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LINEAR DISCRIMINANT ANALYSIS OF MULTIPLE GROUPS IN RURAL SETTLEMENTS OF AKWA IBOM STATE, NIGERIA

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ABSTRACT

This study examined the levels of stock of social infrastructure and the spatial pattern of development in rural areas of Akwa Ibom State, Nigeria. Empirical and theoretical approaches were employed in the investigation and data on 21 social indicator variables/surrogates were collected from 50 villages in the State using questionnaire and field observation as research tools. An index of social infrastructure stock was evolved and hierarchical cluster analysis statistics was applied on the stock of social infrastructure in order to group the communities on the basis of social infrastructure profiles. The single linkage cluster analysis was employed to illustrate the linear combination of the communities in rural areas that were found to fall into low (Group 1), fair (Group 2), moderate (Group 3) and high (Group 4) performance patterns of social infrastructure stock. The result shows that the study area is characterised by many vulnerable communities that are very weak in stock of social infrastructure. The multiple linear discriminant Analysis (MLDA) technique was used to assess the optimality of earlier groupings of settlements in the study area. The result showed that MLDA correctly classified 97.6 per cent of the settlements. The technique correctly classified most of the Group one settlements with a few misclassifications but correctly classified all the remaining groups of settlements without any misclassification. In addition, health infrastructure was identified as the single most important independent variable that discriminated the four groups of settlements obtained earlier, thus highlighting its contribution to improving the social infrastructure in the study area.

Introduction

Social infrastructure covers such basic services as education, health, water, electricity, communication and transportation services, housing and other social services needed to facilitate industrial and other socio-economic development[1,2&3]. Providing infrastructure services to meet the demand of households, industry and other users is crucial in modernisation[4] while lack of it reduces rural-urban linkages and impedes sustainable growth[5]. In Nigeria, most rural areas characterise low level infrastructure than the urban areas. According to the World Bank[6], the growth of farm productivity and non-farm rural

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employment in the rural areas where most of the poor reside, is linked to the extent and quality of social infrastructure. The use of basic social infrastructure as a development strategy forms the World Bank's parameter for assessing the level of prosperity or poverty anywhere in the world. Therefore, is the need to adopt social planning framework as a powerful and result- oriented planning strategy not only for solving humanity's social problems but also economic problems[7].

Social infrastructure development is a cardinal issue in the Millennium Development Goals (MDGs) to address socio-economic needs of the poorest economies in the world. Some of the indicators of the MDGs include halving extreme poverty, increasing access to safe drinking water, education and healthcare facilities for all by the year 2015[8]. More interestingly, the seventh goal of the MDGs focuses on the need to ensure environmental sustainability. This goal provides the framework for a more robust approach in the context of sustainable human settlements development in Nigeria. Considering that Nigeria subscribes to the MDGs as a member of the comity of Nations, it is envisaged that sustainability of our enviornment and human life will not be achieved unless, among other things, human settlements in both rural and urban areas are made economically buoyant, socially vibrant and environmentally sound through the instrumentality of social infrastructure networking.

Akwa Ibom was selected for this study because it is one of the major oil producing States in Nigeria and for this reason receives far more revenue from the Nigeria's federation account than the non-oil producing States. Despite this high revenue, preliminary investigation has shown that the level of rural infrastructural development in the State is indisputably low, although the pattern of development from the perspective of social infrastructure distribution has not been substantively established.

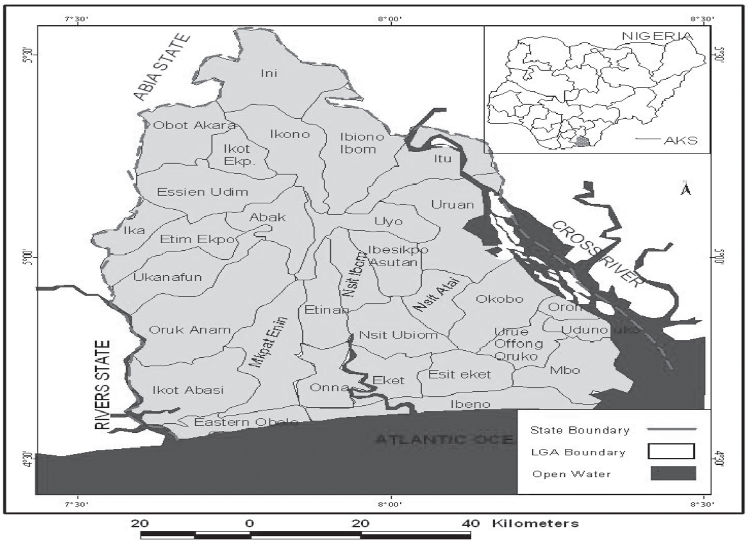
Located in the Niger Delta region of Nigeria (Fig.1) Akwa Ibom is a major oil producer, yet it is characterised by rising waves of youth restiveness typical of States in the region. It is the second most populated State in the region with an average density of 634 persons per square kilometer[9]. Aster[1] applied cluster analysis to group 50 rural settlements in the State on the basis of social infrastructure stock without further investigation to explain or identify factors that were useful in the classifications.

