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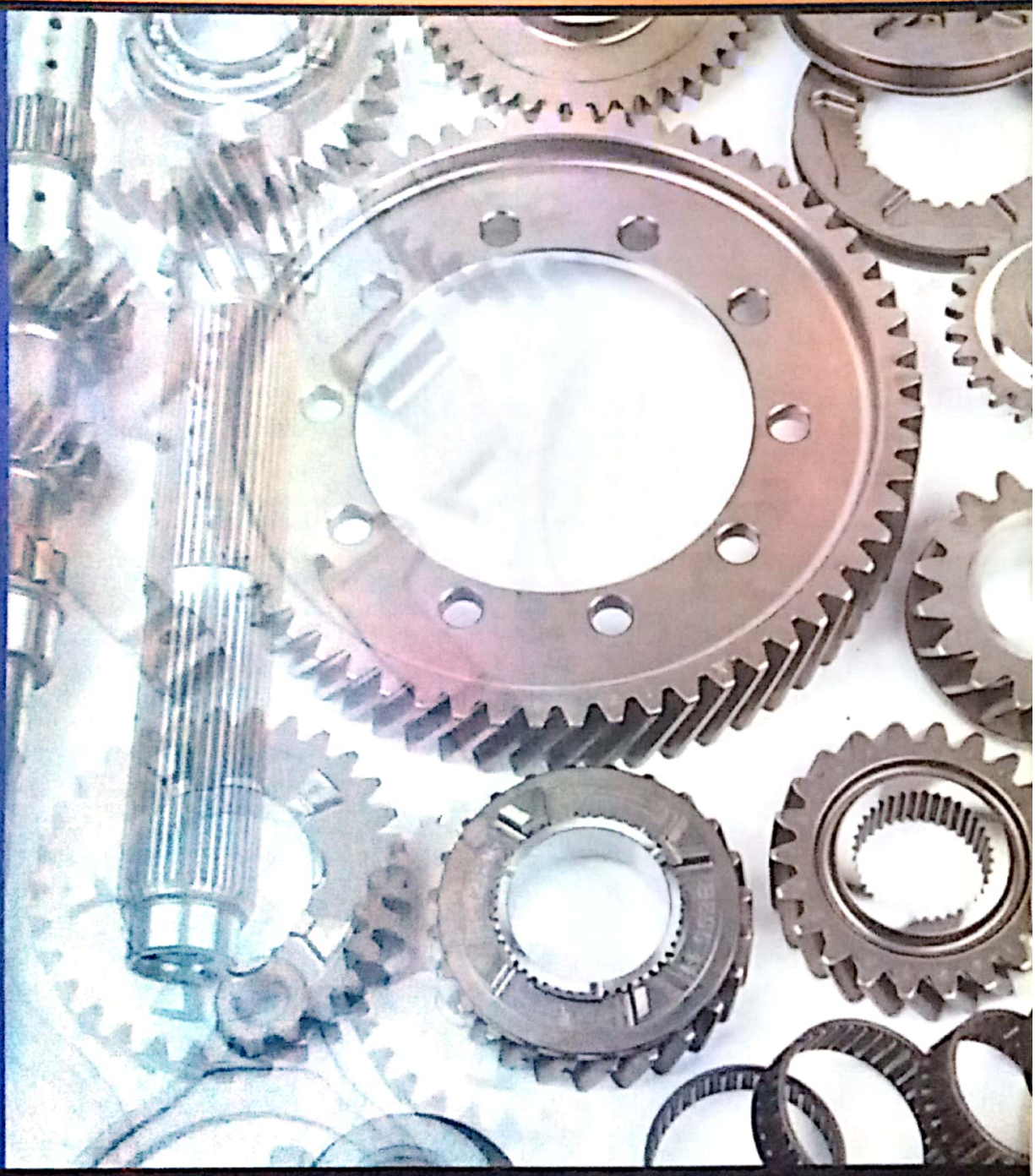

Behavioural Approach to Electrical Energy Management in Residential Buildings in Niger State, Nigeria.

