *et al* (2016) revealed that residents' well-being is related to their satisfaction with urban green infrastructure. The study further revealed residents that considered themselves satisfied with their lives visited parks more frequently and for longer periods than the residents that were not satisfied with their lives. The identified studies on residents' satisfaction focused on Mexico, France, Greece and Portugal while the studies that examined the level of residents' satisfaction with green infrastructure are limited in the West African sub region and Nigeria in particular. Despite the important roles green infrastructure plays in community development, utilization rates of green infrastructure have been low due to poor residents' perception (Green *et al,* 2012; Mayer *et al,*. 2015; Bos & Brown 2015). Some other factors that affect utilization in urban green infrastructure can be broadly categorized as biophysical and social factors Cook *et al*. (2012). The latter encompasses institutional, socio-cultural, and cognitive factors (Cook *et al*. 2012; Matthews *et al*. (2015). Institutional impediments include preventative rules and regulations, a lack of sufficient incentives, and economic or cost related issues. Socio-cultural barriers such as social status and social norms limit individual decision-making capacity and predispose individuals to particular landscaping activities. Cognitive factors such as environmental knowledge, values, perceptions, and attitudes influence perception and utilization of green infrastructure Matthew, (2015). Most studies have found that residents use or express a willingness-to-use green infrastructure if transactions costs are limited or made free. (Thurston *et al*. 2008; Thurston *et al*. 2010; Barnhill & Smardon, 2012; Green *et al*. 2012; Baptiste *et al*. 2015). Cost may be particularly relevant when considering the relationship between green infrastructure and socioeconomic status but the actual adoption and relatively good perception primarily occurred in high-income areas (Heynen *et al*. 2006; Ando and Freitas, 2011. Locke and Grove (2016) opined that cost may become a factor only when residents' income is considered. In addition to monetary cost, reducing other transaction costs may also promote green infrastructure perception and utilization. In the contrary, Baptiste (2014) opined that willingness-to-adopt and use green infrastructure is not in any way related to socioeconomic status the residents. In a nutshell, residents' perception and utilization of green infrastructure appears to be limited to immediate environmental benefits; aesthetic values, local storm water and urban temperature control which is primarily informed by negative personal experiences such as temperature variability, flooding and erosion, strong and disturbing wind but such experiences and perception about green infrastructure may not be sufficient or and guarantee effective utilization and satisfaction that may necessitate effective delivery of green infrastructure in the study area. This work examines the determining factors of residents' perception and utilization of the available green infrastructure in the study area.

