Personnel's level of Knowledge and Opportunities for Saving Electrical Energy in Woodwork Industries in Katsina State, Nigeria

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Abstract

The study determined the p*ersonnel's level of knowledge on electrical energy savings and potentials* in woodwork Industries Katsina State ,Nigeria .The study adopted descriptive sur*vey research design. The target population of the study was 1,135, stratified random sampling technique* was used and the total of 4 0 8 *subjects were sampled .Mean and standard deviation were used for answering the research questions .* Analysis of Variance (ANOVA)was used for testing the null hypotheses at 0 . 0 5 level of significance .The findings of the study revealed *that the woodwork industrial* personnel*s* were somehow knowledgeable on electrical energy savings in woodwork industries and there is no significan*t* difference in their mean response .The study shows that promoting awareness on electrical energy ma*nagement practices, through public enlightenment campaigns, giggles, use of electrical energy efficient motor, ensured power factor correction by capacitor, development of positive behaviour among electricity users in the industries and proper motivation of employees towards energy management practices were potentials of electrical energy savings in woodwork industries and there is significance difference in their mean response. The woodwork industry* owners should *raise* awareness *through posters and ensure that their staff* are well knowledgeable on electrical energy savings .

Keywords: Personnel, Knowledge, Electrical energy, Saving Potentials, Woodwork Industries

Introduction

Energy is a key resource in the development of any nation. It has been one of the most important resources of the 21st century. The quantity of energy consumed by any nation has been used as proxy for how well it has developed or for establishing the pace at which it is developing (Abdelaziz, 2018). Energy is therefore a crucial factor for economic competitiveness and employment and hence a large amount of it is required in countries with faster economic growth. Abdelaziz (2018) stated that energy is a crucial input of socio-economic progress and ensures higher human development. Energy is needed in increasing quantities to support economic and social progress and build a better quality of life in developing countries as Nigeria. Energy is of different forms this comprises of mechanical, potential, nuclear, thermal, solar, kinetic, wind, heat and electrical energy among others (Omowuminmi, 2015).

Electrical energy is a form of energy resulting from the flow of electric charges. The movement of electrons from one atom to another is what results in electrical energy. According to Jutta (2022), a sufficient and constant supply of electrical energy is indispensable for the economic development of industrialized countries. Benedict (2022) confirmed that electrical energy waste has negative impact on the industrial growth. Electrical energy is wasted each day due to lack of awareness among societies and in fact, energy awareness is the first step to achieve energy sustainability. Furthermore, without electrical energy awareness, efforts to promote energy conservation can be difficult and lead to energy wastage. Many industries are confronted with issues of electrical energy wastage due to the lack of awareness among the operators of machines and facilities (Chris, 2018). According to Benedict (2022), despite the fact that the technical opportunities are many and energy saving potential is real, most consumers and utilities have not taken advantage of it by auditing electrical energy used to identify areas of lapses in their industries (including woodwork industry).

The woodwork industry is concerned with forestry, logging, timber trade, and the production of primary forest products and wood products (furniture). This industry plays an important role in the economy as it is a major source of employment in Nigeria . According to Wingmore (2 0 2 2), the woodwork industry employs more than 1 0 0 , 0 0 0 people in Nigeria .This clearly indicated that the industry contributes greatly to the country's gross domestic product. Despite these significant contributions, woodwork industry is bedeviled with high cost of electricity that threatens it existence.

The term electrical energy savings refers to the decision and practice of using less electrical energy to save cost in woodwork industries. It is the effort to reduce wasteful energy consumption by using fewer energy services (Sheeran, 2022). The excessive billing of the electrical energy used in woodwork industries is directly related to poor knowledge of electrical energy savings. According to Mohamed *et al.* (2019), knowledge of electrical energy savings involves knowing how much energy appliances used, how efficient they are and how activities affect energy consumption. Poor knowledge of electrical energy savings among operators implies the inability to adopt maintenance practices for efficient electrical energy use in woodwork industries.