The objective of this study is to provide a more effective development strategy based on the proper understanding of the State's rural space. This will be achieved by classifying fifty sampled rural communities in the State on the basis of social infrastructure stock and to proceed to identify the major variables which discriminate these communities. The aim is to provide planners with the appropriate variables to consciously target in their attempt to plan the development of spatially distinct areas. This will make rural development efforts more specific and rewarding rather than the current efforts of applying a blanket planning strategy to the entire rural areas of the State.

Study Area and Method

Akwa Ibom is located in the southeastern coast of Nigeria. The State is wedged between Rivers, Abia and Cross River States and the Republic of Cameroon to the southwest, north, east and southeast, respectively while the Bight of Bonny bordered the State to the south. The State has 31 Local Government Areas with Uyo, Eket, Ikot Ekpene, Abak, Etinan, Ikot Abasi and Oron being the most developed urban centres. According to the 2006 National Population Census result, Akwa Ibom had a total population of 3920208 persons out of whom 87.89 per cent constituted rural population while 12.11 per cent formed the urban population[10]. The large rural component of the population makes it expedient to assess the levels of stock of social infrastructure in rural areas of the State.

Figure 1 : Map of Akwa Ibom State



To achieve this, map of Akwa Ibom drawn on a scale of 1cm representing 2.5 km was divided into grid squares (quadrates) of 0.5 cm sq to provide a framework for selection of units of observations. The use of grid squares is not new as Abiodun[11] applied grid squares as units of observations to analyse industrial growth patterns in Nigeria between 1962 and 1974 and had valid conclusions. A total of 500 quadrates were subsequently numbered serially and sampled using table of random numbers. A total of 50 rural communities were sampled. Data on 21 social indicator variables or surrogates were obtained from each community using direct field observation by 28 research assistants as well as the use of structured questionnaire administered to 400 household heads. The sample size of 400 was statistically determined using Taro-Yamane formula for finite population in order to establish the minimum size of sample for generalisation of result thus :

n = N 177743

1+N(e^2 1+177743 x $(0.05)^2$

Where

n = sample size 1+177743 x (0.0025)

N = Finite Population 177743

e = Level of significance (0.05) 445

I = Unity = 400

Uzoagulu[12]

Since the 50 rural communities differ in terms of population, proportional representation was adopted and systematic random sampling was employed to select household heads proportionately in all the 50 communities for questionnaire administration using variables indicated in Table 1.

Table 1: Indicator Variables of Social Infrastructure

Sector		Variables	Unit of measurement	Standard required (expected)
1	Water (W)	(a)Major source	Borehole(3), well(2), stream/river/pond(1)	Borehole[13]
		(b)Distance	Time	30 minutes[13]
		(c)Borehole	Number / community	1/250 population
2	Health (H)	(a)Types	Hospital(4), Health centre(3), Clinic (2), Disp.(1)	Base on population of community
		(b)Ownership	Government(3), community (2), private(1)	Government ownership
		(c)Hospital beds	Number / health facility	Base on population of community
		(d)Doctors	Number / health facility	Base on population of community
		(e)Nurses	Number / health facility	Base on population of community
		(f)Distance	Kilometers	Base on type of health facility/ community
3	Education(E)	(a)Primary	Number	1/3000 population[14]
		(b)Secondary	Number	1/12000 population[15]
		(c)Distance to primary	Kilometers	2.5 kilometers as maximum
4	Road (R)	(a)Category	Federal(3), State(2), Local(1)	Federal
		(b)Types	Paved(1), unpaved(0)	Paved
		c)Mode of transport	Motorised(3), bicycle(2), on foot(1)	Motorised
		(d) Usage intensity	High(3), Moderate(2), Low(1)	High

(Contd.)

