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An Examination of Causes of Public Water Supply Inadequacies in Abia State, Nigeria

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Abstract

This study examined public water supply inadequacies in Abia State. It employed the sample survey method which involves the administration of questionnaires, oral interview, amongst others. This was done to determine the environmental, systemic and human factors responsible for water supply situation in the area. Principal Components Analysis (PCA) was used to collapse the variables (causes of potable water supply deficiency) into significant components explaining the underlying dimensions of the potable water supply shortages in the area. All the statistical computations and analyses for the PCA were done with IBM SPSS version 20. The study found the mean household size of 7 people which is at variance with the national household mean of 5 people per household while the per-capita consumption of water is 40.9 litres per person per day with a deviation of 74.1 litres. The deficiency in potable water supply from the period of 2004 – 2012 (period of data availability) stood at 237,011,294.5m^3. The use of PCA has thus made it possible to reduce the 30-predictor variables to ten major components or factors of potable water supply deficiencies in the area. These ten components incorporate environmental, systemic and socio-economic factors responsible for potable water supply shortages in the area. The study recommends among others that water agencies should be adequately funded for the procurement of equipments, spare parts and chemicals for purifying and treatment of water in the various stations, and to automate their network surveillance for rapid response to system failures. The Geographic Information System (GIS) technologies will enhance the capability of the agencies to cope with these challenges and should be pursued with vigor.

Keywords: *Causes, Public water, Supply, Inadequacy, Abia State.*

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Background to the Study

Water, as a social service is not only important for the proper functioning of the human system but for overall economic development process. Pure water has no substitute being perhaps the most versatile servant of man. Water has a very high status in the domestic and economic life of both rural and urban dweller. It remains one of the key social amenities without which life will be at a standstill in any environment, settlement or society (Tebbut, 1993).

In spite of its extreme importance, potable water supply in Nigeria is facing serious challenges. Water supply in Abia State is problematic, particularly potable water. The general picture about potable water supply in Abia State is one of either total absence or gross inadequacy of the existing system. Successive governments have been pursuing with vigour aggressive water supply programme. Despite these efforts in water related infrastructure, the public are still disenchanted because access to potable water and the quality of services in this sector remains poor.

The responsibility of providing potable water in Abia State rests solely on the shoulders of the State Water Board. But all it has to show for this is an array of abandoned projects and obsolete equipments that have become monuments, a situation which has resulted in one of either total absence or gross inadequacy of potable water supply. This state of affair in which most existing water supply projects are abandoned is very disturbing and unacceptable because water security is not only for human consumption but provides a take-off ladder for the economic development of any region.

It is an established fact that the demand for water is perfectly inelastic. Therefore, there is no substitute for water. Water can be put into its best use when the water is of very good quality. The development of adequate water supply is a function of availability of water sources; method and efficiency of exploiting the source; and the effectiveness of the distribution system (Chima, 1994). Hence, the availability of water sources without proper method of exploiting them and subsequent distribution to the final consumers may result in potable water supply shortages in relation to demand.

From the literature search, no study has been done in Abia state to identify the environmental, systemic and socio-economic factors responsible for potable water supply deficiencies. Chima (1988) used Factor Analysis (FA) to analyze causes of water shortages in Isiala Ngwa of Imo state while Phil-Eze (1986) also used the FA as a statistical method to determine the underlining factors influencing drainage basin morphology and the factors influencing runoff in those basins in Southeastern Nigeria. Chima (2000) used Principal Component Analysis (PCA) to determine success and failures of water supply projects in parts of Imo state while Alozie (2012) also used PCA to determine the factors that are capable to impede the exploitation of resources in wetlands. These aspects of the potable water supply have been scantly treated by workers in Nigeria and this study therefore hopes to fill the existing gap in knowledge.