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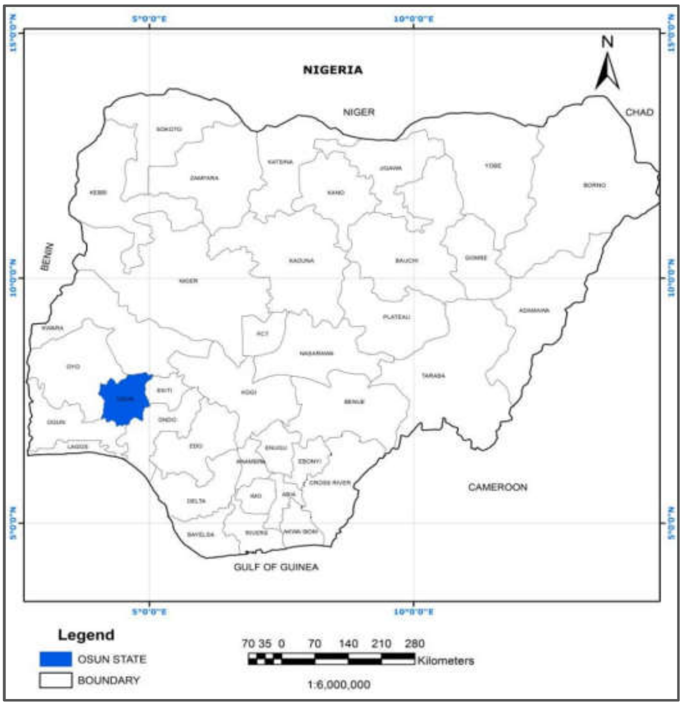
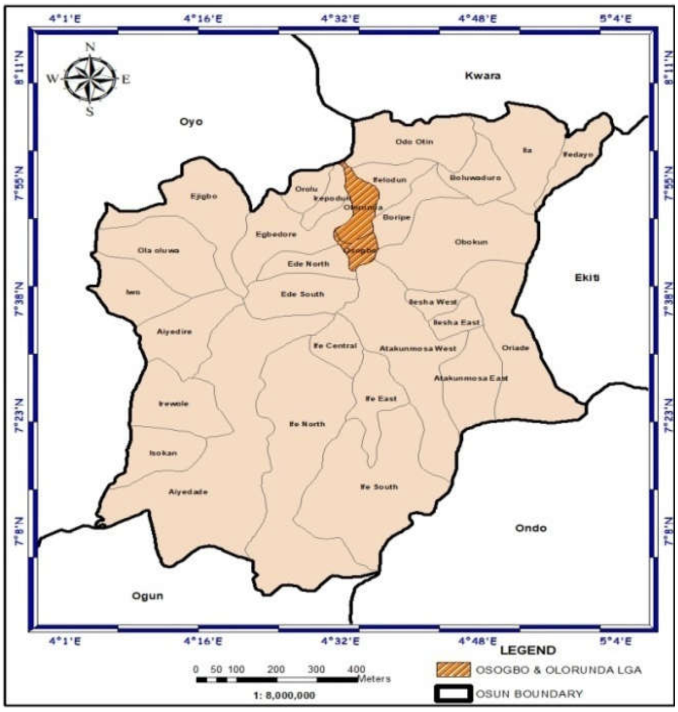
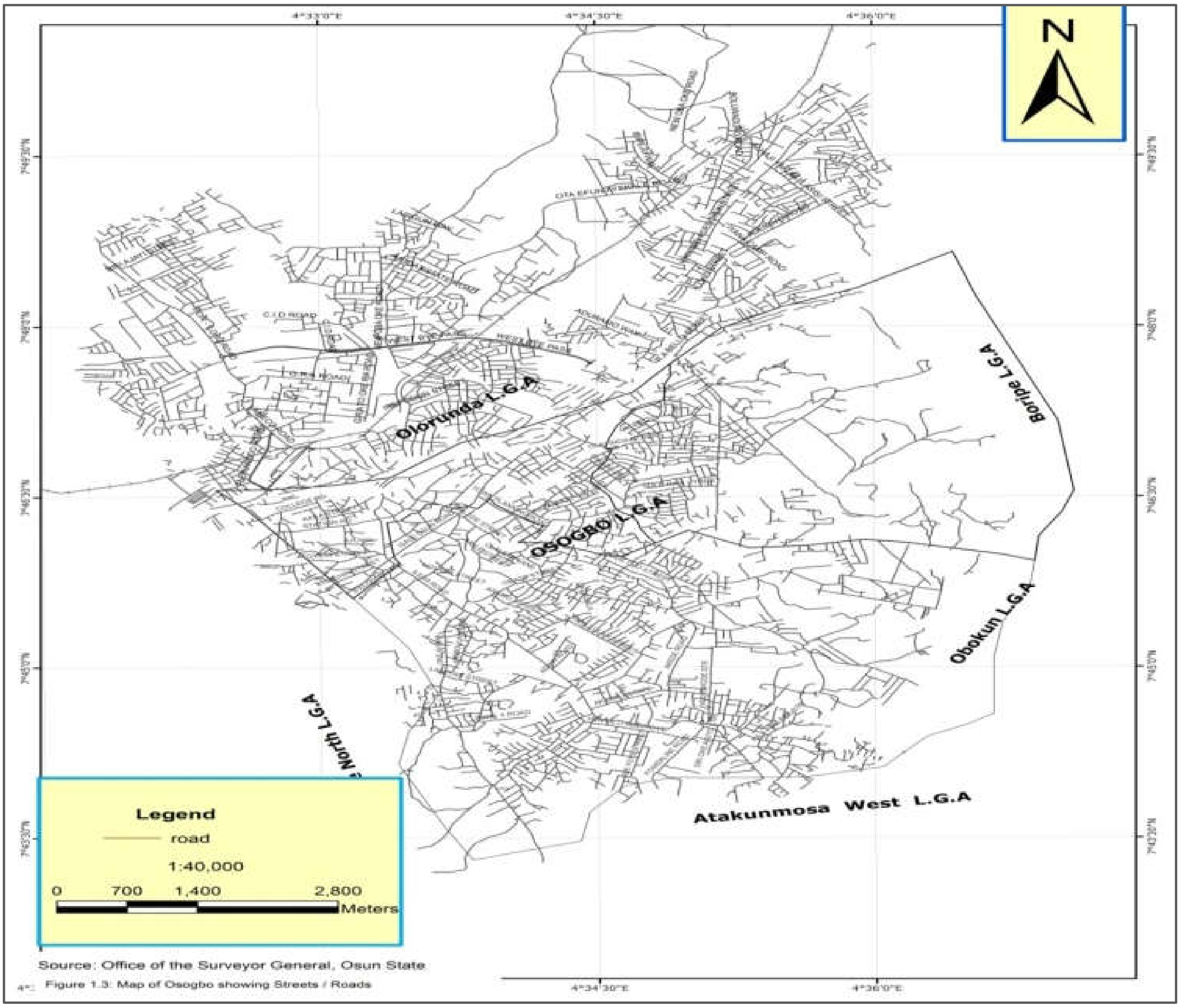




Source: Office of Surveyor General, Osogbo

Fig.1Map of Nigeria, showing Osun State

Fig. 2 Map of Osun Showing Osogbo



Source: Office of Surveyor General, Osogbo

Fig. 3 Road Map of Osogbo

The Study Area

Osogbo is the capital city of Osun State, Southwest, Nigeria located between latitude 7º46'N and 7.767ºN and longitude 4º34'E and 4.567ºE with an area of about 47kmsq. Osogbo is also the headquarters of two Local Governments: Osogbo and Olorunda with a projected population of 430, 1004 from National Population Commission (NPC, 2006). The city is mainly populated by Yorubas and has attracted other ethnic groups and Nationalities. See figures (1, 2 and 3). Among the notable green infrastructure in Osogbo includes is the Nelson Mandela Freedom Park. Agunbelewo; Gbongan-Ibadan Road; Jaleoyemi-Asubiaro, Oba-Adenle Garden Ayetoro area and Abere in Osogbo among others. The few available green infrastructures are poorly distributed among the different residential areas (see Figure 3). This might have contributed to poor perception and utilization.

