Multivariate Analysis of Factors Responsible for Visual Pollution in the Central Business District of Ore Town, Ondo State, Nigeria

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Abstract

One of the key features of many primordial settlements in sub-Saharan Africa and their resurgence as urban centres is visual pollution and deterioration in environmental quality. This is due to the inability of city authorities to regulate what is assembled, built or displayed in public spaces. The paper deals with multivariate analysis of factors responsible for visual pollution in the Central Business District (CBD) of Ore Town, Ondo State, Nigeria. Fifty indicators capable of causing visual pollution were sourced from field survey of 133 respondents selected randomly using structured questionnaire. Data analysis was carried out using descriptive statistics and factor analysis/principal component analysis (FA/PCA) in SPSS. Results showed that about 69.6% of the combined effects of 50 factors explained the variations in visual pollution in the CBD of Ore Town with a 30.4% error margin. Based on the first extracted component, disorderly placement of posters, chaotic arrangement of electricity lines/pole, haphazard arrangement of signposts/billboards, graffiti (writing on roads, fences and public areas) and potholes on road were identified as the most pressing factors responsible for visual pollution in the CBD of Ore Town. Multivariate statistics with the use of FA/PCA, therefore, demonstrated a veritable and robust analytical framework in assessing complex indicators of global environmental change to support policy and sustainable development. The study recommended massive urban sensitization, infrastructure renewal and planning which take into cognizance anthropogenic and ecological disasters to restore and guarantee visual esthetics and environmental quality.

Keywords: Factor Analysis, PCA, Pollution, Visual, Ore Town

INTRODUCTION

One of the key features of many primordial settlements in sub-Saharan Africa and their resurgence as urban centres is deterioration in visual environmental appearance and quality. In 1950, about 30% of the world's population lived in urban areas which later increased to about 4.2 billion people (55%) at the end of 2018 with a projected figure of 751 million people (68%) by 2050 (United Nations Department of Economic and Social Affairs-UN DESA, 2018). Daily, rural-urban drift have transformed many prehistoric settlements who were hitherto population clusters (Ur et al., 2007), antique settlers (Biello, 2007) and a peculiar model of houses scattered out from the inner religious compounds like shrines (Mark, 2014) to vibrant spaces of growth, shrink, and transformations (Piro and Ganser, 2016). These developments creates momentous adverse consequences particularly when the seeming prospects offered by the urban centres are not met. Added to the urban decay are poor planning and ineffective governance strategies by municipal authorities to contain the hurried changes. The tipping point is not only the decline in visual

esthetics but the deterioration in overall physical environmental appearance and quality, hence, visual pollution.

According to Milan and Tanaya (2015), human initial intuition of a neighborhood is its visual environment that entails a mosaic of built and natural forms. Visual pollution is defined as the whole of irregular formations (Kan *et al*., 2012 cited in Jana and De, 2015). It may refer to everything altered by human activities that are unattractive and affect people's ability to enjoy or appreciate the view and vista. Anything that interferes with the beautiful scenerie and other defacements may become a cause of visual pollution (Chmielewski et al., 2015). It may consist of garbage (solid waste) thrown in different places, cables or wires running in the urban areas in an unorganized fashion, billboards ill-arranged and alluring, old decaying buildings, discarded civil and structural engineering supplies, electricity poles, telecommunication masks, skywriting etc (Cvetković, 2018; Wakil, 2019). They are subjective and literally, depend on the eye of the beholder.

Nevertheless, the eye, which is the perceptory organ for visual esthetics, get modified on prolonged exposure to visual pollutants. Visual blight and visual clutter are two terms of relevance here. Visual blight may refer to dazzling billboards, power lines, ugly buildings etc (Kumar and De, 2015). Visual pollution occurs everyday in an uncontrolled urban fabric and the built environment. It may impair a person's ability to find certain objects in such environments or in finding a person we are trying to meet in the street (Asher, 2013). Factors responsible for visual pollution are multifarious, including administrative negligence, excessive advertisement, and vandalism. A situation where the municipal authority loses control over what is built or assembled in public spaces often leads to visual pollution. Visual pollution is also a consequences of the inability of city planners and managers to know where to put what and what is displayed on the street. Besides, when the problem of buildings in unauthorized locations are left unresolved no matter who is involved, visual pollution is inevitable.

Similarly, excessive advertisements are oftentimes literally suffocating because not even the green areas (trees, land, parks, etc.) are spared in the desire to ensure good visibility (Bankole, 2013).The existence of disorganized, torn, unequal and giant billboards also creates visual pollution. Despite the fact that advertisement does inform the consumers about different products but the social and cultural implications of excessive advertisement remain unclear and have stirred intellectual attention in many circles. There is this confusion between perception and interpretation. Anti-social menaces which include vandalism, graffiti, offensive messages, obscenities, buildings and street markings of course contribute to visual pollution (Kumar and De, 2015; Shrivastava and Choudhary, 2016; Nami et al., 2016).