The potential of electrical energy savings is an estimate of how much energy efficiency is available in woodwork industries under a given set of parameters. According to the State and Local Solution Center (2022), the potential of electrical energy savings is the total energy that could be saved by efficiency measures, without consideration of cost or willingness of users to adopt the measures.

Hence, in order to ascertain the potentials of electrical energy savings in woodwork industries, there is need for professional feedback from woodwork employees. The woodwork industries employee include: the manager, machine operators and machinery repairers. The woodwork industry managers are individuals with the experience to supervise day to day activities of both machine operators and repairers. According to Hofstede *et al.* (2020), woodworking machine operators have ideas areas where energy is used as they are directly in charge of utilizing electrical energy in woodwork industries. Gosselin *et al.* (2017) stated that woodworking machinery repairers perform electrical repairs that include fault finding and replacement of faulty electrical components, windings of electrical motors and others which can either reduce electrical energy used. The woodwork employees and lecturers in electrical and electronics technology and engineering possess the knowledge needed for effective electrical energy management to provide sufficient information in the management of electrical energy in wood industries.

Statement of the Problem

Industries are the main features of modern civilization that provide man with the necessary finished products as well as employment opportunities. Wood processing and furniture industry is an important industry in Nigeria, having significant impact on economic development of the nation. Wood working machines tools are power driven tools that utilize electricity for their operations.

Unfortunately, many industries in Nigeria are folding up, while others are relocating their power plants to more business-friendly countries because of high cost of doing business in Nigeria (Olatunji *et al.,* 2018). They further lamented that industries spends more than ₦1.8 billion weekly in the running and maintenance of generators that powered their machines due to lack or epileptic power supply. Today`s world is looking for energy alternatives as well as solution due to electrical energy shortage, price unsecure supply of energy and issue of massive wastages (Saba, *et al*., 2022). There are rich chances to save 70% to 90% of energy and cost of running fan, lighting, electric pump systems; 60% in areas such as heating and cooling systems, office electric equipment/appliance and 50% for electric motor through proper adoption of electrical energy management practices (Daniel, *et al.,* 2021). It is therefore, necessary to manage the available electricity in Nigeria for continuous used. Appropriate management will drastically reduce electrical power consumption thereby increase access to electricity, reduction in customers' energy bills, reduction in the need for new power plant, transmission and distribution networks, stimulation of economic development and increases in the competitiveness of local enterprises. However, energy wastage in industries including woodwork industry hold negative implications to social-economic development of developing countries such as Nigeria (State & Local Solution Center, 2022).

It is therefore worth researching on areas where electric energy is wasted and how to reduce the wastage considering the fact that woodwork industries require electrical energy to drive machines and other equipment. The determined the Personnel's level of knowledge on electrical energy savings and opportunities for the woodwork industries in Katsina State, Nigeria.

Aim and Objectives of the Study

The study investigated the Personnel's level of knowledge in electrical energy saving and opportunities for the woodwork industries in Katsina State, Nigeria. Specifically, the objectives determined the:

1. Knowledge level of personnel on electrical energy savings in woodwork industries in Katsina State .
2. Potentials of electrical energy savings in woodwork industries in Katsina State.

Research Questions

The study sought answer to the following questions.

1. What is the knowledge level of personnel on ways to saves electrical energy in woodwork industries in Katsina State ?
2. What are the potentials of electrical energy savings in woodwork industries in Katsina State?

Hypotheses

The following null hypotheses were formulated and tested at 0.05 level of significance:

HO_1: There is no significant difference in the mean response of machine operators, machine technicians and managers on the knowledge level on electrical energy savings in woodwork industries in Katsina State.

HO_2: There is no significant difference in the mean response of machine operators, technicians, managers and lecturers of electrical and electronic technology and engineering on the potentials of electrical energy savings in woodwork industries in Katsina State.