MATERIALS AND METHODS

Primary and secondary data were used for the study. Multistage sampling technique was also adopted. Osogbo, the study area was stratifies into (a) The Core; Akogun, Atelewo, Owoope, Ataoja A, & B, Otun Jagun A & B, Alagba, Jagu A & B, Eketa, Ekeri and Owode 1. (b) The Intermediate Zone; Owode 11 and Balogun Ataoja C & D, Are-ago Otun-Balogun and (c) Suburban residential zone including Agowande, Ayetoro, Ataoja E and Babakekere. According to National Independent Electoral Commission (INEC), 24 political words exist in the study area, two (2) political wards were systematically chosen in each zones. Google Earth was used to map the area identified and to select the streets were copies of questionnaire were administered on the 10th house head making up the 10% of the total number of buildings in the chosen political words (see Tables 1and 2). The correlation analysis was used in examining the association between two or more variables. Correlation analysis was used in examining the association among socioeconomic characteristics, spatial, personal/social and economic factors. Kendall (τ) and Pearson's correlations (r) were used in analyzing the categorical and continuous data respectively. Factor Analysis was later used in reducing the observable variables into their latent variables. This was done in accordance with the laws of convergent and divergent realities. Convergent reality ensured that all the variables that were supposed to unite under the same factors united while divergent reality ensured that those that were expected to separate under different factors separated. In order to resolve the issue of collinearity between the predictors, Principal Component Analysis (PCA) was employed. The Kaiser Normalization test was used to determine the dataset suitability for factor analysis. A Varimax rotation matrix was conducted to ensure that the variables rearranged themselves in such a way that one of the components loaded highly on one of the original variables and loaded lowly on others. Rotation converged in 3 iterations and a two-component solution yielded clearly interpretable results. In order to predict the dependent variable accurately, multiple regression analysis was carried out based on the factors generated from the factor analysis. Thus, the dependent variable was residents' perception of infrastructure which was predicted with the factors.

Data Presentation and Discussion

It is one thing for infrastructure to be available; it is another for residents to derive satisfaction from such infrastructure. It is expected that the higher the importance attached to an infrastructure, the higher the satisfaction respondents would derive from it usage. Therefore, in order to critically examine residents' perception of available green infrastructure, the satisfaction that residents derived from available green infrastructure will be examined.

For ease of analysis, the green infrastructure utilization was measured through a personally devised index termed *Residents Satisfaction Index* (*RSI*). Residents rated the identified fourteen green infrastructure which were obtained through literature review using one of the five Likert scales of 'Very satisfied' (VS), 'Satisfied' (S), 'Unsure' (US), 'Dissatisfied' (DS), 'Very Dissatisfied' (VDS). The findings are presented in Table 3. In the study area, the green infrastructure that respondents' derived the highest level of satisfaction were parks (RSI_s= 3.55). Other green infrastructures arranged in the order of the satisfaction derived were outdoor sport fields, street trees, allotments, and green roof. The respective RSI were 3.37, 3.29, 3.10 and 3.09. (each of which is higher than the study area index (RSI_s= 3.08)).

The green infrastructure that respondent s' derived satisfaction less than the study area's average were; urban forests, home gardens, green corridors, public green spaces, rain gardens, blue roof, vertical greening, city square and plazas and cemetery and religion yards. In the core area, with an index of 3.97, 3.90, 3.69, 3.37, 3.32, 3.12 and 3.07 respectively (each of which is higher than the core residential area index (RSI_s= 2.94)), the green infrastructure that residents derive the highest satisfaction were: street trees, parks, outdoor sport fields, home gardens, allotments, green roofs, green corridors and urban forests. Similarly, in the transition area, the green infrastructure residents derived the highest satisfaction from were: 'outdoor sport fields', 'parks', 'street trees', 'allotments', 'urban forests' and 'green roofs'. The respective *RSI* were 3.15, 3.08, 2.86, 2.54, 2.29 and 2.21 (each of which is higher than transition area index (RSI_T = 2.12). Likewise, investigation in the suburban area confirmed that residents derived the highest satisfaction from parks (RSI_{is}= 3.67). Other green infrastructure that residents derive the highest satisfaction arranged in other of significance were: 'green roofs', 'green corridors', 'allotments', 'urban forests', 'home gardens' and 'street trees'. The respectively RSI were 3.50, 3.41, 3.41, 3.28, 3.18 and 3.03.

Factors Influencing the Perception of Residents of Green Infrastructure

In order to appreciate the importance of the degree of satisfaction expressed by residents, the 14 green infrastructures in table 4 were classified into four main groups using multi criteria analysis. This was adopted from Arianoutsou *et al* (2011). The four main groups were (a) indicators with positive deviation about the mean of GIII but with negative deviation about the mean of RSI (b) indicators with negative deviation about the mean of GIII but with positive deviation about the mean of RSI (c) indicators with positive deviation about the mean of GIII and RSI; and (d) indicators with negative deviation about the mean of GIII and RSI.

Group A: These were indicators considered to be very basic to human existence that is, they were with high importance to residents but the satisfaction derived from them was very low. These variables were public green spaces, rain gardens and green roofs. It can be deduce that the low level of satisfaction that residents derive from these green infrastructures with is very importance would strongly influence their perception about the infrastructure in the study area.

Group B: The second group of indicators was those not considered to be of high priority in meeting the needs of residents, but respondents' derived a very high level of satisfaction with them. The indicators in this category were parks, street trees, allotments, outdoor sport fields and urban forests This implies that these indicators would strongly influence respondents perception about the environment despite not seen as a priority.