The effects of exposure to visual pollution may be vast and penetrating. They include distraction, decreases in opinion diversity, and loss of identity (Yilmaz, 2011). It also include traffic congestion and health hazards of diverse kinds (Jana and De, 2015). Robol (2012) also reported irritability and psychological disturbances as well as eye fatigue as among the effects of exposure to visual pollution. Other consequences of visual pollution include loss of sense of hygiene and aesthetics, feeling of civility in addition to the overall loss of quality of life of individuals residing in the community. Moreover, teenagers who are highly exposed to visual pollution from childhood are

generally bereft of subtle aesthetics and they get used to these unsightly surroundings thereby losing their natural desire to correct it (Yusuf, 2013).

When almost all urban and suburban areas are infested with the same kind of visual pollution, it naturally eliminates the uniqueness of each place and causes homogenization of our communities (Jana and De, 2015). Areas free from visual clutter, like a huge lawn, a picturesque landscape, a forest, hills, greeneries etc. are visually soothing, they help to re-energize human wellbeing, soothe our pains and restore our productivity. Thus, though we feel that the visual environment is integral to our daily experience of the built and natural worlds yet, the altering of this visual environment is often taken for granted (Jana and De, 2015).

Iyorakpo (2015) stressed that the rate of rapid urbanization taking place in many primordial settlements in sub-Saharan Africa will lead to the emergence of several unplanned structures, haphazard deposition of refuse, lack of drainage, inadequate housing facilities, among others. These problems associated with urbanization and other consequences of unplanned and uncontrolled urban growth and the consequent impacts are widespread. In Ore Town, Ondo State, Nigeria, visual pollution has created serious environment, development, governance and planning challenges to municipal authorities and the city dwellers. Thus, in an attempt to investigate the complexities and interrelations of several factors responsible for visual pollution, several frameworks including multivariate analysis abound in the literature.

Multivariate analysis has been conceptualized to refer to any statistical framework capable of evaluating the complex interrelationships, causes and effects of several factors responsible for certain or multiple phenomena in space and time simultaneously (Johnson and Wichern, 2007; Hair Jr et al., 2010). Notable multivariate frameworks used in environmental pollution and quality analysis include multiple linear regression analysis, discriminant analysis, cluster analysis, factor analysis (FA), principal component analysis (PCA), biplots, multidimensional scaling, and canonical correlations among other (Manoj and Padhy, 2014; Marden, 2015; Chmielewski et al., 2015; Ebqa'ai and Ibrahim, 2017; Cvetković et al., 2018; Nuñez-Alonso et al., 2019). In all, FA and PCA is very flexible and have enjoyed extensive application in environment and development research. They have inherent ability to reduced several redundant variables into most important components (Manoj and Padhy, 2014; Marden, 2015). It is based on these capabilities that the study deployed PCA-based multivariate approach in the assessment of the visual quality in Ore Town, Ondo State, Nigeria. The prime motivation is to contribute to enhancing urban planning and management. Consequently, this study hypothesized that there is no significant relationship between visual aesthetic factors and visual pollution in the Central Business District (CBD) of Ore Town, Ondo State, Nigeria.

METHODOLOGY

Study Area

This study was carried in the CBD of Ore Town, Ondo State, Nigeria. Ore is the administrative headquarters of Odigbo Local Government Area (LGA), Ondo State as seen in Figure 1. It lies approximately between latitude 6^{O} 43' and 6^{O} 47' North of the Equator and longitude 4^{O} 51'and 4^{O} 55' East of the Greenwich Meridian.