Geography of the Area

Abia State lies within approximately latitudes $4^{\circ}40'$ and $6^{\circ}14'$ north, and longitudes $7^{\circ}10'$ and 8° east, and shares common boundaries with Enugu State in the North and Ebonyi State in the northeast; to the west is Imo State, and to the northwest is Anambra State. To the south and southwest, it shares borders with Rivers State; and to the east and southeast with Cross River and Akwa Ibom States respectively. The State covers an area of about 5,243.7sq.km which is approximately 5.8 percent of the total land area of Nigeria. With its capital at Umuahia, it has seventeen local government areas (LGAs).

In terms of relief, Abia State lies generally on a flat and low-lying land, generally less than 120m above sea level. Geologically, there are nine main geological formations from south to north. These include: the Benin formation (Coastal Plain Sand); the Bende-Ameki Group - Eocene (Clay, clayey and shale); the Nkporo Shale Group - Upper Senionian (Shale and mudstone); the Nsukka formation (Upper Coal Measures), the Igali sandstone (False-bedded Sandstone), the Eze-Aku Shale Group and the Asu River Group (Ijioma, 2000).

Abia State falls within the sub equatorial climatic zone with clearly marked dry season and double maxima rainfall in August and September. Relative humidity is usually high throughout the year. It varies considerably between the rainy and the dry seasons. The rainy months often have an average relative humidity of 80-90 percent while the dry months have an average relative humidity of 50-70 percent. The average monthly sunshine hours of the area are 4.8. The mean monthly evapotranspiration is 136mm (Abia State official website). The soils of Abia State fall within the broad group of ferrallitic soils of the coastal plain sand and escarpment (Ijioma, 2000). The vegetation is ordinarily considered part of tropical rain forest which is the dominant natural vegetation in most parts of southern Nigeria.

The national census of Nigeria carried out in 2006 puts the provisional population of Abia State at 2,845,380 while its projection to 2015 is 3,652,627. There was thus an increase of 807,247 people over a period of 9 years. The high population of the study area could have some implications for the potable water supply situation. It could lead to potable water supply shortages as a very high population will be depending on one of either total absence or gross inadequacy of the potable water by the water Board. On the other hand, the high population of the area could be used to develop potable water supply projects through proper planning and implementation.

Method of Study

This study employed the sample survey method. The sample survey involves the administration of questionnaires, oral interview, and direct observation, amongst others. This was done to determine the environmental, systemic and human factors responsible for water supply situation in the study area.

The survey was conducted using carefully designed questionnaire calculated to elicit as much information as was required or considered relevant to the goals of the study. Pre-coded questionnaire was administered to the respondents by the researcher (assigned by trained interviewer in some cases). In order to test the validity and reliability of the research instrument, the preliminary survey was conducted. In this preliminary survey, a total of 280 copies of questionnaire were pre-tested in the field to establish the likely response rate and the type of questions (data structure) to be employed in the detailed survey.

In the main study, 1400 copies of questionnaire were administered in the field. However, we could not get our entire questionnaire from the respondents. This may either be due to the fact that they did not understand the necessity for filling out the questionnaire or that most respondents could not be found during the time of collection. Because of this, it was impossible to recover the expected 1400 copies of household questionnaire and on the whole, 1146 households responded. This gave 81.9% response rate and 18.1% non-response.

Although, the questionnaire largely contained close-ended questions for easy collation of responses, some open-ended questions were included to allow respondents some freedom to state their case concerning the system of interest, in order to obtain a clearer insight into questionnaire items. However, six (6) field assistants were used to conduct the questionnaire administration and retrievals. Also used were interview schedules answered by the zonal and unit leaders in the State Ministry of Public Utilities and the State Water Board. Information on the general activities of the water Board and other vital information found necessary for the work were thus provided by the unit leaders and the Board respectively. Private borehole operators and water vendors who may provide alternative sources of water to the households were also interviewed. Oral interviews were used to complement the response obtained from the questionnaire. Oral interviews became very necessary since most of the respondents cannot read nor write but are intellectually rich in ideas especially those pertaining to their welfare.

