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RESEARCH ARTICLE

SOLAR PHOTOVOLTAIC AS AN OPTION (ALTERNATIVE) FOR ELECTRIFICATION OF HEALTH CARE SERVICE IN ANAMBRA WEST, NIGERIA

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ABSTRACT

The study examined rural health care service in Anambra west with a focus on alternative energy source for its electrification. The study adopts literature search and a survey design; questionnaires were administered to three health centers, 13 care givers and 269 clients receiving care in the facilities. The data were presented in tables and analyzed with multiple regression analysis. The study revealed that the health care services in Anambra West are operating at a dismal level, which was as a result of inadequate electricity for running the health center, skilled human resources/personnel, lack of information and health services. These factors most especially inadequate electricity correlated to a high level of client dissatisfaction with care received (99.3%). A significant association on health centers was observed between client satisfaction and marital status, educational level and occupational group ($P<0.05$) but no association on health center was observed with electricity supply ($P>0.05$). Also most of the hospitals visited lack basic modern health facilities. The implication of this is that it has led to the abysmal poor quality of health care services in the various health centers in the community. The importance of electricity for quality care cannot be overemphasized as it will not only ensure healthy living but will also contribute in combating mortality rate which is high in this part of the country. Consideration was made on the most economical power usage which solar photovoltaic emerged as the cheapest, noiseless, readily available and conducive energy source for health centers in rural areas. And Anambra West is located in a remote region optimal access to the sun's rays hence making solar power one of the widely known renewable energy source.

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INTRODUCTION

Electricity, as an essential commodity in remote healthcare facilities needs to be adequate to power the facilities there. However, the availability of electricity to support proper rural health services is less than adequate in many countries, (Antonio, 1998). Powering health facilities, currently in Nigeria there is no capacity to ensure uninterrupted power for facilities that are connected to an unreliable power grid. Information is provided here to help the user weigh the various energy systems with a focus on appropriate solutions and special considerations for off-grid rural health centers. A literature review undertaken by (Brenneman, 2002) summaries that lack of modern energy sources negatively impacts health centers. Without electricity for refrigeration, health clinics cannot safely administer vaccines or a number of other medicines. Without a constant source of good lighting, doctors cannot safely perform operations or even adequately examine a patient at night. Many doctors and nurses simply won't serve at health clinics that don't have outdoor lighting to provide for their safety.

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Thus, it is difficult, if not impossible to establish a safe and efficient health clinic that provides quality health care services without electricity or more modern energy sources. Current studies on science, technology and innovation; came up with renewable energy technologies (RETs) usage to support rural development, (UNITED NATIONS CONFERENCE ON TRADE AND DEVELOPMENT, 2010). In the U.S., developing renewable energy resources would (1) save money, (2) create two to five time more jobs per unit of electricity produced than coal and nuclear power plants, (3) eliminate the need for oil imports, (4) cause much less pollution and environmental degradation per unit of energy used (Miller, 2001). The study area was Anambra West Local Government Area, which is one of the twenty one (21) local government areas in Anambra State. It is located at the western part of the state and has its headquarters at Nzam. It is bounded in the East and West by Anambra River and River Niger respectively. In the North of Anambra West, it is bounded by Uje Local Government Area of Kogi State and in the South by the confluence of Anambra Rivers and Niger. It comprises of nine (9) communities among which are Innoma Aka-ator, Nzam Ogbe, Oroma Etiti Anam, Umueze Anam, Umuikwu Anam, Umudora Anam, Umuenwelum Anam, Nmiata Anam,

Umuoba Anam and Obodo-otu. The local government lies in the latitude 6.14N and longitude 6.45E.Anambra West is highly populated having good health-care system but has inadequate electricity to maintain the facilities. Its low-land area occupies estimated area of about 80 square kilometers with a population density of about 167,303 having 21 health centers, (National Population Council, 2006). These facilities are unable to provide basic and effective services. This poor performance is attributed to various factors including poorly equipped health facilities, insufficient staff, lack of clearly defined roles and responsibilities, and inadequate electricity supply. Of all these, the major reason for the deficiency of health treatment in Anambra West is the absence of the energy needed to utilize healthcare equipment, properly store medicines and vaccines, and bridge the geographical gaps that separate patients from the medical care they need. Until the energy issue is addressed this problem will persist. Solar for health is one such opportunity. It was undertaken through qualitative research method, precisely, interviews of patients, care-givers and researcher investigate the following three research sub-questions.

- What economic impact can the solar PV have on individuals and the health centers?
- How can the solar PV improve health centers activities in the communities at large?
- How will the implementation, use, and end of life of the solar PV electricity impact the health center?
- This aims to show how adopting a renewable energy source will reduce the economic cost of maintaining health facilities and improve the quality of health-care level in rural areas.

Methodological Approach: Seven facilities from 21 health centers were randomly selected but inclusion and exclusion criteria approach was used on the health centers that would be assessed.