Table 1: *(Contd.)*

5	Others (O)	(B)Nearness to bank	<500m(5), 500-1km(4), 1.1km-3kms(3), 3.1kms -5kms(2), >5kms(1)	<500m
		(P)Nearness to police		
		(M)Nearness to market		
		(E)Electricity supply	Available(1), not available (0)	Availability
		(T)Telephone (GSM)	Available(1), not available (0)	Availability
Water Index		Level of achievement for a, b, c = observed + expected x 1. Index =levels of achievement for a, b, c + 3		
Health Index		Level of achievement for a, b, c, d, e, f = observed + expected x 1. Index = levels of achievement for a, b, c, d, e, f + 6		
Education Index		Level of achievement for a, b, c = observed + expected x 1. Index =levels of achievement for a , b, c + 3		
Road Index		Index = summation of levels of achievement for a, b, c + 10		
Others Index		Index = summation of scores for B, P, M, T, E + 17		

Source : Atser[1].

These variables relate to issues of availability, adequacy and accessibility. The initial concern was to determine the availability of infrastructure and level of adequacy while the next consideration was on the level of accessibility in terms of distance measured in kilometres or time spent in accessing existing facilities. The spatial pattern of social infrastructure stock was depicted using data evolved to measure levels of development in five social sectors as shown in Table 1. The levels of development in these social sectors were subsequently summed up to obtain the stock of social infrastructure in each community. The hierarchical cluster analysis was applied on the stock of social infrastructure in order to group the communities on the basis of their social infrastructure profiles using version 13.0 of the statistical package for Social Sciences. One of the simple forms of cluster analysis is the single linkage cluster analysis which offers a simple way of summarising relationship in the form of a dendrogram. This was employed to illustrate the linear combination of the communities on the basis of their stock of social infrastructure.

To assess the optimality of such a grouping procedure and thus bring to light the variables which differentiate or discriminate these groups, a multiple groups linear discriminant analysis was performed on all the four groups earlier obtained from the cluster analysis procedure. Linear discriminant analysis is a multivariate technique which allows for a study of the differences between two or more groups of objects with respect to several variables simultaneously. In employing the technique, our interest is in the way in which groups differ on the basis of some sets of characteristics i.e. how well they discriminate and which characteristics are the most powerful discriminators. Discriminant analysis achieves this by extracting one or more linear combinations of the discriminating variables such that an individual can be assigned to one or more than one group without the least chance of being misclassified. In terms of assumptions, discriminant analysis shares most of the common assumptions of the multiple linear model, yet Lachenbruch[16] and Klecka[17], among others, have noted that linear discriminant analysis is relatively robust as it is unaffected by departures from normality or heterogeneity of variances. The discriminant function is written as :

$$Z = b_1x_1 + b_2x_2 + \dots b_nb_n + c$$

Where ,

Z = the score of the discriminant function

b = the standardised weight of the coefficient to be estimated (a reflection of the relative of importance of each discriminating variable)

x and n = the standardised discriminating variables and number of observations or predictor variables used.

C = Constant

Discriminant functions were estimated with SPSS Version 14 using a direct procedure which entered all the explanatory variables into the model.

Results

The initial study by Atser[1] witnessed the use, among others, of cluster analysis technique to group the settlements into four groups based on their performance on the social infrastructure stock of the study area presented in Table 2. In order to determine the spatial patterns of development of social infrastructure in the study area, the results of preliminary analysis of levels of access to social infrastructure were integrated into one as

Table 2 : Levels of Social Infrastructure Stock in the Study Area

S.No.	Social Infrastructure / Communities	W	E	H	R	O	Observed total stock	Observed mean	Expected total stock	Expected mean
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
1.	Ito Ika	-1.67	2.20	-2.00	1.0	0.4	-0.07	-0.01	43.39	2.16
2.	Iqua	-0.67	0.60	-1.10	1.0	0.1	-0.07	-0.01	54	2.70
3.	Ikot Inyang	-1.67	1.50	-0.9	0.60	0.5	0.03	0.00	47.26	2.36
4.	Mbiabong Ikono	-1.67	3.40	-2.50	0.70	0.4	0.33	0.07	45.99	2.29
5.	Nwot Ikono	-0.41	1.30	-1.20	0.70	0.4	0.79	0.16	48.68	2.43
6.	Ikot Umiang	-1.67	1.20	0.50	0.90	0.3	1.23	0.25	56.06	2.80
7.	Urukim	-0.32	0.10	0.50	0.60	0.4	1.28	0.26	62.75	3.13
8.	Ikot Udo Obobo	-1.67	0.60	1.10	1.0	0.4	1.43	0.29	59.59	2.97
9.	Ikot Ekpaw	-0.56	2.10	-1.02	0.60	0.6	1.72	0.34	59.59	2.97
10.	Aka Ekpeme	1.78	1.50	-2.50	1.0	0.6	2.38	0.48	47.04	2.35
11.	Ikot Udo Offong	1.67	3.40	-0.30	0.60	0.4	2.43	0.49	55.56	2.77
12.	Ikot Etefia	-1.67	2.9	0.30	0.60	0.4	2.53	0.51	102.36	5.11
13.	Ikot Odube	1.21	2.40	-2.00	0.70	0.5	2.81	0.56	40.53	2.02
14.	Nsasak	0.64	1.50	-0.00	0.90	0.4	3.44	0.69	59.7	2.98
15.	Ikot Ibok	-1.67	1.70	3.20	0.50	0.2	3.91	0.78	53.18	2.65