Generally, simple statistical techniques like frequency distribution, percentages and means were used as tools for comparison while tables, were used to show the relationship of variables for easy analysis. In addition to these, Principal Components Analysis (PCA) was used to collapse the variables (causes of potable water supply deficiency) into significant components explaining the underlying dimensions of the potable water supply shortages in the area. All the statistical computations and analyses for the PCA were done with IBM SPSS version 20.

Demand-Supply Relationship of Potable Water Supply

The terms water demand and water consumption have been used interchangeably by several workers. This is because the consumption of water in any geographical area determines the demand and in most cases, the factors that affect water demand also affect the consumption pattern. This may justify their interchangeable use. However, the major difference between demand and consumption is that, water consumption is usually less than the demand. Because of this, most workers have used present water consumption patterns to predict and forecast future water demands for domestic and other uses.

However, in this study, water demand is taken to mean the expected (or anticipated) amount of water required by the urban people for their domestic activities. While consumption is the actual amount of water fetched and consumed by the people. It is also pertinent at this juncture to point out that we are basing our inquiry on household domestic water demand and consumption.

In this study, for us to effectively ascertain the water demand situation in the study areas, some indices would be of importance. These indices are; the size of household, the quantity of water used per person per day, the population, water demand and the quantity of water supplied in the area. Using the 1146 recovered questionnaires, the results of analyses of the various indices leading to water demand and consumption patterns as well as supply are discussed below. The mean household was found to be 7 people per household. This mean household is at variance with the national household mean of 5 people per household. The mean household domestic water consumption from the questionnaire samples shows that the per-capita consumption of water was 40.9 litres per person per day with a deviation of 74.1 litres for the urban areas of Abia State.

Future water demand was based on the per capita water consumption of 115 litres per person per day as recommended by the World Health Organization (WHO). That is, 115 litres per head per day × the population for the year. Using the projected population, available data shows water demands from 2004 – 2012 in Table 1.For water supply estimation, potable water supply for the base year (2004) is 135,080.00m^3/day while the projections for years up to 2012 were made. Having gotten the estimated water demand and supply, the margin of potable water supply deficiency is shown in Table 1.

Table 1: Potable water supply deficiency in umuahia urban

Period	Estimated water demand (m^3/day)	Estimated water supply (m^3/day)	Estimated population served	Deficiency in water supply (m^3/day)
2004	24,756,490.45	135,080.00	215,273.83	24,621,410.45
2005	25,499,010.95	201,809.52	221,730.53	25,297,201.43
2006	25,660,410.00	301,503.42	223,134.00	25,358,906.58
2007	26,430,222.30	450,446.11	229,828.02	25,979,776.19
2008	27,223,128.90	672,966.49	236,722.86	26,550,162.41
2009	28,039,823.25	1,005,411.94	243,824.55	27,034,411.31
2010	28,881,017.20	1,502,085.44	251,139.28	27,378,931.76
2011	29,747,447.90	2,244,115.65	258,673.46	27,503,332.25
2012	30,639,870.90	3,352,708.78	266,433.66	27,287,162.12
Total	**246,877,421.85**	**9,866,127.35**	**2,146,760.19**	**237,011,294.5**

Table 1 shows that 9,866,127.35m^3 of water were supplied from 2004 – 2012 to the urban population, whereas about 246,877,421.85m^3 were demanded from a projected population of 2,146,760.19. Therefore, the deficiency in potable water supply from the period of 2004 – 2012 stood at 237,011,294.5m^3. From the analyses done so far, it has been discovered that the inhabitants (households) have little access to potable water supply. The next issue is to find out why there are potable water supply shortages from the public water works (Water Corporation) and what factors are responsible.

Factors Responsible for Inadequacies of Urban Water Supply

Urban centers are witnessing the in-migration of people, and consequently, experiencing pressure on the water distribution system, which in most cases is unable to accommodate the number of inhabitants, thus, creating problems. This is a very common situation in Nigerian urban centers. Definitely, any urban area where water is inadequate suffers in terms of economic, social and health measures. In spite of the importance of water to life, the problems of acquiring safe water are quite enormous. This problem of water shortages when viewed from another direction is incident on a number of consequences as seen from the works of various scholars.