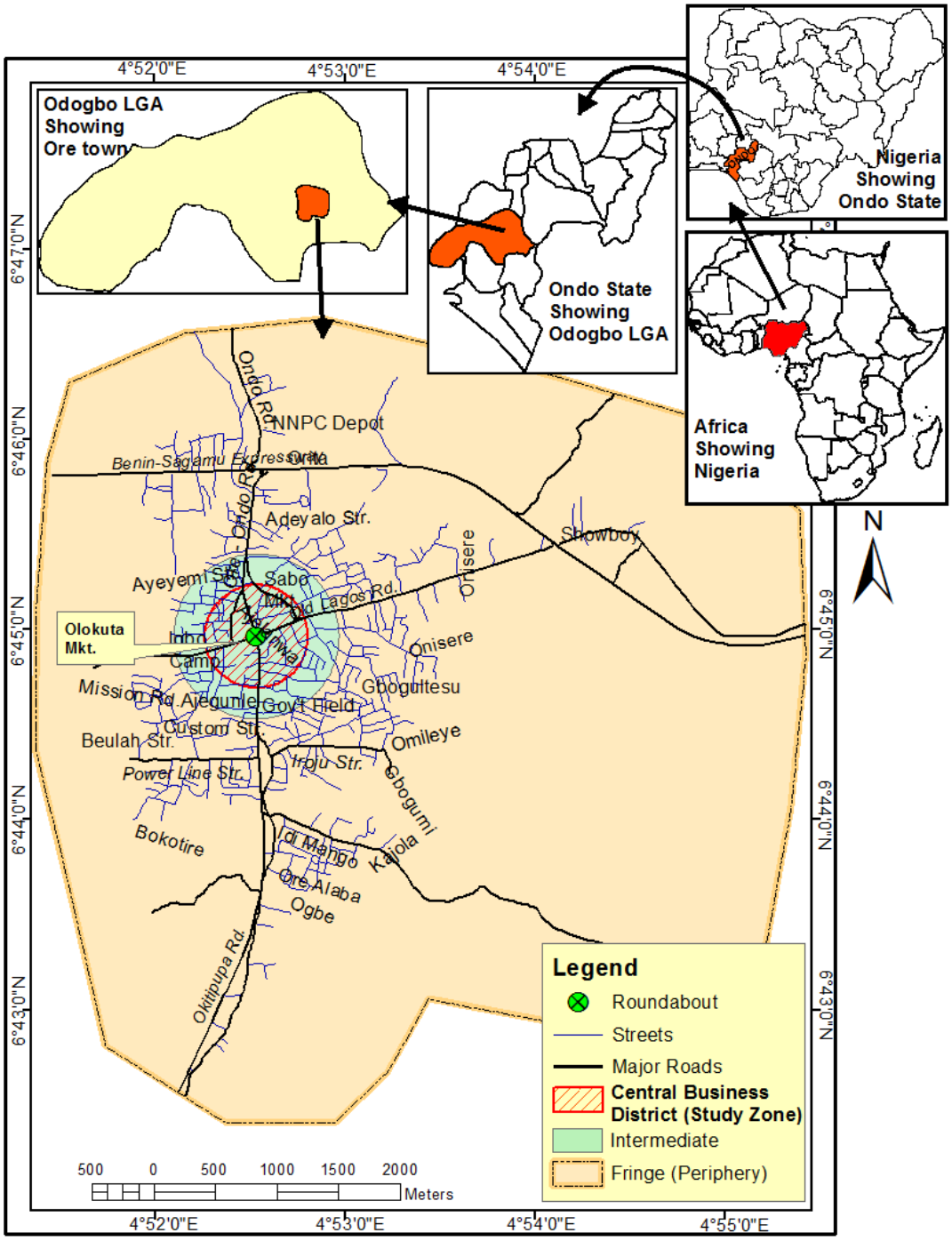

Figure 1: Ore Town Showing the Central Business District (Study Zone)

Ore, which is a nodal town serving as a linkage between the eastern and western parts of Nigeria occupies a land area of about 66.2km^2. The town has been experiencing unprecedented growth in the past decade both in population and in physical expansion. As of 1964, Ore was a mere road junction where motorists from Lagos to the eastern part of Nigeria stopped-over to refuel their vehicles, eat and also engage in other social activities. The surrounding land was a thick forest where people mainly traders and farmers engaged in subsistence and commercial farming. This

was before the civil war. During the Nigeria Civil War of 1967-1970, it was also a military base for the Nigeria troops. There were the defunct 202 infantry battalions and a small military camp at Constain which is a small settlement near Ore. From 1986 various factors have contributed to the emergence of Ore as one of the major urban settlement in Ondo state The increase in population which affects the expansion of the town was due to increase in commercial activities, and most importantly the location of the town as a nodal town (Aguda et al., 2013).

The CBD of Ore Town in 1964 was estimated to be approximately 1.2km^2 which is approximately 2 percent of the study area. The study area in Ore Town grew to about 11.3km^2 (18 percent of the total land area) in 1986 and 13.2km^2 (approximately 21.2 percent of the total land area) in 2002. The possible expansion value of the town by the year 2027 was also calculated using the average rate of expansion of 1964 to 1986 and 1986 to 2002. Therefore, expansion value in 2027 would be 55.33km^2 (Aguda et al, 2013). The population of Odigbo LGA was put at 230,351 (NPC, 2006). The current population of Ore Town, the administrative headquarter of the local government is about 183,821.

In terms of climate, Ore Town is located within the Humid Tropical climate with an absolute yearly precipitation of between 1500-2000mm. It is set apart by two unmistakable seasons. The dry season happens among November and March while the rainy season starts from April to October. The temperature changes from 21^{0}C to 29^{0}C during the time with a normal estimation of 25^{0}C. The mean month to month relative moistness is under 70%. The regular vegetation of this zone is of the swamp tropical rainforest type, made out of an assortment of hardwood timbers. An important aspect of the vegetation of the study area is the prevalence of tree crops. The major tree crops include cocoa, coffee, rubber oil palms and citrus, cocoa being the most prevalent over most of the state. The natural vegetation has been very much degrading as a result of human activities, the chief which is based on the rotation of the bush fallow system. As a result, the original vegetation is now restricted to the forest reserve.

The economic activities in the CBD of Ore Town are highly influenced by the nodal nature of the town. These economic activities can be classified into primary, secondary and tertiary activities. Primary economic activities mainly include farming, hunting, lumbering. Secondary activities include cottage industries scattered all over the place such as asawmill, hotel services, and furniture industries. The major tertiary activities in the CBD of Ore Town include services such as banking and marketing. Also, industrial activity prominent in Ore Town is the location of Nigeria National Petroleum Corporation (NNPC) depot. In addition, the CBD of Ore Town provides an enabling environment for the growth of retail and social services as a result of the links it has with other regions (Ondo, Benin City, Okitipupa and Sagamu).