Table 1. Selected Street within Residential Zones of the Study Area

Residential zone	Olorunda LGA		Osogbo LGA		Total No. of Sampled Streets	Total No. of selected Streets
	No of Streets	No of selected streets	No of Streets	No of selected streets		
Core	83	8	112	11	195	19
Transition	79	8	102	10	181	18
Suburban	62	6	46	5	108	10
Total	224	22	260	26	484	48

Source: Google Earth and Author's Field Survey, (2020)

Table 2.Number of Buildings in Selected Streets

Residential zone	No of Buildings	Sample Size (10%)
Core	846	85
Transition	715	72
Suburban	563	56
Total	2124	212

Source: Google Earth and Author's Field Survey, (2020)

Table 3 Satisfaction derived from Green Infrastructure in the study area

Green Infrastructure	Core	Transition	Suburban	Study Area
	RSI	RSI	RSI	RSI
Parks	3.90	3.08	3.67	3.55
Street trees	3.97	2.86	3.03	3.29
Outdoor sport fields	3.69	3.15	3.28	3.37
Allotments	3.32	2.54	3.41	3.10
Urban forests	3.07	2.29	3.28	2.88
Green roof	3.31	2.21	3.50	3.09
Home garden	3.37	1.91	3.18	2.82
Green corridors	3.12	1.42	3.41	2.98
Public green space	2.22	2.04	2.80	2.35
Rain gardens	2.81	1.69	2.67	2.39
Blue roof	2.09	1.84	2.62	2.18
Vertical greening	2.64	1.74	1.82	2.07
City square and plazas	2.23	1.80	1.78	1.94
Cemetery& religion yards	1.35	1.09	1.22	1.22
Mean Aggregate	RSIc = 2.94	RSI_T =2.12	RSI_S =2.91	RSIs=3.08

Source: Authors' Compilation (2020)

Table 4. Deviation about the means of GIII and RSI

Group	Environmental attributes	Deviation about FII	Deviation about RSI
A	Public green space	0.44	-0.71
	Rain gardens	0.39	-0.03
	Green roof	0.34	-0.07
B	Parks	-0.08	0.49
	Street trees	-0.08	0.71
	Allotments	-0.12	0.63
	Outdoor sport fields	-0.16	0.22
	Urban forests	-0.17	0.83
C	City square and plazas	0.35	1.05
	Green corridors	0.32	0.07
	Vertical greening	0.31	0.25
	Home garden	0.29	0.20
D	Cemetery& religion yards	-0.02	-0.54
	Blue roof	-0.53	-0.17

Source: Authors' Compilation (2020)

Group C: This group is made up of indicators considered by respondents to be important in satisfying their needs. These indicators were city square and plazas, green corridors, vertical greening and home gardens. These are highly prioritized facilities and a very significance influence on the perception about the environment. The absence of these facilities can force respondent to employ self-help.

Group D: In this group are indicators that respondents attached little or no importance to and satisfaction derived from them was also low. This was so as respondents improvised substitutes for themselves. Included among the indicators were cemetery and religion yards and blue roofs. Typical examples of these are people burying their love ones in front of their houses and convert every building available to religion yards in the study area.

Residents' Perception on Green Infrastructure in the Three Residential Zones of the Study Area

Residents' perception was assessed using a number of variables as factor that determines perception of respondents across the three residential areas under study. These factors were later categorized into four broad groups such as Socioeconomic Factors (gender, income status, length of residence, race/ethnicity, educational status, occupation and religious believe), Economic factors (significant impacts on job opportunity, increase the internal generated income of our LGA, significant impact on daily activities increase in tax payment and abject poverty), Spatial factors (Nearest to resident, availability, distribution, location), Personal/Social factor (increase in population/ Urbanization, preference of infrastructure, infrastructure type, high crime rate, effect on health, inadequate security, unemployment, government policy, satisfactory derive from the green infrastructure).

Table 5: KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.771
Bartlett's Test of Sphericity	Approx. Chi-Square	9097.402
	Df	378
	Sig.	.000

Table 6. Correlation matrix of selected variables used in factor analysis

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
1	1																											
2	.863**	1																										
3	.842**	.973**	1																									
4	.967**	.843**	.833**	1																								
5	.817**	.956**	.968**	.813**	1																							
6	.825**	.956**	.959**	.822**	.972**	1																						
7	.289**	.354**	.324**	.267**	.316**	.324**	1																					
8	.329**	.377**	.372**	.320**	.368**	.386**	.274**	1																				
9	.325**	.363**	.374**	.332**	.358**	.367**	.262**	.934**	1																			
10	.290**	.384**	.378**	.304**	.367**	.362**	.260**	.935**	.930**	1																		
11	.288**	.359**	.367**	.330**	.363**	.368**	.242**	.916**	.946**	.958**	1																	
12	.334**	.404**	.387**	.307**	.354**	.385**	.290**	.925**	.951**	.946**	.916**	1																
13	.257**	.367**	.389**	.263**	.369**	.375**	.204**	.336**	.344**	.354**	.349**	.355**	1															
14	.231**	.334**	.330**	.228**	.320**	.344**	.336**	.481**	.439**	.467**	.442**	.457**	.596**	1														
15	.202**	.291**	.290**	.205**	.285**	.294**	.329**	.216**	.285**	.225**	.236**	.264**	.463**	.306**	1													
I6	.246**	.354**	.375**	.278**	.376**	.362**	.319**	.196**	.204**	.210**	.207**	.177**	.349**	.357**	.408**	1												
17	.223**	.218**	.230**	.220**	.219**	.217**	.290**	.248**	.255**	.223**	.242**	.214**	.244**	.423**	.379**	.383**	1											
18	.194**	.262**	.214**	.202**	.218**	.194**	.311**	.097	.102	.111	.094	.093	.127	.250**	.335**	.373**	.409**	1										
19	.211**	.280**	.253**	.195**	.244**	.274**	.151*	.140*	.142*	.108	.112	.177**	.307**	.234**	.256**	.244**	.022	.309**	1									
20	.215**	.303**	.302**	.180**	.283**	.291**	.124	.166*	.124	.151*	.113	.160*	.304**	.255**	.213**	.287**	.076	.282**	.910**	1								
21	.180**	.262**	.291**	.185**	.291**	.304**	.100	.112	.146*	.121	.153*	.127	.274**	.212**	.226**	.295**	.079	.264**	.855**	.921**	1							
22	.169*	.246**	.245**	.152*	.233**	.252**	.113	.102	.098	.152*	.098	.137*	.244**	.186**	.191**	.258**	.045	.291**	.801**	.877**	.873**	1						
23	.168*	.276**	.296**	.173*	.293**	.300**	.099	.133	.126	.163*	.157*	.144*	.266**	.254**	.205**	.286**	.070	.282**	.830**	.929**	.951**	.873**	1					
24	.200**	.280**	.270**	.206**	.260**	.277**	.159*	.142*	.114	.135*	.132	.137*	.243**	.234**	.211**	.307**	.085	.336**	.882**	.913**	.879**	.853**	.883**	1				
25	.179**	.294**	.299**	.174*	.331**	.282**	.117	.111	.104	.161*	.147*	.102	.263**	.198**	.206**	.325**	.093	.313**	.779**	.902**	.889**	.822**	.888**	.899**	1	.		
26	-.005	.068	.052	-.014	.046	.080	.162*	.030	.017	.024	.036	.049	.169*	.271**	.232**	.254**	.218**	.086	.081	.065	.068	.038	.080	.122	.081	1		
27	-.111	-.070	-.070	-.123	-.078	-.070	.020	-.019	-.041	.001	-.013	-.008	.110	.047	.178**	.114	-.059	.105	.169*	.193**	.160*	.175*	.155*	.204**	.208**	.385**	1	.
28	.247**	.347**	.357**	.256**	.380**	.377**	.252**	.247**	.191**	.235**	.246**	.195**	.279**	.324**	.210**	.341**	.293**	.188**	.443**	.525**	.548**	.454**	.539**	.545**	.568**	.242**	.011	1