Methodology

The study adopted the use of descriptive survey research design, the study was carried out in Katsina State, Nigeria. The target population of the study was 1,135 subjects. 1,100 personnel from woodwork industries and 35 Lecturers The study sampled 408 subjects. 378 personnel of wood industries Katsina State and 30 lecturers using sampling Table by Krejcie and Morgan. The instrument for data collection was a structured questionnaire. Instrument was validated by three experts two of them from the Department of Industrial and Technology Education FUT Minna and one from the department of Electrical Engineering Hassan Usman Katsina State polytechnic. A pilot study was conducted to test the reliability of the instrument by using 10 personnel from woodwork industries and 10 Electrical and Electronics Technology and Engineering Lecturers. The internal consistency of the instrument was calculated using Cronbach Alpha reliability formula which has been found to be more appropriate for reliability test survey research. The reliability coefficients obtained for all the sections were as follow; cluster A, 0.83; Cluster B, 0.76. The reliability coefficient for the entire 28 items questionnaire was determined to be 0.81. These results indicated that the instrument is reliable and it is therefore considered appropriate for use. The copies of questionnaire were administered to the respondents by the researcher through the help of 14 research assistants to facilitate the administration. The research assistants were informed on the objectives of the study and how to locate the subjects. They were also educated on how to issue, fill and retrieve the questionnaire. Statistical Package for Social Sciences (SPSS) version 21 was used to carry out all the necessary data analysis. Mean and standard deviation were used for answering research questions. Analysis of Variance (ANOVA) was used for testing the null hypotheses. Tukey Honest Significant Different (HSD) test of multiple comparisons was used where significant mean differences exist, in other to locate the groups that are responsible for or that contributed to the rejection of the null hypotheses.

Research Question One

1. How knowledgeable are personnel on electrical energy savings in woodwork industries in Katsina State?

Table 1: Mean Scores and Standard Deviation on the knowledge level of personnel on ways to saves on electrical energy savings in woodwork industries in Katsina State

S/No	*ITEM*	$\bar{x}$	*SD*	*REMARK*
1	Switching off the lights when not in use saves energy	3.02	0.53	K
2	Regular usage of natural day lighting helps in energy saving.	2.80	0.55	**K**
3	Regulate the light to regulate illumination level needed using dimmer saves energy.	2.41	0.62	SK
4	Resetting light timers periodically to minimize energy wastages.	2.02	0.85	SK

5	Utilization of low wattage lamp to provide required light saves energy.	2.32	0.83	SK
6	Replacing incandescent bulb with more efficient bulb such as Light Emitted Diode saves energy.	2.51	0.72	K
7	The use of automatic control devices such as motion sensors saves electricity	2.24	0.61	SK
8	Usage of task lighting saves electricity	2.48	0.82	SK
9	Utilization of electronic ballast saves electricity.	2.01	0.59	SK
10	Compact Fluorescent lamp (CFL) saves 65% of energy more than Incandescent bulb.	1.38	0.49	NK
11	Light Emitting Diodes (LEDs) saves 75% of energy more than Incandescent bulb.	1.42	0.61	NK
12	High Intensity Discharge Lamps and Induction lamps saves 70% of energy to Incandescent bulbs for outdoor lamps	1.54	0.74	**NK**
13	High Intensity Discharge Lamps and Induction lamps saves 70% of energy to Halogen lamps for outdoor lamps	1.49	0.85	NK
14	The use of dimmer switches saves significant energy when compared to manual switch.	2.57	0.86	K
15	Utilization of properly sized electric motor for operation saves energy	2.62	0.63	K
16	Running of the motor when needed saves energy	2.72	0.55	K
17	Regular lubrication of rotating parts helps in saving energy	2.44	0.62	SK
18	Rewinding reduces the efficiency of motor and causes waste of energy	2.28	0.85	SK
19	Energy is saved when motor is not overloaded	2.49	0.83	SK
20	Provision of adequate ventilation to motor saves energy consumption.	2.38	0.67	SK
21	Operating motor at low power factor led to energy wastages	1.34	0.61	NK
22	Operating motor at high power factor saves energy	1.44	0.82	NK
23	Sharpening of cutting edge of equipment saves energy	2.52	0.59	K

Keys: N= 364 No of respondents, ₹) Mean, SD – Standard Deviation K=Knowledgeable SK=Somehow Knowledgeable and NK=Not Knowledgeable

Table 1 revealed that the respondents were knowledgeable in regular usage of natural day lighting, running of the motor when needed, regular lubrication of rotating parts and Sharpening of cutting edge of equipment helps in saving electrical energy in woodwork industries in Katsina State in both lightening and electric motor with mean values ranging from 2.57 – 3.02, but were not knowledgeable with item 10, 11,12,13,21 and 22. The result also revealed that the standard deviation (SD) of the items ranges from 1.34 –1.49 this shows that the respondents were not very far from mean and from one another in their responses showing that the items were valid.