From the review of literature, various scholars such as Nkemdirim, (2010); Enger and Smith (2004); Longe, Omole, Adewumi, and Ogbiye (2010); Horsefall and Spiff (1998); Juma (1998); UN (2005); Chima et. al; (2008); Johnstone and Wood (2001); and Falusi, (1986); and from preliminary survey, it is our assumption in this study that the causes of potable water supply shortages in the area of study lie within the variables listed as shown in Table 2. These variables reflect environmental, systemic and socio-economic factors and are a fair reflection of the factors responsible for potable water supply shortages in urban areas of the country. In this study, it is our belief that these assumed variables which are subject to and amenable to quantitative analysis using PCA will adequately address the major factors/causes responsible for potable water supply shortages in the study areas.

Analysis of water Supply Deficiency from the Water Board

One of the main attributes of any Geographical investigation is its ability to answer 'why' questions (Chima, 1994). In this case, why has potable water deficiency persisted over time despite many attempts by the government to remedy the situation? To answer this question, it is necessary to find out the root factors responsible for water deficiency from the public water supply in the areas. This is necessary since the solution to any geographical problem requires the elucidation of its root causes/factors. In this study, we attempt to verify our assumption which states that the causes of potable water supply deficiency in the study areas are influenced by environmental, systemic and socio-economic factors, using the Principal Component Analysis (PCA) as explained in the methodology.

Extraction and Analysis of the Components

In order to verify the causes of potable water supply deficiency in the study area, information on the causes of potable water supply shortages were used as well as other primary data collected by the researcher from the field in the quest to find the causes of water supply deficiency in the area. Altogether, 30 variables were obtained from the field by the use of closed and open-ended questionnaire and interview schedule. The 30 variables incorporate environmental, systemic and socio-economic factors (Table 2). The data on the 30-predictor variables, obtained by summing up the number of times a particular variable occurs in an area, were transformed into a matrix of inter-correlations between the variable to know the strength of their inter-correlations.

Since public water supply (water Board) whose one of the major objective is to provide water to the people in potable quality and quantity contributed an insignificant amount of water to the people, the researchers deem it necessary to ascertain why such potable water supply deficiency in the study area. Thus, the analysis of the factors responsible for potable water supply deficiency became necessary.

Table 2: The 30-predictor variables responsible for water supply deficiency in the study area

Label	Variable Description
POOR	Poor planning (due to unreliability & unavailability of data)
FUND	Inadequate funding & embezzlement
STAFF	Lack of technical staff to operate and maintain water supply systems
POP	Rapid population growth
MGT	Inefficient management practice
GOVT	Heavy reliance on the Government for funding
PROJ	Abandonment of projects
FACT	Lack of expansion of existing facilities
SPARE	Lack of spare parts for repairs
PUMPS	Use of low cost and inappropriate pumps
PHCN	Erratic nature of power supply
EQUIP	Use of obsolete equipments
STORG	Inadequate storage facilities
BILLS	Non payment of water bills by the consumers
TOPO	Unfavourable topography making it difficult for water distribution
STEAL	Stealing of components of the pumping plants
REVE	Inefficient billing/revenue collection system
ANDO	Administrative bureaucracy and indolence by the workers of the water Board
ATT	Careless attitude of the people in handling the public standpipes

Label	Variable Description
MONIT	Lack of proper supervision and monitoring by the water Board
MACH	Incessant breakdown of machines
FUEL	Inadequate fuelling and repairs of pumping plants
TRANS	Lack of vehicles for distribution of materials by the water Board
TREAT	Lack of water treatment materials/chemicals
LEAK	Leakage pipes/or wastages of water
ADMIN	Unwillingness to change by the government (administrative inertia)
PROF	Poor remuneration of professionals
RATION	Infrequent running of standpipes due to water rationing
PIPE	Lack of distribution pipes/systems
SETT	Insufficient functional standpipes in the areas having pipe borne water relative to settlement size.