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Abstract

The study investigated behavioural approach to electrical energy management in residential buildings in Niger State, Nigeria. The study adopted cross sectional survey research design. The population of the study was 191,416 heads of households in residential buildings that are connected to the distribution network in 25 Local Government areas of Niger State. The sample for the study consisted of 1,290 heads of households, drawn through Multistage Sampling Techniques. Two research questions were formulated to guide the study. The instrument used for data collection was a structured questionnaire. Statistical Package for Social Sciences (SPSS version 19) was used for data analysis. Mean and Standard Deviation were used to answer the research questions. The finding of the study shows that, consumers in Niger State rarely adopted the following human behavioural practices; utilization of low wattage lamp to provide required light, usage of appropriate colour for walls and ceilings for better illuminations, switching off light when not in used and they also practiced electrical energy load management habits at very high extent; ironing of cloth at the peak period and utilization of incandescent and halogen bulbs during peak period. It was recommended among others that; Policy and law makers with a sense of urgency should formulate policies and laws that will help in changing human behaviour and there should be more awareness on electrical load management habits among residents in order to cultivate positive practices towards energy usage during the peak period of electricity usage.

KEY WORDS: Behavioural approach, Management practice, Electrical energy, Electrical consumers.

Introduction

Energy in whatever form is essential to mankind. It is one of the essential inputs for social and economic development and a basic need in modern life. It contributes to nation's growth and development (Yen &Wai, 2010). Thurman and Younger (2008) defined energy as the capability to do work as influenced by the ability to perform work. Energy has many forms in nature among which are heat (or thermal), light, chemical, mechanical and electrical energy. Among these forms of energy, electrical energy is considered as the most important, because it is the major driver for technological and economic development of a nation (Sambo, 2006; Gupta, 2010).

Electrical energy is derived from the flow of electrical charges, and is commonly referred to as electricity. Electricity is used for several applications such as lighting, heating, cooling and operation of electrical machines. It is generally accepted as an essential commodity for biological lives, as it improves the standards of living and facilitates economic development and poverty reduction (Nnaji, 2011; Ubi, Effiom, Okon & Oduneka, 2012). An electric power system consists of three main hierarchical stages of Generation, Transmission and Distribution Systems.

The National Electrical Power Authority of Nigeria (NEPA) was established by decree No 2 of April 1972 as a result of merger of Electricity Corporation of Nigeria (ECN) and the Niger Dams Authority (NDA). It further metamorphosed to Power Holding Company of Nigeria (PCHN) in 2005. The PHCN, as a company, was unbundled in 2013 into 18 companies as follows: six generating companies, one transmission company (Transmission Company of Nigeria-TCN), and 11 distribution companies. The mandate of PHCN was to maintain and coordinate an economic and efficient system of power generation, transmission and distribution to all parts of the country (Saba, Atsumbe, Otor &Tsado, 2013).

Niger State receives electricity through Abuja Electricity Distribution Company (AEDC) (Awosope, 2014). AEDC has the mission to promote and ensure an investor-friendly industry and efficient market structure to meet the needs of Nigeria for safe, adequate, reliable and affordable electricity. The attainment of this mission depends on the adoption of proper electrical energy management practices by the customers.

The concept of electrical energy management practices as it relates to this study can be defined as the efficient and conservative ways of managing electricity to save energy and offer practical means of achieving economic competitiveness, environmental quality, and energy security. Electrical energy efficiency and conservation is an intentional action taken to reduce electrical energy consumption by utilizing more efficient technological equipment, devices and processes.

Most electrical consumers in industries and residential buildings in Nigerianlack the needed electrical energy management practices.They also lack the culture of maintenance and utilization of

electrical power in an efficient and manageable manner. These attitudes therefore lead to frequent power failure, indiscriminate change of phase, loss of lives and properties of consumers. The model of electrical energy management practices developed by Mohon, Kiss and Leimer in 1983 viewed electrical energy management practices in terms of technology and management/behaviour. Technology approach has been divided into two groups: the use of more efficient technology and maintenance, and management/behavioural approach which deals with lifestyle, load management habits and task definition. In support of this, Ting, Mohammed, Wai and Alias (2010) viewed electrical energy efficiency as the adoption of technology that requires the use of less energy to perform the same function or more while electrical energy conservation is the behaviour that is necessary in utilizing less energy.

Proper electrical energy management practices reduce energy wastages. For instance, Aduba (2012) observed in his study that, if Nigerians are using 10 million incandescent 60W bulbs per hour, the nation will be consuming 600 megawatts per hour, but if these 60W incandescent bulbs were changed to 5.20W Light Emitting Diodes (LEDs), the nation will be consuming 52MW This implies that, 548MW will be saved and used in some other areas without necessarily building another power plant. Furthermore, Tsado (2014) pointed out that there are abundant opportunities to save 70% to 90% of energy and cost for lighting, fan, pump systems; 50% for electric motor and 60% in areas such as heating, cooling, office equipment and appliances through proper electrical energy management practices.