Research Design, Datasets, Sources, Sampling Procedures

This study adopted survey research approach with principal data retrieved from fieldwork using structured questionnaire as the main research instrument. The Institute of Food and Agricultural Sciences, University of Florida (IFAS, 2008) sample size framework was used in the selection of 399 respondents from the 2019 projected population of 183,821 in Ore Town. The formula is presented in equation1 as:

$$\frac{n = N,}{[1+N\,(e)^2]} \qquad (1)$$

Where: n= sample size, N= population size, and e = margin of error which is 0.05 or 5%

A total of 50 environmental descriptors representing aesthetic variables/factors capable of impacting negatively on the visual appearance of the town were identified. They were generated from previous studies and field reconnaissance. The CBD was randomly selected and based on the sampling size of 399, 133 questionnaires were administered at this sampling/spatial unit. In each of the streets, a stratified sampling method was adopted at every tenth house on each side of the street until the questionnaires were exhausted. During the field survey, respondents were asked to list the five most important aesthetic variables/factors responsible for visual pollution in their neighbourhood. Respondents were also expected to express their opinions on the 50 visual pollution factors using a five-point Likert framework. The scale ranged from *Very serious/very impactful, Serious/impactful*, somewhat *serious/some impact, no serious/little impact* and *no real impact*. These scales indicated the extent to which each of the 50 esthetic variables/factors listed caused visual pollution in their neighbourhood.

Analytical Frameworks

The multivariate statistical analysis deployed in the investigation of the 50 factors responsible for visual pollution in the CBD of Ore Town was factor analysis. Factor analysis (FA) is an inferential statistical technique (Marden, 2015) deployed primarily to either reduce large volume of data to a manageable size. The technique can also uncover the underlying configuration within the dataset (Chmielewski et al., 2015; Ebqa'ai and Ibrahim, 2017). In data reduction, FA eliminates unnecessary (extremely associated) variables from the data file and possibly substituting the whole dataset with a less significant number of uncorrelated variables (Cvetković et al., 2018; Nuñez-Alonso et al., 2019). The purpose of structure detection is to examine the underlying (or latent) relationships between the variables (Marden, 2015).

The aim of deploying the FA framework in this research was for data reduction where principal component analysis (PCA) was used. The PCA begins by finding a linear grouping of variables (component) capable of explaining as much variation in the original variables as possible (Kline, 1994). It then finds another component that accounts for as much of the remaining discrepancy as possible and is uncorrelated with the previous component, continuing in this way until there are as many components as original variables. Usually, a few components will account for most of the variation, and these components can be used to replace the original indicators. In this study, 50 aesthetic variables/factors of visual pollution in Ore Town were extracted from questionnaires. Factor analysis was then used to test the proposed hypothesis which states that "*there is no significant relationship between visual aesthetic factors and visual pollution in Ore Town*".

RESULTS AND DISCUSSION

Demographic characteristics of survey participants

The result of the demographic characteristics of survey participants indicates that 76 (36.2%) were male while 69 (36.5%) were female. Also, 32 (24.1%) of the respondents were under the age grade

of 20 - 29 years, 37 (27.8%) were under the age grade of 30 - 39 years, 36 (27.1%) were under the age grade of 40 - 99 years, 19 (14.3%) were under the age grade of 50 - 59 years while 9 (6.8%) were 60 years and above. Besides, education has been adjudged as the bedrock of sustainable development. Thus, majority (n = 56; 42.1%) of the survey respondents were educated up to secondary level, 33 (24.8%) had primary education, 26 (19.5%) were educated up to tertiary level, 14 (10.5%) acquired professional qualification whereas 4 (3%) had no formal education.The findings on sex contradict earlier results of Kquofi and Glover (2012) whose majority of the study respondents were female while that of age corroborates the same authors where age category 20-55 years constituted majority of the participants. The finding on educational qualification also implied that the majority of the study respondents were literate with considerable aptitudes to effectively perceive visual pollution in the area. Again, this result agrees with Kquofi and Glover (2012) findings in Kumasi region of Ghana.

Factors Responsible for Visual Pollution in Ore Town

A total of 50 aesthetic factors responsible visual pollution in the CBD of Ore Town and other emerging urban centre were extracted from the literature and field surveys. These variables were presented to respondents who selected five most prevalent factors which disfigure or reduce the visual aesthetics in the neighbourhood. At the end of the survey, related factors were carefully sorted, grouped in the order of importance and ranked based on the number of occurrences (count) of each factor and the result is presented in Table 1. As it could be seen, old buildings/structures/houses and roof emerged the top ranked factor causing visual pollution in the CBD of Ore Town based on the count of 71 respondents. The 2nd most perceived factor was drainage related issues (no gutters, blocked drainage, waterlogged/stagnant water on the street, flooding and erosion) based the rating of 66 respondents.

The 3rd most perceived factor was filthiness/street littering/offensive odour from neighbourhood based on the rating of 61 respondents while the 4th was untarred street/road network based on the response of 59 respondents. The 5th most perceived factor was roadside trading/inappropriate display of goods on main roads/streets as a result of the rating of 52 study participants. On the contrary, undeveloped bushy areas, contrasting building colours as well as chaotic arrangement of electricity pools/lines and communication masks were all ranked the 24th factors responsible for visual pollution in Ore Town. Details of other factors and their respective ranks are all presented in Table 1.