(Contd.)

Table 2 : *(Contd.)*

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
16.	Eyo Nsek	-0.37	2.80	0.60	0.90	0.4	4.33	0.87	44.18	2.20
17.	Ikot Akpadem	1.41	1.40	-0.00	1.0	0.6	4.41	0.88	60.1	3.00
18.	Utu Nsekhe	2.60	1.40	-0.50	0.70	0.4	4.60	0.92	46.88	2.34
19.	Etibe Afaha	-1.67	1.70	4.20	1.60	0.4	5.23	1.05	114.76	5.73
20.	Ikot Uko	1.64	3.20	-0.50	0.70	0.5	5.54	1.11	41.87	2.09
21.	Ndon Ebom	0.45	3.9	0.10	1.0	0.4	5.85	1.17	104.47	5.22
	Group 1 Total	-7.63	40.80	-4.02	16.30	8.70	54.13	10.83	1247.84	62.27
	Mean	-0.36	1.94	-0.19	0.78	0.41	2.58		59.42	
22.	Ikot Obio Odongo	1.59	1.50	2.70	0.60	0.5	6.89	1.38	57.92	2.89
23.	Mkpok	2.38	2.10	1.40	0.60	0.5	6.98	1.40	63.47	3.17
24.	Ndukpoise	-0.67	3.90	3.20	0.60	0.1	7.13	1.43	70.97	3.54
25.	Ukpom Usung Ubom	1.89	2.70	1.50	0.70	0.7	7.49	1.50	42.44	2.12
26.	Mbiakpa Ibakesi	-0.60	1.20	6.20	0.50	0.4	7.68	1.54	61.19	3.05
27.	Okoro Inyang	1.86	3.30	1.40	0.80	0.6	7.96	1.59	41.13	2.05
28.	Utu Edem Usung	2.30	0.60	4.10	1.0	0.7	8.70	1.74	65.63	3.28
29.	Ikot Akpabim	1.80	1.10	4.50	0.80	0.7	8.90	1.78	52.82	2.64

(Contd.)

Table 2 : *(Contd.)*

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
30.	Ikot Ukana	-1.67	1.90	8.10	0.60	0.4	9.33	1.87	46.22	2.31
31.	Ukana	2.40	2.00	3.70	0.70	0.7	9.50	1.90	48.22	2.41
32.	Mbak Ikot Abasi	-0.60	1.40	8.30	0.60	0.4	10.1	2.02	57.1	2.85
33.	Ekparakwa	0.51	2.10	6.50	0.80	0.4	10.31	2.06	66.28	3.31
34.	Mbiaso	1.96	2.90	4.10	1.0	0.4	10.36	2.07	41.75	2.08
35.	Nkari	0.44	2.20	6.80	0.70	0.4	10.54	2.11	69	3.45
	Group 2 Total	13.57	28.90	62.50	10.00	6.9	121.87	24.37	784.14	39.15
	Mean	0.97	2.06	4.46	0.71	0.49	8.71		56.00	
36.	Ikot Ubo	1.47	2.00	6.50	0.90	0.5	11.37	2.27	83.27	4.16
37.	Mbokpu Eyekan	0.47	1.70	8.50	0.70	0.5	11.87	2.37	61.5	3.07
38.	Akpa Utong	1.60	1.90	7.20	0.90	0.4	12.0	2.40	57.35	2.86
39.	Ibiaku Uruan	0.22	3.90	8.00	0.70	0.4	13.22	2.64	76.34	3.81
40.	Ikot Abia	0.49	5.40	6.20	1.0	0.5	13.59	2.72	53.5	2.67
41.	Ekeya	-0.64	4.40	8.40	0.80	0.7	13.66	2.73	95.03	4.75
	Group 3 Total	3.61	19.30	44.80	5.0	3.0	75.71	15.14	426.99	21.32
	Team	0.60	3.22	7.47	0.83	0.5	12.62		71.16	

(Contd.)