The 30-predictor variables have been abbreviated to enable clarity and eligibility as shown above. Having tested the KMO statistic and the Bartlett's test of sphericity which yielded good result to proceed with PCA, factor analysis using the principal component method was used to uncover the latent structure of predictor variables in the responses. The eigen values for each of the 30 predictor variables are given in Table 3.

Table 3: Total variance explained

Component	Initial Eigen values			Extraction Sums of Squared Loadings		
	Total	% of variance	Cumulative %	Total	% of variance	Cumulative %
1. POOR	4.701	15.669	15.669	4.701	15.669	15.669
2. FUND	4.417	14.724	30.393	4.417	14.724	30.393
3. STAFF	3.167	10.558	40.951	3.167	10.558	40.951
4. POP	2.418	8.060	49.011	2.418	8.060	49.011
5. MGT	2.117	7.058	56.068	2.117	7.058	56.068
6. GOVT	1.906	6.354	62.423	1.906	6.354	62.423
7. PROJ	1.668	5.559	67.982	1.668	5.559	67.982
8. FACT	1.349	4.498	72.479	1.349	4.498	72.479
9. SPARE	1.264	4.214	76.694	1.264	4.214	76.694
10. PUMPS	1.055	3.515	80.209	1.055	3.515	80.209
11. PHCN	.913	3.043	83.252			
12. EQUIP	.711	2.371	85.622			
13. STORG	.632	2.107	87.730			
14.BILLS	.598	1.994	89.724			
15. TOPO	.588	1.960	91.684			
16. STEAL	.498	1.659	93.343			
17. REVE	.393	1.309	94.651			
18. ANDO	.356	1.188	95.839			
19. ATT	.308	1.028	96.867			
20. MONIT	.209	.695	97.562			
21. MACH	.178	.592	98.154			
22. FUEL	.146	.486	98.640			
23. TRANS	.117	.391	99.032			
24. TREAT	.083	.275	99.307			
25. LEAK	.070	.234	99.541			
26. ADMIN	.045	.149	99.690			
27. PROF	.037	.125	99.815			

28. RATION	.029	.097	99.912			
29. PIPE	.019	.062	99.974			
30. SETT	.008	.026	100.000			

Extraction Method: Principal Component Analysis

From Table 3, the major components in the component matrix and hence the number of components to be meaningfully extracted are identified using the Guttman-kaiser rule (Field, 2000) which suggests that only those factors with an eigen values larger than one should be retained. This he called the most important components. It is clear from Table 3 that 10 principal components/factors have eigen values larger than one and these account for 80.209% of the total variance explained. Thus 10 principal components/Factors were extracted by the principal component method with varimax rotation with Kaiser Normalization. The rotated components' loadings are given in Table 4.

Table 4: Varimax Rotated Component Matrix[a]