Relationship between visual aesthetic factors and visual pollution in the CBD

The postulated hypothesis bordered on the relationship between the 50 aesthetic variables/factors reducing visual appearance and visual pollution in Ore Town. Factor analysis (FA) with principal component analysis (PCA) algorithm in SPSS 22 were used. To ascertain the adequacy of the sample, Kaiser-Meyer-Olkin (KMO) and Bartlett's Tests were used and the result is shown in Table 2. However, previous analysis by Arumugam et al (2010) showed that KMO coefficient of more than 0.60 is good enough for PCA to be executed. Thus, at 95% confidence level, the sample was declared adequate and fit for FA/PCA to be carried out based on the KMO of 0.643.

Table 1: Frequency count and ranking of most important aesthetic variables/factors that cause visual pollution in the CBD of Ore Town

Esthetic variables/factors	Count	Rank	Esthetic variables/factors	Count	Rank
Old Buildings/Structures/ Houses and Roof	71	1st	Dumped/Abandoned household and construction materials/junk materials	11	15th
Drainage related issues (No gutters, blocked drainage, waterlogged/stagnant water on the street, flooding and erosion)	66	2nd	Unpainted houses, building and structures	9	16th
Filthiness/street littering/offensive odour from neighbourhood	61	3rd	Dust especially during hamatan and dry season	8	17th
Untarred street/road network	59	4th	Dilapidated buildings/structures	7	18th
Roadside trading/inappropriate display of goods on main roads/streets	52	5th	Pest infestation and loitering of streets by animals	6	19th
Crowded buildings/houses/ structures	45	6th	Buildings, houses and shops too close to roads/streets and development in unauthorized/ unplanned areas	6	19th
Lack of/Poor/Bad/Narrow Road Network	43	7th	Roadside gambling/ smoking/ hooligans/ rapist at night	5	20th
Poor Hygiene	34	8th	Graffiti/writing on the roads, fence, walls and disorderly placement of posters, sign posts and banners at public places	5	20th
Too many shops and kiosk	27	9th	Incompatible land uses/encroachment of commercial activities into residential areas	4	21st
Poor street layout/planning/ beautification	18	10th	Absence of walkway	4	21st
Waste management issues (indiscriminate dumping of refuge along the road and gutters/poor evacuation)	18	10th	Uncompleted buildings/abandoned projects	3	22nd
Roadside parking/abandoned vehicles	16	11th	Rugged topography	3	22nd
Poor Housing/building design	16	11th	Absence of open space	2	23rd
Vehicular traffic congestion	15	12th	Poor street maintenance	2	23rd
Too many wooden, substandard and make-shift structures	15	12th	Absence of flowers and ornamental trees	2	23rd
Poor infrastructural amenities	13	13th	Undeveloped bushy areas	1	24th
Poor street lighting especially at night	12	14th	Contrasting building colours	1	24th
Potholes on the road	12	14th	Chaotic arrangement of electricity pools/lines and communication masks	1	24th

Table 2: Result of Kaiser-Meyer-Olkin and Bartlett's Test of Sampling Adequacy

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.643
Bartlett's Test of Sphericity	Approx. Chi-Square	2920.875
	df	1225
	Sig.	.000

Similarly, in FA/PCA, communalities point towards the degree of variation of individual indicator explicitly predicted. Initial communalities are approximations of the variability of individual indicators explicitly predicted by all the components or factors (Kline,1994). As seen in Table 3, all the initial communalities were equal to 1.0 indicating a perfect correlation between respective visual pollution factors/indicators and the extracted components. Also, the extraction communalities denotes predictions of the variability of individual determined by the components. However, the top five visual pollution factors/indicators with high communalities were chaotic arrangement of electricity lines/poles (0.785), *indiscriminate waste disposal* (0.781), *graffiti (writing on roads, fences and public areas)* (0.775), *rugged topography/terrain* (0.774) and *poor infrastructural amenities* (0.773). The indicator with the lowest communality of 0.521 was *absence of open space* while those of other factors can be perused in Table 3. Kline (1994) reported that lower communalities are unsuitable in FA/PCA. The communalities of 0.521 and above therefore implied that the extracted components equivalently represented the investigated visual pollution factors/indicators in the CBD of Ore Town.