Electrical energy behaviour is an aspect of direct personal energy consumption that depends on personal decision. These include the decision for or against certain electrical appliances, the choice for more or less energy efficient appliances and behavioural patterns which are independent of technical aspects, for example, switching off the light and lowering thermostat. The way energy is being used depends on an individual consumers. Electricity users' positive or negative life style to electrical energy usage may likely affect the user. But it should be noted that the basic objectives of any electrical power generation system is to provide adequate and stable electricity to consumers in the most economic and saferway.

Statement of the Problem

It is sad to observe that, about 30 to 40% of electricity generated is being lost from point of generation to utilization in Nigeria (Ubi, *et al*, 2012 and Tsado, 2014). Okechukwu (2014) reported that, the then Minister of Power, Prof. Chinedu Nebo, said Nigerians wasted over 1,000 Megawatts of electricity generated amounting to N400bn, which could be used for other purposes. Various factors such as lack of proper electrical energy management practices, stations and sub-stations related problems could have been responsible for these wastages (Sambo, 2006). The implication of this is that,

planning of appropriate interventions strategies for electricity users will be difficult and so there will be continuous epileptic power supply, customers will continue to pay more charges while, others will be denied access to electricity and attendant continuous environmental degradation. Residents in Niger State, for instance, are highly indebted to Abuja Electricity Distribution Company (AEDC).The power supply to the state is usually epileptic for operating electrical equipment/appliances in residential buildings despite the fact that the state housed three hydro- electric generation stations. Against this backdrop, a need arouse for greater understanding of electrical energy management practices as adopted by residents in Niger State for the purpose of planning appropriate interventions strategies. This study therefore intends to investigate the electrical energy management practices adopted by electricity consumers in residential buildings in Niger State, Nigeria.

Purpose of the Study

The main purpose of this study was to investigate the behavioural approach to electrical energy management practices in residential buildings in Niger State.Specifically this study determined:

1. Human behaviour related practices as adopted for conserving electrical energy in residential buildings in Niger State, Nigeria.
2. The electrical load management habits as adopted by consumers in residential buildings in Niger State, Nigeria.

Research Questions

The following research questions were formulated to guide the study:

1. What are the human behaviour related practices adopted for conserving electrical energy in residential buildings in Niger State, Nigeria?
2. What are electrical load management habits adopted by consumers in residential buildings in Niger State, Nigeria?

Methodology

This study adopted a cross sectional survey research design. This design enables the researcher to describe the attitudes, opinions, behaviours or characteristic of the electricity consumers on their practices of electrical energy management. The study was carried out in all the25 local governments areas of Niger state. The state was divided into three geo - political zones, i.e, Zone A. B and C.

The target population for the study was 191,416 heads of households of residential buildings that are connected to the distribution network in the State. The sample for the study consisted of 1,290 heads of households drawn through Multistage Sampling Techniques. Firstly, Stratified Sampling was used to draw 15 towns, (five towns from each zone in the state and one town from each of the local government). The data for the study was collected using a structured questionnaire. The data analysis was carried out using

SPSS version 19. Mean and Standard Deviation were used to answer the research questions, The decision rule was based on the resulting Mean score interpreted relative to the concept of real lower and upper limits of numbers as shown in Table 1.

Table 1: Five Point DecisionScale

S/N	Scale	Point
1.	Highly Adopted (HA)	3.50 – 4.00
2.	Adopted (A)	2.50 – 3.49
3.	Rarely Adopted (RA)	1.50 – 2.49
4.	Not Adopted (NA)	0.50 – 1.49
5.	No Opinion (NO)	0.00 – 0.49

Research Question 1

What are the human behaviour related practices adopted for conserving electrical energy in residential buildings in Niger State?

Table 2: ***Residents Mean Opinions on Human Behaviour Related Practices Adopted for Conserving Electrical Energy in Residential Buildings in Niger State.***