Inclusion Criteria

- Only primary health centers that provide immunization and anti-natal services with a minimum of 10 Client/patient per clinic day were selected for the study. This was to ensure that the services provided in the center were being utilized. This was used in a similar study in Tanzania, (Boller, 2003).
- Out-patient/ pregnant women who have attended clinic at least twice a month were included in the study to ensure that they have been exposed enough to the energy usage of the health center, so as to form their own opinion on the quality of care they had received. This was also used in other similar studies on quality of health services (Osungbade, 2008).
- For health worker's interview, providers who have been rendering services at the center for at least 2years were interviewed. This was to capture enough workers who can give account on the services being rendered. Another study, (Sword, 2012), on the same subject made use of this and this was also to make for comparison.

Exclusion criteria

- Primary health centers that had less than 10 clients per clinic day were excluded from the study.
- Patients that have attended the health center once were also excluded.
- Women who declined to participate in the study were also excluded.

Sample size determination: For assessing client satisfaction, sample size was determined using the formula for calculating sample size in population greater than 10,000 (Araoye, 2004).

$$n = \frac{z^2 pq}{d^2}$$

Where n = calculated sample size;
z = standard normal deviate at 95% confidence interval=1.96
p = percentage of clients satisfied with antenatal care service;
q = the complementary probability of p, 1 - p (i.e. percentage of clients not satisfied with care service)
d = precision level 5%=0.05

In a study on the quality of antenatal services at the primary health center level in southwest Nigeria, it found that 81.4% of clients were satisfied with antenatal care received (Araoye, 2004).

Therefore

p = 81.4% = 0.814 and q = 1 – p = 1 - 0.814 = 0.186

$n = 1.96^2 \times 0.814 \times 0.186 / 0.05^2$

n = 232.6

Therefore the estimated minimum sample size n = 232.6, approximately 233

However 269 clients were eventually used in the study.

The HCs selected were Umudora Anam, Mmiata Anam and Umueze Anam, the assessment was carried out in these 3 facilities. Facility selection was based on the services rendered to the client, the usage of service rendered and the population visitation per day.

Data Collection Approach: The two attributes of quality according to (Donabedian, 1980; Donabedian, 1988 and Donabedian, 2003), which are structure and outcome were studied. Both qualitative and quantitative methods of data collection were used. Qualitative data instrument was oral interview with the respondents. Required data were collected from observation of service activities in the facility, care providers, and documentation reviews through an interview/discussion approach. Quantitative data were collected for patient bio-data, electricity supply, facility utilization and observation checklists, whereas qualitative data were gathered through feedback sessions and interviews with facility staff. Data obtained using the observation check list were analyzed manually while quantitative data from client interviews were analyzed with the aid of Statistical Package for the Social Sciences version 20 (SPSS). Meanwhile, frequencies distributions of all relevant variables were presented in tables and charts. Means and standard deviation were also determined to summarize data further and test of statistical significance was carried out using chi square with statistical significance set at $p< 0.05$.

RESULTS/ DISCUSSION

This study looked at the two aspects of quality: structural and outcome attribute according to, (Donabedian, 1980; 1988 &

2003) and it is worth noting that inadequacy of electricity affects the quality of service in the HC and is likely to influence effective utilization and compliance with interventions with its negative effects on mortality indices. Some of the facilities studied had adequate basic infrastructures as found in similar study (Tetui, 2012), both electrical equipment and human resources. Its contribution to good patronage of the facilities cannot be ruled out as shown in Table 1.

Final score for structural attribute of quality
252/342 X 100 = 73.6%

Table 1. Structural Attribute Quality

	Facility 1 (observed)	Facility 2 (observed)	Facility 3 (observed)	Total expected per facility
Infrastructure	42 (93.3%)	23(51.1%)	44 (97.7%)	45
Electrical	35(89.7%)	24(61.5%)	33(84.6%)	39

	Total score for three facilities (observed)	Grand total for three facilities (expected)
Infrastructure	109 (80.7%)	135
Equipment	92 (78.6.%)	117
Human resource	51(56.6%)	90
Total	252	342

Table 2. Information on electricity usage witnessed in the facility

	No (%)	Yes (%)	Total
Availability of power	211(78.4%)	58(21.6%)	269
Hours of electricity supply		Frequency	percentage
0-4		225	83.6
5-9		44	16.4
10-14		0	0.0
15-19		0	0.0
Total		269	100.0
Current state of electricity supply		Frequency	percentage
Very Good		0	0.0
Good		2	7.4
Fair		47	17.5
Poor		133	49.4
Very Poor		87	32.3
Total		269	100.0
	Good (%)	Not Good (%)	Total
Overall	2(0.7%)	267(99.3%)	269

Table 3. Outcome attribute quality on respondents' satisfaction with health service received

	Very satisfied (%)	Satisfied (%)	Indifferent (%)	Dissatisfied (%)	Very dissatisfied (%)	Total
General Satisfaction	18(6.7%)	22(8.2%)	19(7.1%)	123(45.7%)	87(32.3%)	269
	Satisfied (%)	Not satisfied (%)	Total			
Overall satisfaction	40(14.8%)	229(85.1%)	269			