**. Correlation is significant at the 0.01 level (2-tailed). *. Correlation is significant at the 0.05 level (1-tailed).
a.Determinant = 2.659E-020
Table 6: Correlation matrix of selected variables used in factor analysis

Factor analysis used operates on the notion that measurable and observable variables can be reduced to fewer latent variables that share a common variance and are unobservable which is known as reducing dimensionality (Bartholomew *et al* 2011). Summarized in Table 5 are the results of Kaiser-Meyer-Olkin (KMO). KMO of 0.71 (71%) indicates that patterns of correlations are relatively compact and so factor analysis should yield distinct and reliable factors. According to Field (2005), the value of KMO should be greater than 0.5. The KMO value in this study was 0.71 which is within the range of being good. Then, there is confidence that factor analysis is appropriate for the data. Furthermore, the Bartlett's test is another indication of the strength of the relationship among variables. This tests the null hypothesis that the original correlation matrix is an identity matrix. The result of Bartlett's test was significant (p=0.000) using 5% level of significance. This further confirmed that factor analysis is appropriate.

Presented in Table 6 is the correlation matrix of factors on attraction component of residents' perception. The table contains Pearson Correlation Coefficient between all pairs of variables. It is important to eliminate multi collinearity (Variable that are highly correlated with other variables) and singularity (variables without correlation with other variables) in the data set. Therefore all variables in this data set correlated fairly well and only few among the correlation coefficients were relatively large and these cannot create multicollinearity and singularity in the data. Also, the determinant which is a good measure of determining the level of multicollinearity and singularity is 2.659E-020 as presented in Table 6, which is far greater than the value of 0.00001 as suggested by Field (2005). Presented in table 7 are the initial communalities of the factors before extraction through Principal Component Analysis (PCA) with an initial assumption that all variable are common with 1.000 each. After extraction, it was observed that each variable reflects common variance in the data set, which is evident in the proportion of the variance explained by the underlying factor. For instance, variable such as income status, available green infrastructure, length of residence, proximity to work and preference of green infrastructure have associated variation of 0.953(95.3%), 0.952(95.2%), 0.951(95.1%), 0.947(94.7%) and 0.945(94.5%) respectively. Other variables with lower associated variation are significant impact on job opportunity, abject poverty, satisfaction derive from the infrastructure, religious believe with 0.479 (47.9%), 0.457 (45.7%), 0.436(43.6%) and 0.382 (38.2%). It is expected that the communalities after extraction must be high for a reasonable representation. The average communality as computed from Table 7 is 0.775 (77.5%) which is substantial to perform Principal Component Analysis Interpreting factor loadings is key in Factor Analysis but one important decision is the number of factors to extract. Factor loadings are measurement of relationship between variables and factors. A rule of thumb as suggested by Tabacknick and Fidell (1996) informed that variable with loadings 0.32 and above may be interpreted. Comrey and Lee (1992) suggested a range of values to interpret the strength of relationship between variables and factors. Loadings of 0.71 and higher are considered excellent, 0.63 very good, 0.55 good, 0.45 fair and 0.32 poor. Thus, all items with primary loadings over 0.55 were observed for the factor analysis in this study.

According to Kaiser's criterion, five factors could be extracted (Gorsuch, 1983). However it is important to note that this criterion is appropriate when there is less than 30 variables and the communalities after extraction is greater than 0.7 (Field, 2005). This study satisfies the condition where 28 variables are loaded for analysis with average communality value of 0.775 after extraction and 212 sample size. Presented in Table 8 were the lists of the eigenvalues associated with linear component (factor) before extraction, after extraction and after rotation. Before extraction there were 28 linear components (same number as the available variables). The eigenvalue associated with each factor represented the variance explained by that particular linear component and also represented the percentage of variance explained. From the table, five factors with the initial eigenvalues of between 1.199 and 10.132 were extracted with 77.5% as total variance explained. Factor 1 accounted for 36.18% of the total variance explained in the original dataset; factor 2 accounted for 18.16% while factor 3, 4 and 5 accounted for 11.33%, 7.55% and 4.28% respectively. All factors with Eigen values above 1 were extracted and represented under the column extraction sums of squared loadings.