Table 3: Communalities of visual pollution factors/indicators and extracted components

Indicators/Factors	Initial	Extraction	Indicators/Factors	Initial	Extraction
Uncompleted buildings	1.000	.681	Graffiti (writing on roads, fences and public areas)	1.000	.775
Dilapidated buildings/structures	1.000	.632	Chaotic arrangement of electricity lines/poles	1.000	.785
Incompatible land use such as sitting of markets in residential areas	1.000	.679	Disorderly arrangement of cloth lines	1.000	.706
Unpainted houses	1.000	.712	Junks/abandoned vehicles	1.000	.729
Crowded buildings	1.000	.728	Poor street lighting especially at night	1.000	.718
Old buildings	1.000	.703	Roadside parking of vehicles	1.000	.669
Poor housing designs	1.000	.665	Roadside trading	1.000	.722
Contrasting building colours	1.000	.655	Vehicular traffic congestion	1.000	.697

Encroachment of commercial activities into residential areas	1.000	.584	Haphazard arrangement of signposts/billboards	1.000	.736
Untarred road	1.000	.600	Communication masts	1.000	.607
Potholes on road	1.000	.688	Inappropriate display of goods along major streets	1.000	.711
Absence of road network	1.000	.684	Offensive odour from neighbourhood	1.000	.675
Narrow road network	1.000	.695	Erosion	1.000	.724
Absence of walkway	1.000	.760	Flooding	1.000	.682
Non adherence to planning standards	1.000	.690	Stagnant water/waterlogged streets	1.000	.576
Poor street layout	1.000	.650	Dust	1.000	.687
Undeveloped bushy areas	1.000	.715	Rugged topography/terrain	1.000	.774
Street littering	1.000	.737	Blocked drainages	1.000	.662
Indiscriminate waste disposal	1.000	.781	Absence of drainages	1.000	.667
Absence of open space	1.000	.521	Absence of ornamentals	1.000	.693
Poor evacuation of waste	1.000	.733	Dumped household appliances and objects	1.000	.694
Poor hygiene/filthiness	1.000	.664	Makeshift structures e.g. shops and kiosk, etc.	1.000	.770
Loitering of streets by animals	1.000	.701	Poor infrastructural amenities	1.000	.773
Pest infestation	1.000	.747	Old building roofs	1.000	.701
Disorderly placement of posters	1.000	.720	Dumped/abandoned construction materials	1.000	.730

The total variance explained by the initial solution as well as the extracted components is presented in Table 4. Based on Kaiser principle (Nuñez-Alonso, 2019), *eigenvalues* exceeding 1 were extracted during the analysis, thus making the first 15 principal components to form the extracted solution. In general, the results in the extracted components showed that the 15 components explained about 69.6% of the variability in the original 50 factors with about 30.4% loss of information. However, the first five components significantly explained about 40.5% of the variability of visual pollution in the CBD of Ore Town.

Table 4: Components and Total Variance Explained

Components	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	7.212	14.423	14.423	7.212	14.423	14.423
2	4.700	9.400	23.823	4.700	9.400	23.823
3	3.199	6.398	30.221	3.199	6.398	30.221
4	2.709	5.417	35.638	2.709	5.417	35.638
5	2.429	4.857	40.495	2.429	4.857	40.495
6	2.085	4.171	44.666	2.085	4.171	44.666
7	1.853	3.707	48.373	1.853	3.707	48.373
8	1.715	3.430	51.803	1.715	3.430	51.803
9	1.649	3.297	55.100	1.649	3.297	55.100
10	1.419	2.838	57.937	1.419	2.838	57.937
11	1.330	2.661	60.598	1.330	2.661	60.598
12	1.263	2.526	63.124	1.263	2.526	63.124
13	1.155	2.310	65.435	1.155	2.310	65.435
14	1.070	2.139	67.574	1.070	2.139	67.574
15	1.005	2.010	69.584	1.005	2.010	69.584

Component 1 had the highest *eigenvalues* of 7.212 contributing 14.4% to the overall variability in the original 50 variables while Component 2 had *eigenvalues* of 4.7 (9.4% of variability). In contrast, Component 3 had *eigenvalues* of 3.199 (6.4% of variability), Component 4 had *eigenvalues* of 2.709 (5.4% of variability) whereas Component 5 had *eigenvalues* of 2.429 (4.5% of variability). The 15th Component (*eigenvalues* of 1.005) was the lowest contributor (2.01%) to the overall variability in the original 50 variables.

To establish the relationships between the extracted components and the 50 factors responsible for visual pollution in the CBD of Ore Town, the first component was used. This is because the component had the highest *eigenvalue* and hence, influence the variability in the original 50 factors. Zare et al (2011) and Nuñez-Alonso (2019) reported that in most scenarios, majority of the variation in the main data is always explained by the 1st extracted component.

Based on these principles, the abridged version of the component matrix of the 1st principal component and rank is presented in Table 5. It shows the relationship between the1st principal component and the top five factors responsible for visual pollution in the CBD of Ore Town. These first five factors were highly correlated with the 1st component based on (loadings ≥ 0.5). These include disorderly placement of posters (0.639), chaotic arrangement of electricity lines/pole (0.608), haphazard arrangement of signposts/billboards (0.604), graffiti (writing on roads, fences and public areas (0.551) and potholes on the road (0.545).

Table 5: Abridged Version of Factor Loadings from the 1st Principal Component and Rank

Factors/Indicators	Loadings	Rank
Disorderly placement of posters	0.639	1
Chaotic arrangement of electricity lines/poles	0.608	2
Haphazard arrangement of signposts/billboards	0.604	3
Graffiti (writing on roads, fences and public areas)	0.551	4
Potholes on road	0.545	5

Nevertheless, a retrospective appraisal of the first five factors that were highly correlated with the 1st component using their coefficients of multiple determination (CMD) revealed intriguing findings. The deployment of CMD of the indicators also facilitated the arrival of more definitive conclusions regarding the extent to which each factor contributed to visual pollution in the Central Business District of Ore Town. Thus, disorderly placement of posters contributed about 41% to visual pollution in the Central Business District of Ore Town. Also, 37% of the visual pollution in the Central Business District of Ore Town can be attributed to chaotic arrangement of electricity lines/pole and 36% byhaphazard arrangement of signposts/billboards.