	Component									
	1	2	3	4	5	6	7	8	9	10
x9	.919	-.061	.084	.029	-.045	-.055	.091	-.061	-.100	-.083
x5	.888	-.002	.022	-.067	-.139	-.060	-.015	-.005	-.009	.157
x6	.679	-.013	-.263	.054	.150	-.313	.001	.201	.165	.230
x23	-.577	-.086	.094	.058	.182	-.480	.119	.183	.037	.368
x18	**-.501**	-.148	.368	.104	.498	-.049	.030	.362	.147	-.041
x21	-.096	**.763**	.152	-.025	.238	.001	.249	.134	.280	-.082
x20	.197	**.744**	.109	.091	-.048	.121	-.360	-.142	-.004	.076
x7	.318	**-.709**	.021	.330	.051	-.190	.065	-.007	.170	-.040
x13	.242	**.646**	.371	.144	-.205	-.076	.279	-.159	-.065	-.179
x19	.173	-.084	**-.834**	.146	.111	-.166	.010	-.126	.031	.259
x12	.070	.172	**.657**	-.314	.077	.005	-.039	-.268	-.045	.321
x17	.204	.323	**.534**	.166	-.240	.446	-.019	-.014	.095	-.170
x4	-.323	.218	**.430**	-.366	-.267	.395	.163	-.192	.093	.193
x22	.026	.258	.157	**-.803**	.103	.142	.039	-.145	.200	-.049
x2	-.038	.185	-.077	**.643**	.038	.119	.413	.188	.344	.280
x28	-.207	.175	-.049	**.567**	-.181	-.039	-.179	-.385	-.090	-.083
x26	-.163	-.041	.207	**-.513**	.131	-.296	.472	-.225	-.025	-.036
x1	.001	-.015	.115	.155	**-.827**	.072	-.128	.069	-.058	-.024
x25	-.264	.000	.022	-.142	**.596**	.502	-.141	-.013	-.123	-.144
x8	.097	-.473	.177	.031	**-.511**	.203	-.264	-.104	.133	-.253
x29	-.392	-.201	-.284	.214	.425	-.345	.064	.374	-.092	-.245
x11	-.150	.044	.184	-.004	-.007	**.841**	.054	.105	-.025	-.027
x10	-.064	.010	-.034	.090	-.038	-.110	**-.892**	-.146	-.030	-.010
x14	.015	.182	-.381	.219	.395	-.217	**.597**	-.083	.176	.228
x30	-.118	.192	.020	-.020	.013	-.096	.165	**.832**	.176	-.143
x3	.063	-.208	-.080	.173	-.059	.192	-.074	**.791**	-.220	.122
x24	-.301	.172	.004	.145	.231	.052	-.199	.063	**-.778**	.050
x15	-.436	.013	.125	.281	.175	-.218	.122	.046	**.661**	.149
x27	-.213	.243	-.147	-.202	.148	.177	-.265	.039	**.614**	-.165
x16	.090	-.027	-.092	.068	-.018	-.072	.049	-.036	-.050	**.910**

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
a. Rotation converged in 19 iterations.
(Significant loadings are in bold)

Note: For sake of space, X1, X2, X3, etc were used to Represent the Various Components as seen in Tables 2 and 3

To determine the significance of the variables that are related to each component, component loadings above ± 0.6 are usually considered 'high' and those below ± 0.4 are 'low' (Garson, 1998). This cut-off is an arbitrary decision and represents an explaining power above 50%. The value is also based on the size of the loadings and this is chosen in order to ease interpretation.

In order to improve interpretation of the components, the eigenvectors (that is, components) were rotated on their axes towards the direction of maximum variance. This was achieved by a process known as variance maximization (or varimax) (Kaiser, 1959). In Table 4, 0.5 was used as a criterion and variables are arranged in the order of components' loadings in each component. Results of the varimax rotation are presented in Table 4. Varimax rotation was applied to the components so that the loadings on some variables are either increased or decreased. This enables clearer interpretation of the components. From Table 4, the extracted Principal Components with constituent variables and loadings are given in Table 5.

Table 5: Variables with highest (that is, ±0.50) loadings

Component	Constituent Variables	Loadings
Component 1	MGT	.888
	GOVT	.679
	SPARE	.919
	ANDO	-.501
	TRANS	-.577
Component 2	PROJ	-.709
	STORG	.646
	MONIT	.744
	MACH	.763
Component 3	POP	.430
	REVE	.534
	EQUIP	.657
	ATT	-.834
Component 4	FUND	.643
	FUEL	-.803
	ADMIN	-.513
	RATION	.567
Component 5	POOR	-.827
	FACT	-.511
	LEAK	.596
Component 6	PHCN	.841
Component 7	PUMPS	-.892
	BILLS	.597
Component 8	STAFF	.791
	SETT	.832
Component 9	TOPO	.661
	PROF	.614
	TREAT	-.778
Component 10	STEAL	.910

Note: The absolute loading for X_4 (POP) is less than 0.5, but has its highest loading in component 3 and as a result was included in PC3.