The last column of the table (labelled rotation sums of squared loadings), represented the eigenvalues of the factors after rotation. The rotation had the effect of optimizing the factors structure and one consequence for these data was that the relative importance of the five extracted factors was equivalent. Furthermore, the results presented in Table 8 showed the rotated component of matrix of respondents' perception in the study area. This table explained the structure of the variables that has been studied and was used in the reduction of the variable into five factors. It is important to note that variables loading about 0.50 have been highlighted. Also, only factors that had at least three (3) variables which were highly loaded that 0.50 would be named and discussed (Morgan et al, 2005). This implies that only factor 1,2,3, and 4 would be named and explained.

Factor 1 had eight variables loaded on it. These variables are preference of infrastructure (0.956), infrastructure type (0.948), effect on health (0.945), available infrastructure is not effective (0.934), inadequate security (0.919), high rate of crime (0.911), increase in population (0.892), and satisfaction derive from the infrastructure (0.523). By the nature of these variables loading on factor 1, this group is ***Infrastructure Provision.***

Factor 2 has six variables loading, they are: length of residence (0.925), income status (0.924), occupation (0.918), educational status (0.918), gender (0.904) and race/ethnicity (0.896). This group is referred to as ***Socioeconomic Factors***

Factor 3 has 5 variables loading which are: the only available green infrastructure in my area (0.953), Proximity to my place of work (0.947), it is unevenly distributed in my area (0.945), it is located on my plot of land (0.944), nearest to your residence/settlement/village (0.938). This group can be termed ***Spatial Factors.***

Factor 4 has 5 variables that are highly loaded on it, these include, and significant impact on daily activities (0.788), location and environment of dwelling (0.679), increase the internal generated income of our local government area (0.596), significant impacts on job opportunity (0.558) and Religious believe (0.552). This group can be refers to as ***Economic Factors.***

The summary of the variance explained by the extracted components after rotation is presented in Table 9. Finding revealed that ***personal/social*** factor plays significant role in respondents' perception in the study area as they accounted for 36.18% among the rest factors extracted. The next component in the order of loading variability among the 28 variables is socioeconomic factor with 18.16% of the extracted components. This places emphasis on the socioeconomic factor to determine the respondents' perception in the study area. The next components, spatial and economic factors have a share of 11.33% and 7.55% respectively of the extracted components. From the foregoing, it is evident that personal/social and socio economic factors play an important role in influencing residents' perception on green infrastructure in the study area. These findings thus corroborated the views of Baptiste *et al* (2015) and Byrne et al (2015) that personal and socioeconomic factors have strong relationship with residents' perception and utilization of green infrastructure.

The four factors (Components 1, 2, 3 and 4) were used for further analysis using multiple regression analysis in a sequential order of the four models. According to Field (2005) multiple regressions is used when there are several explanatory variables that predict outcome or when the effect of a factor that can be manipulated is being tested. In this study, the dependent variable was residents' perception of green infrastructure. This was regressed with Infrastructure provision, socioeconomic, spatial and economic factors. The summary of the multiple regression analysis on each of the factors is thus presented. In the regression model, spatial factor was the entry variable. Evident in this regard, the effect of spatial factor of the residents' perception on green infrastructure was determined. Spatial factor had a coefficient of multiple determination ($R^2 = 0.103$) which made a good predictor of residents' perception of green infrastructure. This implies that 10.3% of the residents' perception of green infrastructure was predicted by spatial factor. In the regression model 2, economic factor was added to spatial factor in predicting the effect on residents' perception of green infrastructure. The two components were known to have a coefficient of multiple determination ($R^2 = 0.186$).This implies that 18.6% of the residents' perception of green infrastructure was predicted by economic factor. Furthermore, in order to ascertain the actual percentage contribution of economic factor to the model, the coefficient of determination for the economic factor was determined as change in coefficient of multiple determination ($\Delta R^2 = 0.226$). Hence, 22.6% residents' perception of green infrastructure was predicted by economic factor. Also, socioeconomic factor was added to spatial and economic factors in predicting the effects on residents' perception of green infrastructure in the regression model 3.

Table 7. Communalities before and after Extraction process

Residents'' Perception of Green Infrastructure Indicator	Initial	Extraction
Income status	1.000	.953
The only available green infrastructure in my area	1.000	.952
Length of residence	1.000	.951
Proximity to my place of work	1.000	.947
Preference of infrastructure	1.000	.945
It is located on my plot of my land	1.000	.941
Occupation	1.000	.939
It is unevenly distributed in my area	1.000	.936
Educational status	1.000	.934
Nearest to your residence/settlement/village	1.000	.931
Green infrastructure type	1.000	.924
It is affecting my health	1.000	.920
The available infrastructure is not effective	1.000	.906
Inadequate security	1.000	.878
Gender	1.000	.863
Race/ethnicity	1.000	.853
High rate of crime	1.000	.844
Increase in population	1.000	.825
Significant impact on daily activities	1.000	.649
Unemployment among the youths	1.000	.636
Government policy	1.000	.628
Location and environment of dwelling	1.000	.548
Increase in tax payment	1.000	.546
increase the internal generated income of our LGA	1.000	.507
Significant impacts on job opportunity	1.000	.479
Abject poverty	1.000	.457
Satisfaction derive from the infrastructure	1.000	.436
Religious believe	1.000	.382

Extraction Method: Principal Component Analysis.