Table 2 : *(Contd.)*

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
42.	Abak Ikot	1.78	2.60	8.80	1.0	0.6	14.78	2.96	47.22	2.36
43.	Atiamkpat	1.44	4.1	8.30	0.70	0.4	14.94	2.99	68.09	3.40
44.	Ikot Oku Ikono	1.61	2.80	9.10	0.90	0.6	15.01	3.00	55.22	2.76
45.	Okobo Ebughu	1.50	4.80	7.60	1.0	0.5	15.40	3.08	66.94	3.34
46.	Ikot Ibiok	2.27	5.10	6.70	1.0	0.6	15.67	3.13	67.4	3.37
47.	Use Offot	2.70	5.0	6.42	0.70	0.7	15.70	3.14	72.92	3.64
48.	Ituk Mbang	1.18	5.50	8.20	1.0	0.8	16.68	3.34	84.3	4.21
49.	Mbiokporo 1	0.93	1.70	14.00	0.80	0.7	18.13	3.63	52.93	2.64
50.	Nung Udoe Itak	0.43	6.9	9.50	0.90	0.7	18.43	3.69	71.92	3.59
	Group 4 Total	13.84	38.50	78.62	8.20	5.6	144.74	29.23	586.94	29.31
	Mean	1.53	4.27	8.73	0.91	0.6	16.08		65.21	

Source : Atser[1]. Key : W = Water Index, H = Health Index, E = Education Index, R = Road Index, O = Other Infrastructure Index.

shown in Table 2. Specifically, the index values on water supply, education, health care facilities, road network and other facilities are summed up into one index which defines the overall level of development of the communities on the basis of stock of social infrastructure. Thus, the general performance of the study area in terms of stock of social infrastructure, ranges from -0.07 as the least score to 18.43 as the highest score. A total of 17 sampled communities have total performance scores of 10 and above while 33 communities representing 66 per cent score less than 10 points.

Table 2 presents the observed and expected total and mean stock of social infrastructure. On the basis of the magnitude of the observed total stock, the 50 communities are rearranged in descending order with defined cut-off line after each cluster. Further analysis is performed on the stock of social infrastructure using cluster analysis model. This is to aid the classification of communities under study on the basis of their infrastructural profiles. From the result of the cluster analysis, four groups of communities emerged as shown in Table 3.

Table 3: Summary Statistics of Cluster Analysis for Observed Stock

Cluster	Number of cases	Range of stock	Cluster total stock	Mean stock per settlement	Mean stock per facility	Status
1	21	-0.07 – 5.99	54.13	2.58	0.5	Low
2	14	6.00 – 10.99	121.87	8.71	2.5	Fair
3	6	11.00 – 13.99	75.71	12.62	1.7	Moderate
4	9	14.00 -18.99	144.74	16.08	3.2	High
Total	50	-0.07-18.99	396.45	7.93	1.5	

Source : Atser[1] .

Social infrastructure and other basic facilities have minimum population threshold as requirements for their provision. These minimum requirements were used alongside the population of the various communities to establish the expected total and mean stock of social infrastructure for the study area. However, the four clusters that emerged from te study were derived from the observed mean stock. The expected stock per cluster however places all the settlements in the category of low levels of development except a very few communities which have observed mean stock above their expected mean stock values. These communities are Nung Udoe Itak : 3.69 (3.59); Mbiokporo 1:3.63 (2.64); Ikot Oku Ikono : 3.00 (2.76); Abak Ikot : 2.096 (2.36); and Ikot Abia : 2.72 (2.67). Interestingly, these four communities fall in the fourth cluster indicated as developed group of settlements (see Table 2).

From Table 3 the cluster analysis has grouped the communities into four clusters or categories based on their observed levels of performance on stock of infrastructure. This implies that the initial 50 communities could be adequately classified into four groups. In order to further determine the critical need-gap levels among the four categories of settlements, the social infrastructure profile of each group is analysed. The first group was composed of a total of 21 settlements which performed poorest on the social infrastructure stock computed. This was followed by the second group with 14 settlements. Next was group 3 with 6 settlements while group 4 with 9 settlements performed highest on the social infrastructure stock. The first group consists of 21 communities. The characteristics of this group include a very weak positive performance score on social infrastructure stock as Table 2 shows. With a total cluster stock of 54.13 points and an average of 2.58, the overall performance score for the group is very weak. Water supply sector records the weakest performance as exemplified by its negative mean score of -0.36. This is followed by the health sector with a negative mean score of -0.19. The education infrastructure has the strongest positive score in this group as indicated by its mean score of 1.94. Among the 21 communities, Iqua and Ukana have the weakest mean score (-0.01) while Ndon Ebom records the highest score of 1.17. This group is deficient in almost all the social infrastructure indicators. The negative mean scores observed in the water supply and health sectors, implies the magnitude of the need gap. Thus, this group of communities is the least developed in terms of levels of access to basic social infrastructure and could be termed the most vulnerable communities.