Research Question Two

What are the potentials of electrical energy savings in woodwork industries in Katsina State ?

Table 2: Mean Scores and Standard Deviation on the potentials of electrical energy savings in woodwork industries in Katsina State

	ITEMS	$\bar{x}$	*SD*	*Remark*
1	Promoting awareness on electrical energy management practices, through public enlightenment campaigns, giggles and others.	3.52	0.72	SA
2	Use of electrical energy efficient motor	3.72	0.61	SA
3	Avoid oversized motors	3.62	0.82	SA
4	Ensured power factor correction by the use of capacitor	3.60	0.59	SA
5	Reduce wear and tear	3.43	0.54	A
6	Speed control of induction motor.	3.67	0.61	SA
7	Importation of energy efficient appliances into country.	3.52	0.74	SA
8	Ban on importation of incandescent bulbs by industries	2.97	0.85	A
9	Development of positive behaviour among electricity users in the industries	3.72	0.86	SA
10	Proper policies and legislation on energy management	3.69	0.53	SA
11	Subsidizing the cost of energy efficient appliances.	3.54	0.55	SA
12	Utilization of energy standard and label to show energy consumption information.	3.49	0.62	A
13	Proper motivation of employees towards energy management practices.	3.58	0.85	SA
14	Proper records on energy consumption	3.24	0.83	A
15	Proper policies and legislation on energy management.	3.16	0.72	A

SA= Strongly Agreed ;A = Agreed ;

Table 2 revealed that the respondents jointly agreed to all the items presented on the potentials of electrical energy savings in woodwork industries in Katsina State with mean values ranging from 2 . 9 7 - 3 . 7The result also revealed that the standard deviation (SD) of the items ranges from 0.53 - 0 . 8 6 this shows that the respondents were not very far from mean and from one another in their responses showing that the items were valid .

Hypothesis One

There is no significant difference in the mean responses of machine operators, machine technicians and managers on the knowledge level on electrical energy savings in woodwork industries in Katsina State.

Table 3: Analysis of Variance test for Comparing data Obtained from machine operators, machine technicians and managers on the knowledge level on electrical energy savings in woodwork industries in Katsina State.

	ANOVA					*Levene's Test of Homogeneity of Variances*			
	Sum of Squares	*df*	*Mean Square*	*F*	*Sig.*	*Levene Statistic*	*df1*	*df2*	*Sig.*
Between Groups	.100	2	.050	.250	.779	.332	2	361	.718
Within Groups	72.071	361	.200						
Total	72.170	363							

The statistical result of analysis of variance presented in Table 3 revealed that there was no significant difference in the mean response of machine operators, machine technicians and managers on the knowledge level on electrical energy savings in woodwork industries in Katsina State. The table revealed that the significant criterion (sig.) of Levene's test for homogeneity of variance was 0.718 which is similar to the 0.779 significant criterion (sig) of ANOVA and both are greater than 0.05 (the probability value) and since the F-value of 0.250 at 363 degree of freedom which is greater than 0.05 level of significance. Based on this HO_1 was accepted to be true. This is an indication that there is no difference in the mean responses of the three groups of respondents on the knowledge level on electrical energy savings in woodwork industries in Katsina State.

Hypothesis Two

There is no significant difference in the mean response of machine operators, technicians, managers and lecturers of electrical and electronic technology and engineering on the potentials of electrical energy savings in woodwork industries in Katsina State.