Table 8. Total Variance Explained on Respondent's Perception

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumul. %
1	10.132	36.187	36.187	10.132	36.187	36.187	6.693	23.902	23.902
2	5.087	18.167	54.354	5.087	18.167	54.354	5.534	19.765	43.668
3	3.174	11.334	65.689	3.174	11.334	65.689	5.065	18.089	61.757
4	2.115	7.552	73.241	2.115	7.552	73.241	2.797	9.991	71.747
5	1.199	4.283	77.525	1.199	4.283	77.525	1.618	5.777	77.525
6	.948	3.384	80.909						
7	.877	3.132	84.040						
8	.728	2.600	86.640						
9	.642	2.293	88.932						
10	.583	2.083	91.016						
11	.464	1.657	92.672						
12	.427	1.527	94.199						
13	.353	1.260	95.459						
14	.278	.993	96.452						
15	.217	.774	97.226						
16	.188	.671	97.897						
17	.156	.556	98.453						
18	.104	.371	98.824						
19	.082	.294	99.118						
20	.073	.260	99.379						
21	.058	.209	99.587						
22	.038	.137	99.725						
23	.027	.096	99.821						
24	.014	.052	99.873						
25	.014	.050	99.923						
26	.010	.037	99.960						
27	.007	.026	99.986						
28	.004	.014	100.000						

Extraction Method: Principal Component Analysis.

The three factors were known to have a coefficient of multiple determination ($R^2 = 0.251$). This indicates that 25.1% of the residents' perception of green infrastructure was predicted by residents' spatial, economic and residents' socio-economic characteristics. Also, the actual percentage contribution of socioeconomic factor to the model was determined. The coefficient of determination for the socioeconomic factor was determined as change in coefficient of multiple determination ($\Delta R^2 = 0.384$). This implies that 38.4% of resident's level of vulnerability to disasters was predicted by socioeconomic factor.

In the regression model 4, Infrastructure provision factor was added to spatial, economic and socioeconomic factor in predicting the effects on residents' perception of green infrastructure. The four factors were known to have coefficient of multiple determination ($R^2 = 0.412$).This implies that 41.2% of the residents' perception of green infrastructure was predicted by spatial, economic, socio-economic characteristics and Infrastructure provision factors. Furthermore, in order to ascertain the actual percentage contribution of Infrastructure provision factor to the model, the coefficient of determination for the Infrastructure provision factor was determined as change in coefficient

Table 9. Rotated Component Matrix[a]

Rotated Component Matrix[a]	Component				
	1	2	3	4	5
Preference of infrastructure	.956	.122	.066	.080	.071
infrastructure type	.948	.115	.054	.081	.049
It is affecting my health	.945	.110	.070	.080	.051
The available infrastructure is not effective	.934	.105	.046	.123	.076
inadequate security	.919	.125	.037	.110	.072
High rate of crime	.911	.081	.046	.067	.027
Increase in population	.892	.111	.063	.084	.076
satisfaction derive from the infrastructure	.523	.213	.129	.304	.093
lenght of residence	.175	.925	.191	.166	.038
Income status	.171	.924	.189	.180	.030
Occupation	.178	.918	.192	.156	.057
Educational status	.175	.918	.177	.167	.029
Gender	.086	.904	.135	.119	-.075
Race/ethnicity	.080	.896	.140	.129	-.083
The only available public facility in my area	.079	.164	.953	.109	.010
Proximity to my place of work	.051	.172	.947	.131	-.018
it is unevenly distributed in my area	.066	.166	.945	.111	.008
it is located on my plot of my land	.070	.185	.944	.099	.025
Nearest to your residence/settlement/village	.063	.180	.938	.119	-.002
significant impact on daily activities	-.029	.076	.143	.788	-.027
location and environment of dwelling	.263	.067	-.036	.679	-.109
increase the internal generated income of our LGA	.212	.228	.066	.596	.224
significant impacts on job opportunity	.124	.148	.153	.558	.326
Religious believe	.047	.214	.167	.552	.036
increase in tax payment	.125	.158	.443	.480	.281
unemployment among the youths	.014	-.009	-.025	.240	.760
government policy	.178	-.124	-.026	-.081	.757
Abject poverty	.185	.258	.324	.301	.401
Eigenvalue	10.132	5.087	3.174	2.115	1.199
%variance explained	36.18571	18.16786	11.33571	7.553571	4.282143
Cumulative % variance explained	36.18571	54.35357	65.68929	73.24286	77.525

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
a. Rotation converged in 5 iterations.

Source: Fieldwork 2020

Table 10 Summary of factors influencing respondents' perception

Factor	Eigenvalue	%variance explained	Cumulative % variance explained
Infrastructure provision	10.132	36.185	36.185
Socioeconomic	5.087	18.168	54.354
Spatial	3.174	11.336	65.689
Economic	2.115	7.554	73.243

Source: Author's field survey, 2020

Table 11. Regression Coefficient on Residents' perception of Green Infrastructure

Model		Unstandardized Coefficients		Standardized Coefficients
		B	Std. Error	Beta (β)
1	(Constant)	0.469	0.451	
	Spatial Factors	1.029	0.762	0.522
	(Constant)	0.469	1.232	
2	Spatial Factor	1.029	0.762	0.522
	Economic Factor	2.761	0.275	0.654
3	(Constant)	0.469	1.129	
	Spatial Factor	1.029	1.009	0.522
	Economic Factor	2.761	0.275	0.654
	Socioeconomic Factor	3.104	0.951	0.776
4	(Constant)	0.469	1.492	
	Spatial Factor	1.029	1.009	0.522
	Economic Factor	2.761	0.275	0.654
	Socioeconomic Factor	3.104	0.951	0.776
	Infrastructure provision	4.251	0.563	0.945

Source: Author's field survey, (2020)

a. Dependent Variable: Residents perception of Green infrastructure

Note: R =0.371, R^2 = 0.103, [F (1, 173) = 6.402, p = 0.000] for model 1

R =0.454, R^2 = 0.186, ΔR^2 = 0.226, [F (2, 183) = 4.273, p = 0.000] for model 2

R= 0.513, R^2 = 0.251, ΔR^2 = 0.384, [F (2, 814) = 4.367, p = 0.001] for model 3

R= 0.658, R^2 = 0.412, ΔR^2 = 0.651, [F (3, 113) = 5.631, p = 0.001] for model 4 of multiple determination ($\Delta R^2 = 0.651$). Hence, 65.1% of residents' perception of green infrastructure was predicted by Infrastructure provision factor.