The Interpretation of the Principal Components

From Table 3, the first component has an Eigen value of 4.701 and accounts for 15.669% of the total explained variance. The component has high positive loadings on SPARE (lack of spare parts for repairs), MGT (inefficient management practice) and GOVT (heavy reliance on the government for funding), and two negative loadings on TRANS (lack of vehicles for distribution of materials by the water Board) and ANDO (administrative bureaucracy and indolence by the workers of the water Board). The positive signs here mean that there is positive correlation between the component and the variables and they score highly on component 1. On the other hand, the negative signs mean that there is negative correlation between the component and the variable. This also means that even though the variables TRANS and ANDO are very important to the component, they play a negative role to the component compared with the other variables with high positive loadings.

Component 2 has high positive loadings on variables MACH (incessant breakdown of machines), MONIT (lack of proper supervision & monitoring by the water Board) and STORG (inadequate storage facilities); and one negative loadings on PROJ (abandonment of projects). Component 2 which has eigen value of 4.417 account for a further 14.724% of the total explained variance and reflects the inherent problem of operation and distribution of potable water in the state.

Component 3 has an eigen value of 3.167 and accounts for 10.558% of the total explained variance. It has high positive loadings on EQUIP (use of obsolete equipments) and REVE (inefficient billing/revenue collection system). It has negative loadings on component ATT (careless attitude of the people in handling the public standpipes). The absolute loading for POP (rapid population growth) is less than 0.5, but has its highest loading in component 3 and as a result was included in component 3. This means that even though population pressure is not fully pronounced as militating against potable water supply in the study area, the use of obsolete technologies coupled with regarding water as a social service compounded the problem of potable water supply in the study area.

The positive signs on EQUIP, REVE and POP (though less than 0.5) show a positive correlation between the component and the variables. The negative sign on ATT mean that there is negative correlation between the component and the variables. Though this negative component is important to component 3, it plays negative role to the component compared with the positive loadings. This also means that the careless attitude of the people in handling the public standpipes should not come into play as potable water supply services are not rendered to the people.

Component 4 has positive loadings on variables FUND (inadequate funding/embezzlement) and RATION (infrequent running of standpipes due to water rationing). It has negative loadings on FUEL (inadequate fuelling and repairs of pumping plants) and ADMIN (unwillingness to change by the government – administrative inertia). The positive signs on FUND and RATION show it has positive correlation between the component and the variables. The inadequate funding is due to the unwillingness of the government to change (administrative inertia) which manifested in water rationing when available.

The negative signs on FUEL and ADMIN mean that there is negative correlation between the component and the variables. They play negative role to the component compared with the positive loadings. The non availability of funds by the government and embezzlement by officials also resulted to the paucity of capital to fuel and repair pumping plants and thus limits the availability of potable water in the area. Component 4 has eigen value of 2.418 and accounts for 8.060% of the total variance explained.

Component 5 has only one positive loading on LEAK (leakage pipes/or wastages of water) and therefore correlates positively with the variables. Leakage pipes/or wastages of water could emanate from road construction and peoples attitude to public facilities. There should be public enlightenment to educate the people on the dangers of wasting the scarce resource. This calls for efficient use of the available resource. It has two negative loadings on POOR (poor planning due to unreliability and unavailability of data) and FACT (lack of expansion of existing facilities). The negative signs on POOR and FACT show that even though they may be important to component 5, they play negative role to the component. Component 5 has eigen value of 2.117 which account for 7.058% of the total explained variance.

Component 6 with eigen value of 1.906 accounts for 6.354% of the total explained variance. It has only one significant positive loading on variable PHCN (erratic nature of power supply). Erratic nature of power supply could be as a result of paucity of finance to pay PHCN bills or could be management problems on the part of PHCN officials. However, with good planning and the availability of capital, standby electric generators can be bought to supplement their source of power from PHCN. With this variable, component 6 has therefore been identified as the limitation posed by erratic nature of power supply.