Table 4: Analysis of Variance test for Comparing data Obtained from machine operators, technicians, managers and lecturers of electrical and electronic technology and engineering on the potentials of electrical energy savings in woodwork industries in Katsina State

	Sum of Squares	df	*Mean Square*	*F*	*Sig.*
Between Groups	29.629	3	9.876	40.062	.000
Within Groups	96.393	391	.247		
Total	126.022	394			

Table 4 shows the F-calculated value of 40.062 was obtained with associated exact Sig. tailed value of 0.00. Since the associated Sig. tailed value of 0.00 is less than 0.05, the null hypothesis which stated that there is no significance difference between the mean response of machine operators, technicians, managers and lecturers of electrical and electronic technology and engineering on the potentials of electrical energy savings in woodwork industries in Katsina State and hence the null hypothesis is rejected. This implied that, there is significance difference between the mean response of machine operators, technicians, managers and lecturers of electrical and electronic technology and engineering on the potentials of electrical energy savings in woodwork industries in Katsina State. In order to determine between the response of machine operators, machine, technicians, managers and lecturers who is responsible for the significance difference, the Tukey HSD post-hoc test was carried out to locate the groups that are responsible for or that contributed to the rejection of the null hypotheses as shown in Table 5 below.

Table 5: The Tukey HSD post-hoc test between the machine operators, machine, technicians, managers and lecturers of electrical and electronic technology and engineering on the potentials of electrical energy savings in woodwork industries in Katsina State

(I) VAR00001	*(J) VAR00001*	*Mean Difference (I-J)*	*Std. Error*	*Sig.*	*95% Confidence Interval Lower Bound*
	Machine operators	.13957	.05769	.075	-.0093
Managers	Machine Technicians	.13296	.08328	.382	-.0819
	Lecturers	-.92856*	.09568	.000	-1.1754
	Managers	-.13957	.05769	.075	-.2884
Machine operators	Machine Technicians	-.00662	.08865	1.000	-.2353
	Lecturers	-1.06813*	.10039	.000	-1.3271
	Managers	-.13296	.08328	.382	-.3478
Machine technicians	Machine operators	.00662	.08865	1.000	-.2221
	Lecturers	-1.06152*	.11699	.000	-1.3634
	Managers	.92856*	.09568	.000	.6817
Lecturers	Machine operators	1.06813*	.10039	.000	.8091
	Machine Technicians	1.06152*	.11699	.000	.7597

Table 5 above reveals Tukey HSD post-hoc test for machine operators, machine, technicians, managers and lecturers on the potentials of electrical energy savings in woodwork industries in Katsina State. Tukey HSD post-hoc test was carried out to locate the groups that are responsible for or that contributed to the rejection of the null hypotheses and the result indicates Sig. value = 0.00 for lecturers meaning they were responsible for the rejection of the hypothesis two.

Findings of the Study

1. The findings shows that the woodwork industries personnel were somehow knowledgeable on electrical energy savings in woodwork industries and there is no significance difference in their mean responses.

2. The study revealed that promoting awareness on electrical energy management practices, through

public enlightenment campaigns, giggles, use of electrical energy efficient motor, ensured power factor correction by capacitor, development of positive behaviour among electricity users in the industries and proper motivation of employees towards energy management practices were potentials of electrical energy savings in woodwork industries and there is sig difference in their mean responses. The result indicated that the lecturers were responsible for the rejection of hypothesis with significant value of 0.00.