S/No	ITEM	$\bar{X}_1$	S D	RM
1	Utilization of minimum wattage lamp to provide required light.	1.86	1.14	RA
2	Reducing number of lamps when lighting level is high	1.42	0.63	NA
3	Use of automatic control devices such motion sensors, infrared sensors to save electricity.	1.59	0.73	RA
4	Regular usage of natural day lighting.	1.62	0.63	RA
5	Resetting light timers periodically.	1.14	0.56	NA
6	Usage of appropriate colour for wall, ceiling and floor for better illumination	1.42	0.75	NA
7	Regulate the light to illumination level needed using dimmer.	1.59	0.84	RA
8	Replacing incandescent bulb with more efficient bulb.	1.49	0.78	NA
9	Switching off the lights when not in use	1.52	0.69	RA
10	Lowering light fixtures	1.65	.070	RA
11	Regular defrosting of freezing compartment.	2.10	1.10	RA
12	Over loading refrigerator.	3.42	0.85	HA
13	Ensuring refrigerator door's seal are properly tight.	1.56	0.78	RA
14	Switching off refrigerator when necessary	1.51	0.77	RA
15	Allowing the hot items to cool down before refrigerating	1.74	0.62	RA
16	Covering of all food stored in the refrigeration.	1.57	0.61	RA
17	Switch off the A.C when not in use.	1.86	0.75	RA
18	Using A.C and fan at the same time.	2.60	0.79	A

19	Application of dark colour on interior and exterior wall.	1.88	0.70	RA
20	Closing doors and windows properly when A.C is on	2.32	0.87	RA
21	Selection of right temperature during ironing.	1.94	0.86	RA
22	Need to turn off the socket when electricity is interrupted.	1.29	0.82	NA
23	Ensuring seal of oven door is well tight.	1.60	0.76	RA
24	Pre-heat oven for long time.	1.80	0.75	RA
25	Reducing peeping at food inside oven.	1.66	0.65	RA
26	Putting correct quantity of water while cooking.	1.60	0.96	RA
27	Keeping the machine running at full load.	1.52	0.61	RA
28	Switching off machine from socket after the work.	1.84	0.71	RA
29	Use of cool water (instead of hot) while washing.	1.74	0.70	RA
30	Use of outdoor sunlight for drying cloth instead of machine.	3.10	0.51	HA
31	Utilization of properly sized electric motor for operation	1.54	1.11	RA
32	Stop running machine before taking measurement	1.34	1.08	NA
	GRAND MEAN	**1.83**		**RA**

HA = Highly Adopted; A = Adopted; RA = Rarely Adopted, NA = Not Adopted

Table 2 shows that, the respondents highly adopted the listed items; 12 and 30 with mean scores ranging from 2.86 to 3.27 but items 2, 5, 6, 22 and 32 were not adopted. i.e., the respondents rarely adopted the remaining items focusing on human behavioural related practices for conserving electrical energy in residential buildings in Niger State. However, item 18 was adopted. The results of Standard Deviations ranged from a highest of 1.14 to a lowest of 0.51 which shows that the respondents mean responses do not differ significantly. The closeness of the responses adds value to the reliability of the mean.

Research Question 2

What are the electrical load management habits adopted by electricity consumers in residential buildings in Niger State?

Table 3: ***Mean Opinions on the Electrical Load Management Habits Adopted by electricity consumers in Residential Buildings in Niger State.***

S/No	ITEM	$\bar{X}_1$	SD	RMK
1	Operation of electric cooker during peak period.	2.56	0.85	A
2	Utilization of high energy consuming appliances at the same time.	2.50	0.77	A
3	Ironing of cloth at the peak period.	3.94	0.53	HA
4	Operation of electrical washing at the peak period	2.96	0.65	A
5	Over loading of equipment	3.12	0.75	A

6	Boiling of water during the off peak and put inside the flask	1.36	0.76	RA
7	Lowering A.C thermostat during peak period	1.37	0.64	NA
8	Postponing the use of grinding machine to off peak period.	1.40	0.65	NA
9	Use of fan instead of A.C during the peak period.	1.80	0.73	RA
10	Taking advantage of natural air flow instead of A.C during peak period.	1.70	0.66	NA
11	Operation of both fan and A.C during the peak period	2.66	0.87	A
12	Leaving A.C on in an unoccupied room during peak period	2.96	0.79	A
13	Utilization of incandescent and halogen bulbs during peak period.	3.62	0.66	HA
	GRAND MEAN	**2.46**		**RA**

NA = Not Adopted; RA = Rarely Adopted; A = Adopted; HA = Highly Adopted

Table 3 shows the respondents view on electrical load management habits adopted in residential buildings in Niger State. The responses on electrical load management habits in items 7, 8 and 10 were not adopted, items 6 and 9 were rarely adopted and items 1, 2, 4, 5, 11 and 12 were adopted. The results of Table 3 also revealed that the standard deviations of items are in the range of 0.53 to 0.87. The 13 items had their Standard Deviation less than 1.96. This signified that the respondents' views were not too far from the mean and were close to one another in their responses. The closeness of the responses adds value to the reliability of the mean.