The composition of group two is also summarised in Table 2. This group has fourteen-cluster membership with a combined cluster total stock of 121.87 and a mean of 8.71. The overall performance of this category of communities studied is weak as only 4 out of the total cluster membership recorded positive mean scores that are slightly above 2 points. There are only 6 communities in the third group with a combined cluster stock of 75.71 and a mean score of 12.62. The overall performance of this group of communities is moderate as its mean score of 12.62 is above 7.93 representing the mean score for the entire study area (Table 3). Group four comprises nine-cluster membership. It features prominently as the group with a very strong positive performance scores on stock of social infrastructure. The group has a total of 144.74 cluster stock scores and an average of 16.08 point and thus stands out above all other groups in levels of performance (Table 2). On the whole, the distribution of the performance scores among the communities analysed provides a means of easy identification of spatial variation in levels of access to basic social infrastructure in the study area. While three communities have the least mean performance scores of less than 0.01, seven other ones are outstanding among the 50 communities with average performance scores of above 3 points. Generally, majority of the communities as well as the people in the study area have poor access to social infrastructure development.

Optimality of the Settlements Groupings

The result of multiple linear discriminant analysis carried out on all the four groups of settlements earlier derived from a cluster analysis solution is presented in Table 4. The interpretation of the discriminant function analysis on SPSS is reasonably straightforward. Discriminant function analysis is a way of assessing whether members of different groups can be identified on the basis of their scores on a set of variables. There may be several discriminant functions obtained in an analysis. The number depends on the characteristics of the data especially the number of independent variables. Each discriminant function is uncorrelated with the other, that is, they are independent of each other. This ensures that the discriminant functions have the maximum possible power to differentiate between the groups.

Figure 2 : Spatial Patterns of Social Infrastructure in Akwa Ibom State

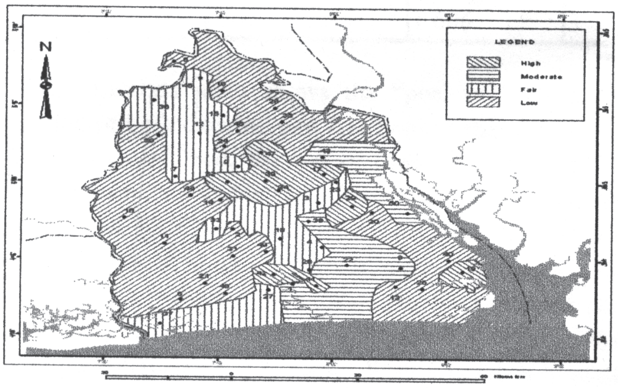


Table 4 : Summary of Canonical Discriminant Functions Eigenvalues

Functions	Eigenvalue	% of Variance	Cumulative %	Canonical Correlation
1.	2.879[a]	61.2	61.2	.862
2.	1.588[a]	33.7	94.9	.783
3.	.239[a]	5.1	100.0	.439

a. First 3 canonical discriminant functions were used in the analysis.

Three discriminant functions have been identified. One is substantial as it accounts for 61.2 per cent of the reliable variance; the second is quite small in comparison as it explains only 33.7 per cent while the third function is insignificant. In Linear discriminant analysis, function 1 is computed upon which the group means are as different as possible. This is followed by function 2 that is orthogonal to function 1 and so on. The eigenvalues and their associated canonical correlations show the relative ability of each discriminant function to discriminate the groups. Usually, eigenvalues that are less than unity are considered useless. The absolute value of the Standardised Canonical Discriminant Coefficient is a measure of discriminatory ability. Having been standardised, it means that the larger the values, the greater the variables' ability to discriminate. The values may then be used to rank the importance of each variable. Table 4 shows that Function I with the engenvalue of 2.879 accounts for about 61.2 per cent of the variance in the social infrastructural stock in the four groups of settlements (the dependent variable) while

Table 5 : Wilks' Lambda

Test of Function (s)	Wilks' Lambda	Chi-square	df	Sig.
1 through 3	.080	18.906	15	.218
2 through 3	.312	8.738	8	.365
3	.807	1.606	3	.658

Function 2 accounts for 33.7 per cent, the third function accounts for the remaining 5.1 per cent making a total 100 per cent. Canonical correlation indicated that Function 1 is very strongly correlated with the four groups of settlements.