Discussion of Findings

Table 1 provides answer to research question one on the knowledge level of the electricity users on electrical energy savings in wood work industries in Katsina State in is both lightening and electric motor use. The findings revealed that the respondents were somehow knowledgeable, all the items presented on the knowledge of machine operators on electrical energy savings in wood work industries in Katsina State in both lightening and electric motor have a mean values ranging from 2.57 – 3.42. over that switching off the lights when not in use, regular usage of natural day lighting, utilization of low wattage lamp to provide required light saves energy and among others helps in energy saving. The machine operators were not knowledgeable on the use of compact fluorescent lamp (CFL) saves 65% of energy more than incandescent bulb and light emitting diodes (LEDs) saves 75% of energy more than Incandescent bulb (Saba *et al,* 2016). LED which referred to as Extra low voltage (ELV) lightings are very vital in all industries because it, helps work to be done ef? ciently and safely and also playing an important part in creating pleasant and comfortable working environment especially in wood work industries . The null hypothesis was accepted to be true. This is an indication that there is no difference in the mean responses of the three groups of respondents on the knowledge level on electrical energy savings in woodwork industries in Katsina State. This is in agreement with the work of Saba, *et al* (2023) which lamented that there is low awareness toward energy usage in SMEs and as long as people are not well informed about these practices, it will often lead to energy wastages.

Table 2 provides answer to research question two on the level of the potentials of electrical energy savings in woodwork industries in Katsina State. The respondent agreed that the level of the potentials of electrical energy savings in woodwork industries is possible by promoting awareness on electrical energy management practices, through public enlightenment campaigns, giggles and others. This is in line with the finding of Saba *et al* (2023) that employees' attitudes towards electrical energy conservation in the work place is not positive, as many of the staff do not ensure adequate practice of electrical energy saving while at work and do not make it a habit to switch off the light while leaving the office. To ensure the right attitudes towards electrical energy savings, they need to be motivated by educating the staff to see the need to save energy. Hofstede *et al*. (2020) added that the inability to ensure electrical energy management practices in woodwork industries may likely lead to significant losses by increasing energy waste and that energy wastage in industries including woodwork industry hold negative implications to socio-economic development of developing countries such as Nigeria. In agreement with the above Daniel, *et al.,* (2021) observed that there are rich chances to save 70% to 90% of energy and cost of running fan, lighting, electric pump systems; 60% in areas such as heating and cooling systems, office electric equipment/appliance and 50% for electric motor through proper adoption of electrical energy management practices. The respondent strongly agreed that the use of electrical energy efficient motor, reducing of wear and tear by oiling or greasing and use of speed control of induction motor. This is in agreement with finding of Daniel, *et al* (2021) who noted that lighting systems and ubiquitous induction motors are the major sources through which electrical energy is being wasted as result of this, energy efficient motors and lighting systems coupled with efficient maintenance system are being proffered.

There is significance difference between the mean response of machine operators, technicians, managers and lecturers of electrical and electronic technology and engineering on the potentials of electrical energy savings in woodwork industries in Katsina State and hence the null hypothesis is rejected. Tukey HSD post-hoc test was carried out to locate the groups that are responsible for or that contributed to the rejection of the null hypotheses and the result indicates Sig. value = 0.00 for lecturers meaning they were responsible for the rejection of the hypothesis, since they are more knowledgeable in energy management as compare to other groups.

Conclusion

Based on the findings of the study, insights on Personnel's level of knowledge on electrical energy savings and opportunities for woodwork industries in Katsina State, Nigeria was provided. The study found out that: found that the personnel were somehow knowledgeable on electrical energy

savings in wood work industries in Katsina State in both lightening and electric motor use, the study found out that switching off the lights when not in use, regular usage of natural day lighting, utilization of low wattage lamp to provide required light saves energy and among others helps in energy saving, The study concluded that promoting awareness on electrical energy management practices, though; posters, public enlightenment campaigns, giggles and others. Avoid oversized motors, ensured power factor correction by use of capacitor, development of positive behaviour among employees in the industries, and proper motivation of employees towards energy management practices and among others can help in reducing energy wastages in wood industries in Katsina State.

Recommendations

Based on the findings from the study, the following recommendations were made:

1. The woodwork industries owners should rise awareness and ensure that their personnel are well knowledgeable on electrical energy savings. This can be done by organizing seminars and talks on electrical energy management in wood work industries in Katsina
2. The woodwork industries owners should ensure promoting awareness on electrical energy management practices , through public enlightenment campaigns ,giggles , use of electrical energy efficient motor , ensured power factor correction by the use of capacitor , development of positive behaviour among personnel and proper motivation towards energy management practices in woodwork industries in Katsina State.

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