On the other hand, graffiti (writing on roads, fences and public areas accounted for 30% of the visual pollution in the CBD of Ore Town while 29.7% can be linked to the presence of potholes on road. Interestingly, this study noticed disparities between the factors perceptually ranked by the respondents and the visual pollution factors empirically determined using FA/PCA. Besides, although the variability was noticed in all the factors responsible for visual pollution in the CBD of Ore Town, they were statistically significant at 0.05 level of confidence. This led to the rejection of the null hypothesis and the adoption of the alternate hypothesis. This implied that there is significant relationship between visual aesthetic factors and visual pollution in the Central Business District of Ore Town.

These findings however agrees with earlier reports by Bankole (2013), Kumar and De (2015), Shrivastava and Choudhary (2016) and Nami et al (2016) among others. For instance Bankole (2013) reported that the proliferation of billboards in many urban centers in Nigeria is responsible for the visual disorder and sensual difficulty vis-à-vis reduction visual responsiveness with grievous implication on urban development and planning. Kumar and De (2015) also linked the proliferation of billboards to health related hazards, obstruction of radio and telecommunication signals, creation of distraction to drivers and blocks birds' navigation. Shrivastava and Choudhary (2016) also attributed the causes of visual pollution to the interplay between human perception, familiarity, ethical necessities, obvious features of market locations, buildings and business symbols and announcements such as style, arrangement, density, and disparity. Nami et al (2016) also reported that the cities' environmental quality, attractiveness, pleasure, bliss and urban vigor have been negatively impacted by the menace of visual pollution.

CONCLUSION

The study attempted an assessment of factors responsible for visual pollution in the CBD of Ore Town, Ondo State, Nigeria. A total of 50 environmental descriptors representing aesthetic variables/factors capable of causing visual pollution were reduced to 15 components with the aid of FA/PCA multivariate analytical framework. At 95% level of confidence, the study established

that there is significant variation in the 50 aesthetic variables/factors responsible for visual pollution. Consequently, about 69.6% of the combined effects of 50 factors could explain the variations in visual pollution in the CBD of Ore Town with a 30.4% error margin. Based on the first extracted component, disorderly placement of posters, chaotic arrangement of electricity lines/pole, haphazard arrangement of signposts/billboards, graffiti (writing on roads, fences and public areas, potholes on road, disorderly arrangement of cloth lines and flooding were identified as the pressing factors responsible for visual pollution in the CBD in Ore Town. Multivariate statistics with the use of FA/PCA, therefore, demonstrated a veritable and robust analytical framework in assessing complex indicators of global environmental change to support policy and sustainable development. The onus, therefore, lies on all critical stakeholders including urban dwellers, developers, entrepreneurs and the planning authorities to evolve a workable governance framework to check billboards/posters proliferations, indiscriminate display of textile wares and graffiti. There is also the need for massive urban sensitization, infrastructure renewal and planning which take into cognizance anthropogenic and ecological disasters to restore and guarantee visual esthetics and environmental quality.

References

Arumugam, N., Fatimah, M. A., Chiew, E. F. C. and Zainalabidin, M. (2010). Supply chain analysis of fresh fruits and vegetables (FFV): prospects of contract farming. *Agricultural economics*.Vol. 56(9), pp. 435-442.

Asher, M. F., Tolhurst, D. J., Troscianko, T. and Gilchrist, I. D. (2013). Regional effects of clutter on human target detection performance. *Journal of Vision*. Vol.13 (5-25), pp. 1-15.

Bankole, O. E. (2013). urban environmental graphics: impact, problems and visual pollution of signs and billboards in Nigerian Cities. *International Journal of Education and Research*. Vol. 1 (6), pp. 1-12.

Biello, D., (2007). Ancient squatters may have been the world's first suburbanites. *Scientific American Newsletter August 30, 2007*. Retrieved on 26th March, 2020 from https://www.scientificamerican.com/article/ancient-squatters-worlds-first-suburbanites/

Chmielewski, S., Lee, D. J., Tompalski, P., Chmielewski, T. J. and Wężyk, P. (2015). Measuring visual pollution by outdoor advertisements in an urban street using intervisibility analysis and public surveys. *International Journal of Geographical Information Science*. DOI: 10.1080/13658816.2015.1104316

Cvetković, M., Momčilović-Petronijević1, A. and Ćurčić, A. (2018). Visual pollution of urban areas as one of the main issues of the 21st Century. 26th International Conference Ecological Truth & Environmental Research, 12-15 June 2018, Bor Lake, Bor, Serbia.

Ebqa'ai, M. and Ibrahim, B. (2017). Application of multivariate statistical analysis in the pollution and health risk of traffic-related heavy metals. *Environmental Geochemistry* and *Health*. Vol.39(6), pp.1441-1456. doi:10.1007/s10653-017-9930-9.