Major Findings

1. Respondents in residential buildings rarely adopted the followings human behavioural practices:Utilization of low wattage lamp to provide required light; usage of appropriate colour for walls and ceilings for better illuminations; switching off light when not in used and allowing hot food to cool down to room temperature before refrigerating. But the following practices were adopted: Usage of air conditioners and fans at the same time; used cool water while washing with a washing machine and Ironing of cloth when air condition is on.
2. Respondents practiced electrical energy load management habits at high extent; ironing of cloth at the peak period and utilization of incandescent and halogen bulbs during peak period. While, operation of electrical cooker during peak period; over loading of equipment/ appliances during peak period and leaving air conditioners on in unoccupied room during peak

period are practiced at high extent. However; lowering air conditioning thermostat during peak period and postponing the use of grinding machines to off peak period are rarely practiced.

Discussion of Findings

The data presented in Table 2 provided answer to research question one. The findings revealed that people rarely adopted positive behaviour towards utilizing low wattage lamp to provide required light, utilizing appropriate colour and they are not switching off their lights when not in use. This implies that people rarely adopted right behavioural practices towards electrical energy management. These findings were supported by the work of Becker and Sligman (1981) and that of Ajzen (1985), in which they observed that, there is a strong indication that people may misuse rather than creating scarcity of resources. This might be the cause of energy crisis witness in Nigeria. The findings were also in- line with that of Muhieldeen, Adam, Salleh, Tang, and Kwong (2008), as they revealed that, consumers' negative behaviour towards electrical management practices contributed significantly to energy wastages. Oyedepo (2012) also agreed that many Nigerians do not put off the outdoor light during the day probably, due to wrong behavioural practices adopted towards electrical energy usage. On the other hand, Loozen and Moosdijk (2001) explained that experiments have shown that 5 – 10 % of the energy can be saved by appropriate use of positive behaviour towards energy saving, which many people fails to practice. It can be further deduced from the findings that, customers adopted the behavioural practices of using air conditioner and fan at the same time, ironing their clothes in a cool room. These negative behavioural practices lead to electrical energy waste.

Table 3 was used to answer research question two. The findings revealed that consumers practice the habits of ironing their clothes at the peak period; utilizing incandescent or halogen lamp during peak period. The findings are in consonance with that of Capehart, Turner & Kennedy, 2005 and Oyedepo (2012) who reported that, electricity consumers in Nigerian are facing extreme electricity shortage, which in turn is seriously affecting all sectors of the economy. On the other hand, because of epileptic power supply, electricity consumers also take the advantage of electricity anytime it is made available and this coupled with the fact that incandescent and/or halogen bulbs are the bulbs mostly used by the consumers all the time. This practice constitutes a lot of electricity wastage. From these findings it can also be deduced that consumers do not take advantage of natural air during the peak period of electricity, they still use air-conditioners and the thermostats are not lowered to reduce the rate of energy consumption and also consumers that have grinding machines do not postponed it use to off peak periods. These negative habits bore down to epileptic power supply witness in residential buildings.

These habits were in agreement with the work of CREDC (2009) who also revealed that due to shortage of electric power supply to residents and commercial areas, consumers use electricity to carry out the task not minding the peak period of electricity usage.

Conclusion

The shortage and/or wastages of electricity supply from AEDC and its high cost among residents in Niger State and Nigeria in general is disheartening as it is seriously affecting the economic and development of the nation at large. In order to find out some of the sources of the electricity wastages this study was carried out. Based on the findings of the study, some of the wastages of electrical energy in residents are as a result of the facts that human behavioural related practices for conserving electrical energy, electrical energy load management habits for the purpose of ensuring efficient use of electrical energy were rarely adopted. It is therefore necessary to create awareness on electrical energy management practices in order to reduce electrical energy wastages associated with poor electrical energy conservation in residents in Niger State, Nigeria.

Recommendations

Based on the findings of this study, the following recommendations are made:

1. As a matter of urgency lawmaker should formulate policies and action about electrical energy management practices that will help in changing consumers' behavior so as to minimize electrical energy wastages in Niger state and Nigeria as a whole.

2. Electricity Management Board in collaboration with Energy Commission and Center for Energy Efficiency and Conservation should be organizing public enlightenment campaigns in order to sensitize electricity users in Niger State on the behaviour related practices towards electrical energy management; this will positively go a long way in changing the customers' behaviour towards electrical energy management and habits during the peak period of electricity usage.