Based on this regression analysis, the regression equations that were built using the standardized and unstandardized regression coefficient are:

For the unstandardized coefficients (B) the regression equation is:

$$y = 0.469 + 1.029x_1 + 2.761x_2 + 3.104x_3 + 4.251x_4 + \varepsilon \quad \ldots\ldots\ldots\ldots \text{(i)}$$

For the standardized coefficients (β), the regression equation is:

$$y = 0.522x_1 + 0.654\,x_2 + 0.776\,x_3 + 0.945x_2 \quad \ldots\ldots\ldots\ldots \text{(ii)}$$

Where:
a = Constant
y = Residents' Perception of Green Infrastructure
x_1 = Spatial Factor
x_2 = Economic Factor
x_3 = Socioeconomic Characteristics
x_4 = Personal/Social Factor
ε = Error Term

The equation (i) and (ii) are the models built for predicting residents' perception of green infrastructure and spatial, economic, residents' socio-economic characteristics and personal/social factor. The equation (i) was built based on the unstandardized regression coefficient of the predictors while existing on different units of measurement. To better explain the predictor with the highest regression coefficient, equation (ii) was computed using the standardized coefficient with the error term eliminated. Thus, the predictors could be compared directly. From equation (ii), Infrastructure provision ($\beta = 0.945$) was the highest predictor of residents' perception of green infrastructure in the three residential areas. The implication of this is that personal/social factor of residents in the residential areas had a strong positive influence on the residents' perception and utilization of green infrastructure. Other factors were residents' socioeconomic characteristics ($\beta = 0.776$), economic factor ($\beta = 0.654$) and spatial factor ($\beta = 0.522$). This indicates that resident' socioeconomic characteristics, economic and spatial factors also had a positive influence on the residents' perception of green infrastructure in the study area.

Summary, Conclusion and Policy Implication

The study revealed that government constituted the major provider of green infrastructure in the three residential densities of the study area. It was also discovered that parks was the most available green infrastructure to respondents (19.1%) in the three residential areas. Other green infrastructure with high level of availability were public green space, home garden, street trees, green corridors, city square/plaza and religion yards among others. The level of adequacies attached to the available green infrastructure determined through Green Infrastructure Adequacy Index (GIAI) measured on a five-point Likert Scale showed that green infrastructure were below just adequate as the mean index for the study areas was 1.28. Green infrastructure considered adequate more than the average adequacy expressed in all infrastructure in the area included: parks, public green space, street trees, and green roof respectively with indices of 1.82, 31.80, 1.30 and 1.28. It was discovered that the most important green infrastructure in the three residential areas was home garden with an index of 4.46. This was above the average index (3.84) computed for the three settlements. Other important green infrastructure were parks (4.44), street trees (4.4), allotments, (4.09) outdoor sport fields (3.93), urban forests (3.99) and green corridors (3.96). However, the green infrastructure perceived to be least in importance were green corridors, public green space, rain garden and cemetery. Measuring the satisfaction residents derived from green infrastructure through the Resident Satisfaction Index (RSI), it was established that the green infrastructure respondents' derived the highest level of satisfaction were parks (3.55), outdoor sport fields (3.37), street trees (3.29), allotments (3.10), and green roof (3.09) each of which is higher than the study area index (RSI_s= 3.08).

The study further classified the available green infrastructure into four main groups using RII and RSI of the green infrastructure. Group A were green infrastructure regarded as important but the level of satisfaction derived was low. In other words, these were green infrastructure with positive deviation about the mean of RII but with negative about the mean of RSI. Green infrastructure in this group included public green spaces, rain gardens and green roofs. Green infrastructure in group B were those considered to be of high importance and respondents' derived a very high level of satisfaction. These were green infrastructure with negative deviation about the mean of RII but with positive about the mean of RSI. These included parks, street trees, allotments, outdoor sport fields and urban forests. Grouped under C were green infrastructure with high importance to respondents and with high level of satisfaction. These green infrastructure were city square and plazas, green corridors, vertical greening and home gardens. The last group (D) was green infrastructure with low level of importance and also with low level of satisfaction. These were cemetery and blue roofs. Factor Analysis was used to extract the determinants of residents' perception on green infrastructure in the study area. The total variance explained by factor 1 was 36.19%, while factor 2, 3 and 4 accounted for 18.17%, 11.24% and 7.55% respectively. The four factors cumulatively explained 73.2% of the data variation. These were respectively called personal/social, socioeconomic, spatial and economic factors. With a model built using the standardized coefficient, it was inferred that Infrastructure provision ($\beta = 0.945$) was the highest predictor of residents' perception of green infrastructure in the three residential areas. The implication of this is that Infrastructure provision of residents in the residential areas had a strong positive influence on the residents' perception of green infrastructure. Other factors were residents' socioeconomic characteristics ($\beta = 0.776$), economic factor ($\beta = 0.654$) and spatial factor ($\beta = 0.522$). This indicates that resident' socioeconomic characteristics, economic and spatial factors also had a positive influence on the residents' perception of green infrastructure in the study area. The work recommends, provision and equitable distribution of green infrastructure in the study area especially the kind that enjoys high perception and more uses. Design and effective enforcement of eco-friendly master plan. Effective and sustainable collaboration among the three tiers of government as well as the private sector, all these could be effectively combined with environmental education.

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