Table 4. Distribution of the determinants of respondents' satisfaction to Health Center

	Satisfied	Not Satisfied	Significance
Age			$P < 0.05$
20-24	8	46	
25-29	9	71	
30- 34	6	84	
35- 39	4	12	
40 and above	15	14	
Marital status			$P < 0.05$
Single	6	8	
Married	22	211	
Divorced	9	8	
Widowed	5	-	
Educational level			$P < 0.05$
No education	13	10	
Fslc	22	147	
Ssce/gce	6	24	
Higher degree	1	46	
Occupational group			$P < 0.05$
Farmer	21	47	
Civil servant	9	51	
Private practice	7	19	
Business	5	110	
Information on health			$P < 0.05$
Not enough	4	103	
Too much	38	124	
Current state of electricity supply			$P > 0.05$
Never had	40	193	
Had once or twice	2	34	

Table 5. Total Outcome Attribute

	Total Outcome score for Respodent	Grand outcome total for the Respodent
Electricity	2(0.7%)	269
Satisfaction	40 (14.8%)	269
Total	42(7.8%)	538

Table 6. Electrical energy consumption pattern

Medical Appliances	Quantity	Power (watts)	Time (hours/day)	Use d/w	÷ 7 days	Energy/day (watt-hours)
Vaccine refrigerator	1	60	5	7	7	300
freezer	1	60	6	7	7	360
Lights, 4 Comp.	4*15	60	5	7	7	300
Microscope	1	15	1.0	4	7	15
Overhead fan	3*40	120	8	7	7	960
Sterilizer	1	1500	0.3	7	7	450
Radio	1	15	12	7	7	180
Television	1	60	3	7	7	180
Suction machine	1	60	1.0	4	7	60
Total Connected Watts:		1,950				2,805
Total Average Energy Consumption 2805						

These are consistent with some other findings hence revealing the availability of equipment. The only short coming in the facility is in the area of equipment not being in use due to inadequacy/absence of electricity to power some equipment which contributed to the high level of dissatisfaction reported in information as shown in Table 2, on electricity usage witnessed by respondent in the facility (267; 99.3%). Overall, 99.3% (267) of the clients were not satisfied with the electricity supply in the facility while 0.7% (2) was okay. From Table 3, the outcome attribute quality on respondents' satisfaction with health service received revealed that majority of the clients, about 85.1% (229), were not satisfied with health care received while 14.8% (40) were satisfied. Majority of the clients, 85.1% (229) of the clients were not satisfied with health care received while 14.8% (40) were satisfied, There is significant association between the respondent's satisfaction of the health services (X^2 =19.0; P=0.000), marital status (X^2 =59.6; P=0.000), educational level (X^2 =37.0; P=0.000), age group (X^2 = 36.4; P=0.000) and occupational group (X^2=25.7; P=0.000) but no association with electricity supply (X^2=3.19; P=0.074) as shown in Table 4.

Table 5 gives the overall quality of service in Anambra West Local Government area is as;

1. Final score for structural attribute of quality from Table 3: 252/342 X 100 = 73.6%
2. Final score for outcome attribute of quality: 42/538 X100 = 7.8%

Structure: 252 out of 342

Outcome: 42 out of 538

Overall Score: $\frac{252+42}{342+538} \times 100$

$$\frac{294}{880} \times 100$$

33.4%

The electrical consumption pattern of Umuikwu Anamin Anambra West as shown in Table 6, was used to predict the estimated PV technology that will help improve the health services in Anambra West. Estimation of PV module power is done using equivalent daily sunshine hours. SPV module wattage, the Daily energy to be supplied by SPV module is divided by the average sun hours per day for the geographical location T (min.)

$$\text{SPV module wattage} = \frac{\text{Daily energy to be supplied by SPV module}}{\text{Equivalent daily sunshine hours}} \quad 1$$

$$3117 \div 5 = 623 \simeq 620\text{W}$$

$$\text{The total number of PV modules needed} = \frac{\text{Total estimated module power}}{\text{Power of single module}} \quad 2$$

$$\frac{620}{100} = 6.2 \sim 7\text{pv module}$$

The initial installation is basically the only cost, so the investment will simply pay for itself for the rest of its life and the lives saved from infant mortality.

Conclusion

The study examines the electrification of health centers in Anambra west with a focus on UmuikwuAnam. The study revealed that the health centers services in Anambra West are operating at a dismal level, which is as a result of inadequate source of power supply on health services. After examining the state of primary health care in the regions discussed and analyzing the case studies presented, it has been established that through the use of solar PV technology there is clear potential to improve the primary health care available to the people living in Anambra West local Government Area, Anambra, Nigeria. Solar PV has the benefit of allowing stand-alone systems in isolated areas requiring little maintenance this will help enhance the health services and reduce the mortality rate in Anambra West.

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