Ganser, R. and Piro, R. (2016). *Parallel patterns of shrinking cities and urban growth: Spatial planning for sustainable development of city regions and rural areas*. New York: Routledge.

Gulgundi, M. S. and Shetty, A. (2018). Groundwater quality assessment of urban Bengaluru using multivariate statistical techniques. *Applied Water Science*. Vol. 8 (43), pp. 1-15. https://doi.org/10.1007/s13201-018-0684-z

Hair (Jr), J. F. K., Black W. C., Babin, B. J. and Anderson R. E. (2010). *Multivariate data analysi*s. New Jersey: Pearson Prentice Hall.

Iyorakpo, J. (2015). Impact of rapid urbanization on environmental quality in Yenegoa metropolis. *European Scientific Journal*. Vol. 11 (23), pp.1857-1881.

Jana, M. K and De, T. (2015). Visual pollution can have a deep degrading effect on urban and suburban community: A study in few places of Bengal, India, with special reference to unorganized billboards. *European Scientific Journal*. Special edition, pp. 1-14.

Johnson, R. A. and Wichern, D. W. (2007). *Applied multivariate statistical analysis*. New Jersey, Pearson Prentice Hall.

Kline, P. (1994). *An easy guide to factor analysis*. London: Routledge.

Kquofi, S. and Glover, R. (2012). Awareness level of environmental aesthetics on KNUST Campus, Kumasi, Ghana: A descriptive account. *Journal of Environment and Earth Science*. Vol. 2 (10), pp. 84-92.

Kumar, M. and De, T. (2015). Visual pollution can have a deep degrading effect on urban and suburban community: A study in few places of Bengal, India, with special reference to unorganized billboards. *European Scientific Journal*.Special edition, pp. 1-14.

Manoj, K. and Padhy, P. K. (2014). Multivariate statistical techniques and water quality assessment: Discourse and review on some analytical models. *International Journal of Environmental Sciences*. Vol. 5 (3), pp. 607-626. doi: 10.6088/ijes.2014050100053

Marden, J. I. (2015). *Multivariate Statistics*. Illinois, Urbana-Champaign University of Illinois Press.

Mark, J. J. (2014). The Ancient City. *Ancient History Encyclopedia*. Retrieved on 26th March, 2020 from https://www.ancient.eu/city/

Milan, K. J and Tanaya, D. (2015). Visual pollution can have a deep degrading effect on urban and sub- urban community: a study in few places of Bengal, India, with special reference to unorganized billboards. *European Scientific Journal*. Special edition, pp. 1857 – 7881.

Nami, P., Jahanbakhsh, P. and Fathalipour, A. (2016). The role and heterogeneity of visual pollution on the quality of urban landscape using GIS; case study: historical garden in City of Maraqeh. *Open Journal of Geology*.Vol.6, pp. 20-29. http://dx.doi.org/10.4236/ojg.2016.61003

Nuñez-Alonso,D., Pe´rez-Arribas, L. V., Manzoor, S. and Ca´ceres, J. O. (2019). Statistical tools for air pollution assessment: Multivariate and spatial analysis studies in the Madrid Region. *Journal of Analytical Methods in Chemistry*. Vol. 2019, pp. 1-9. https://doi.org/10.1155/2019/9753927

Robol, V., Casco, C., and Dakin, S.C. (2012). The role of crowding in contextual influences on contour integration. *Journal of Vision*.Vol. 12 (7 issue 3), pp. 1–18.

Shrivastava, T. and Choudhary, A. (2016). Model to Mitigate Visual Pollution by Ads and Signage for Urban Unison. *International Journal of Engineering Research and General Science*. Vol. 4 (3), pp. 516-521.

United Nations Department of Economic and Social Affairs (UN DESA) (2018). *The 2018 Revision of World Urbanization Prospects*. Geneva, UN DESA.

Ur, J. A., Karsgaard, P. and Oates, J. (2007). Early Urban Development in the Near East. *Science*. Vol. 317 (5842), pp. 1188. DOI: 10.1126/science.1138728.

Wakil , K., Naeem, M. A., Anjum, G. A., Waheed, A., Thaheem, M. J., ulHussnain, M. Q. and Nawaz, R. (2019). A hybrid tool for visual pollution assessment in urban environments. *Sustainability*. Vol. 11 (2211).doi: 10.3390/su11082211.

Yilmaz, D. (2011). In the context of visual pollution: effects to Trabzon City Center Silhoutte. *Asian Social Science*. Vol. 7 (5), pp. 98-109.

Yusuf, H. (2013). Reduction of visual pollution and access to an appropriate color environment. Retrieved on 30th May, 2020 from http://creamainteriors.com/wp-content/uploads/2013/09/Reduction-of-visual-pollution-and-access-to-an- appropriate-color-environment.pdf.

Zare, G. A., Sheikh, V. and Sadoddin, A. (2011). Assessment of seasonal variations of chemical characteristics in surface water using multivariate statistical methods, *International Journal of Environmental Science and Technology*.Vol. 8(3), pp. 581-592, Doi: 10.1007/BF03326244.