Component 7 has one positive loading on BILLS (non payment of water bills by the consumers) and one negative loading on PUMPS (use of low cost and inappropriate pumps). Though PUMPS is important to component 7, it correlates negatively with the variable. It has eigen value of 1.668 which accounts for 5.559% of total explained variance. Component 7 is therefore identified as an indication of non payment of water bills by the consumers. This non payment of water bills could be seen from the angle that people view water supply as a social service from the government.

Component 8 has eigen value of 1.349 which accounts for 4.498% of total variance explained. The component has only two positive loadings on SETT (insufficient functional standpipes in the areas having pipe borne water relative to settlement size) and STAFF (lack of technical staff to operate and maintain water supply systems). Rapid population growth adds pressure on the existing facilities which gave rise to insufficient functional standpipes in the areas having pipe borne water relative to settlement size and which account for deficiency of potable water supply in the area.

Component 9 has two significant positive loadings on variable TOPO (unfavourable topography making it difficult for water distribution) and PROF (poor remuneration of professionals). It has a negative loading on TREAT (lack of water treatment materials/chemicals). Though variable TREAT is important to component 9, it plays a negative role to the component. It has eigen value of 1.264 which accounts for 4.214% of the total variance explained. The positive loading on PROF is in line with the fieldwork which discovered that there is no regular promotion of the workers like their counterparts in the ministries. Allowances and other fringe benefits are not paid in accordance with the stipulated procedures and promptness. The consequences of these are brain drain, resorting to private practices, mechanical approach to human problems, strained relationships and apathy in work places.

Component 10 has only one significant positive loading on variable STEAL (stealing of components of the pumping plants). It has a strong correlation between the component and the variable STEAL. It has eigen value of 1.055 which accounts for 3.515% of the total variance explained. Therefore, component 10 is identified as the limitation posed by stealing of components of the pumping plants that reflects the absence or gross inadequacy of potable water supply in the area.

From the above analyses and interpretation of the principal components, the under listed dimensions may be regarded as the underlying components responsible for potable water supply deficiency in the area:

1. Limitation posed by inefficient management practice.
2. Heavy reliance on the government for funding
3. Lack of spare parts for repairs
4. Lack of proper supervision and monitoring by the Water Board
5. Incessant breakdown of machines
6. The limitation posed by erratic nature of power supply.
7. Lack of technical staff to operate and maintain water supply systems.
8. Insufficient functional standpipes in the areas having pipe borne water relative to settlement size.
9. Unfavourable topography making it difficult for water distribution
10. The problem of theft, stealing of components of the pumping plants.

Conclusion

This study examined the factors responsible for water supply inadequacies in Abia State. It found out demand-supply relationship and deficiency in potable water supply from the period of 2004 – 2012. It found out per-capita consumption of water and the factors which militate against the success of water supply by the Water Board Authorities. In all ramifications, Principal Component Analysis was used to uncover the latent structure of predictor variables in the responses. The use of PCA has thus made it possible to reduce our 30-predictor variables to ten major components or factors of potable water supply deficiencies in the area. These ten components enumerated above incorporate environmental, systemic and socio-economic factors responsible for potable water supply shortages in the area.

Recommendations

a. The government should stop giving positions of authority to political party loyalists who lack the prerequisite knowledge to head the unit.
b. The government should aid and ensure prompt release of funds for the procurement of equipments, spare parts and chemicals for purifying and treatment of water in the various stations.
c. Water agencies should be adequately funded to automate their network surveillance for rapid response to system failures. The geographic information system technologies will enhance the capability of the agencies to cope with these challenges and should be pursued with vigor.
d. The harmonious integrated operations of the power generating institutions (EEDC) and the water Board institution should be ensured so as to improve the services of both bodies. On the other hand, there should be a working standby generating plant as to supplement the power sector and inculcate constant maintenance culture of the equipments.

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