The Wilk's Lambda Table shows the "peel off" significance test of successive discriminant functions. For the combination of both discriminant functions, 1 through 3; all functions tested together, chi-square is 18.906. After the first function is removed, the test of function 2 through 3 shows that chi-square is 8.738. This is still statistically significant at □ = .05 because sig. = .365. Function 3 is equally significant after the removal of the first two functions. This means that the first and second functions are significant as well as the third, if not the third discriminant function would not have been marked as one of the discriminated functions remaining in the analysis. Wilk's Lambda statistic is used to test the Null hypothesis (Ho) that the canonical correlations derived are equal to zero in the population. It is the product of the values of one minus canonical correlation square. It tests which variable contributes significantly to the discriminant function. The closer Wilk's Lambda is to zero, the more the variable contributes to the discriminant function. The chi square statistic is used to test the significance of Wilk's Lambda. If the p-value is less than 0.05, it means that the corresponding function well explains group membership. Wilk's Lambda statistics (Table 5) show that function 1 in the most significant in discriminating the groups. This is followed by function 2 while function 3 is the least significant.

Table 6 : Standardised Canonical Discrminant Function Coefficients

Sector	Function		
	1	2	3
Water	1.425	.739	.006
Education	1.006	-.321	-.199
Health	.928	1.694	.273
Road	.588	.370	.320
Others	.100	.444	.969

Standardised canonical discriminant function coefficient are given for driving discriminant function scores from standardised predictors. The correlation loadings between predictors and discriminant functions are given in structure matrix. These are ordered so that predictor loadings on the first discriminant function are listed first and those loadings on the second discriminant function listed second and so on. Standardised canonical discriminant function coefficients are also known as discriminant refers. As in Principal component analysis and Factor analysis, their loadings are used to name the discriminant functions extracted. The signs indicate whether the coefficient is making a positive or negative contribution to the function extracted. Because they are in standard form, the higher they are the more important they are in explaining the functions extracted. The result shows that water recorded the highest loading (1.425) followed by education (1.006) in function1. Function 1 is therefore, identified as a water/education function. Based on the high loading (1.694) in function 2, this function is significant, and is therefore, identified as a health function. Function 3 loading high (.969) on others; it is also a significiant function.

Table 7 : Structure Matrix

Sector	Function		
	1	2	3
Water	.468*	-.127	.379
Education	.437*	-.430	-.423
Health	.114	-.301	.909
Road	.057	.120	.631*
Others	-.163	.617	.621*

* Largest absolute correlation between each variable and any discriminant function.

Canonical structure matrix reveals the correlation between each variable in the model and the discriminant functions derived. Differently put, it measures directly, the contribution of the criterion and the predictor variables to pairs of canonical variates extrated. It is simply obtained by carrying out the correlation between the original variables (p and q) and the extracted canonical variates. A discriminant function is a sort of variable based on several measured variables. Therefore, in order to understand what the discriminant function measures, it is necessary to know how each of the score variables that contribute to the discriminant function correlate with that discriminant function. This information is found in the structure matrix function (Table 7). This, taken in combination with the classfication result (Table 9), gives a basic understanding of the output of the discriminant function analysis. Table 7 shows that the water sector contributes more and so can be used to predict discriminant function 1. This is followed by education. For discriminant function 2, it is the health sector that contributes more. The third function is influenced by other sectors, this function is also significant. The structure matrix component shows the correlation of each independent variable with each discriminant function and as in factor analysis; the largest values may be used to name each function. In this case function 1 is clearly a water/education function while function 2 may be regarded as a health function. Function 3 may be regarded as other sectors' function; although it is a weak function. This means that the presence of water, education and health facilities are the most important variables in differentiating the four groups of settlements in the study area. The meaning of a discriminant function lies in the variables that were used to derive the discriminant function. Some variables will be strongly related to the discriminant function and others will relate to it poorly. So the variables that correlate with (load on) a discriminant function are the ones that identify what the discriminant function is.

Table 8 : Functions at Group Centroids

Groups	Function		
	1	2	3
1,000	-1.982	.059	.214
2,000	.740	-1.425	-.146
3,000	.033	1.327	-.803
4,000	1.634	.937	.444

Unstandardised canonical discriminant functions evaluated at group means.

Functions at group centroids indicate the average discriminant scores (multivariate means) for each group on each function. The means of each of the group on the resulting discriminant function are calculated. Centroids are the canonical group means. They are means for each group's canonical observation score. The larger the difference between the canonical group means, the better the predictive power. Table 8 shows unstandardised canonical discriminant functions evaluated at group means. The Table shows that the groups are well discriminated as the mean values are far apart from each other. Looking at the signs of the centroids (positive or negative), function 1, which is a water/education function, discriminates Group 1 settlements from the other two (-1.982). Function 2 which is a health function seems to discriminate Group 2 settlements from both Groups 1 and 3 and lastly, function 3 discriminates Group 3 settlements from Groups one and two though it is less significant.

The results indicate that the rows represent actual group membership (original count) and columns represent predicted group memberhship. Within each cell, the number and per cent of cases correctly classified are shown. A Classification Table is also called a prediction matrix or a confusion matrix and it contains the number of correctly classified and misclassified cases. The Table compares the actual group membership with the predicted group membership. It enables us to see how well or how poorly the predicted discriminant

Table 9 : Classification Results

			Predicted Group Membership				
		Groups	1,000	2,000	3,000	4,000	Total
Original	Count	1,000	4	0	0	0	4
		2,000	0	4	0	0	4
		3,000	0	0	1	1	2
		4,000	0	0	0	3	3
		Ungrouped cases	3	2	0	32	37
	%	1,000	100.0	.0	.0	.0	100.0
		2,000	.0	100.0	.0	.0	100.0
		3,000	.0	.0	50.0	50.0	100.0
		4,000	.0	.0	.0	100.0	100.0
		Ungrouped cases	8.1	5.4	.0	86.5	100.0

92.3 per cent of original grouped cases correctly classified.

functions fit actual group membership. In this Table, each row and column corresponds to one of the groups. The numbers on the diagonal represent cases that have been correctly classified. In the Classification Table, the rows are the actual and the columns are the predicted values. All cases will lie on the diagonal axis when prediction is perfectly archived. Table 9 shows how well MLDA has performed the classification. The Table shows that MLDA has correctly classified 92.3 per cent of original cases. The multiple linear discriminant technique correctly classified 100 per cent of Group 1 settlements as Group 1 settlements with no misclassification. The same applied for Group 2, however 50 per cent of Group 3 settlements were correctly classified as Group settlements were correctly classified as Group 3 but misclassified 50 per cent of Group 3 settlements as Group 4 settlements. It correctly classified 100 per cent of Group 4 settlements with no misclassification.

Conclusion

Four groups of settlements namely Group 1 (Low performance), Group 2 (Fair performance), Group 3 (Moderate performance) and Group 4 (High performance) were derived using cluster analysis procedure. After that, efforts were made to assess the optimality of such a classification as well as identify the variables which discriminate these groupings of settlements using multiple linear discriminant analysis (MLDA). The result shows that the multiple discriminant analysis technique correctly classified about 92.3 per cent of the settlements thus confirming the earlier classification obtained using cluster analysis. The result shows that the presence of water, education and health facilities are the most important indicators which discriminate the four groups of settlements in the study area. This is confirmed by inspecting the entries in Table 2. The overall result of the study has some implications for the sustainability of rural communities in Akwa Ibom State. The four settlements groupings depict the varying degrees of concentration of stock of social infrastructure. The observed unequal concentration of stock of social infrastructure implies that some communities and families are more vulnerable than others. The spatial patterns that emerged from this study, serve as a framework for development intervention by government at all levels and other international development agencies to direct attention to the most vulnerable communities in their welfare development efforts. At the present levels of development, the sustainability of most of the rural communities and human life in the study area is in doubt and may not be achieved within the MDGs target period of 2015, unless drastic measures are directed towards making the rural communities economically buoyant and socially vibrant. There is the need to adopt social planning framework as a purposeful and result-oriented planning style to meet the social needs of rural communities and families.

The spatial pattern of the water, education and healthcare facilities distribution are identified as the most important indicators which discriminated the four settlements groupings in the study area. The observed strong disparity which occurred in the spatial distribution of water, education and healthcare facilities, by extension, resulted in the disparity among settlements in terms of overall development. Disparity in access to basic social facilities among families and communities could generate corresponding spatial disparities in levels of productivity as a result of the existing correlation between basic facilities, welfare of population and productivity. Thus, the criticality of basic social facilities in the overall development of the rural communities calls for proactive role by all the tiers of government and the private sector to intervene aggressively in the development of the most vulnerable communities. In this context, the type of basic social facilities should be used based on population threshold in order to bring equity to bear on facility distribution.

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