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Widespread Use of Electric Generators Effects on Environment: Assessment of Gbadebo Business Centre, Mokola, Ibadan

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***Abstract* - In the recent past and presently, industries, commercial centres and households are frequently off grid due to unreliable electric power supply and hence standby electric generators served as an alternative source. It is necessary to carry out investigations into the adverse effects of the widespread use of the generators and suggest ways of mitigating the bad consequences on biological lives in the immediate environment. Gaseous emissions from generators react with ozone layers causing its depletion. This has led to escalation of hitherto uncommon diseases. Likewise, noise pollution emanating from the generators contributed immensely to reported cases of hearing impairments and deafness in humans at early stages of life.**

A commercial centre in Ibadan metropolis (Gbadebo Business Centre, Mokola) was taken as case study in our investigation. Data was gathered from the study area using distributed structured questionnaires. The data gathered was analyzed using Chi-square and Logistic Regression statistical methods. 94.59% of the respondents agreed on widespread use of generators, 56.76% ensured regular exhaust system maintenance while 67.57% agreed that noise pollutions can cause deafness. It was also observed that 51.35% strained ears to listen and 37.84% (14) get upset by noise while 5.4% never get upset. 27% reported death cases range of 1-5 persons.

Majority believed on the adverse effects whereas preferably average did the needful on mitigating the effect of noise pollution on hearing impairments. Public enlightenment programs on adverse effects, regular generator maintenance and enforcement agencies are needed in commercial areas. Government agencies such as the Nigerian Industrial Standards (owner of the SON/NIS certification) and the National Environmental Protection Agency should wake up to the task of enforcing the acceptable noise threshold level(s) in our society and prohibition of turning our country into a dumping ground for substandard electrical products, such as standby generators.

Keywords: Standby electric generators, Widespread use, Environmental Pollution, Hearing impairment, Public enlightenment.

I. INTRODUCTION

Intermittent, unreliable or long time power outages in Nigeria have been a major challenge of Nigerians. A country with estimated population of 200 million people and above has less than 40% of her populace with access to the national grid power supply (Eneche, Onwuka, & Ezigbo, 2017). This leads to the use of standby electric generators by the populace to attain their power needs. Recent and current estimations show that 90% and 30% of businesses and homes respectively use fossil fuel-powered generators. The Energy Commission of Nigeria (ECN) announced that 60 million of the populace use fuel-powered generators [Energy Commission of Nigeria (ECN). 60 Million Nigerians now Own Power Generators. This is the claim of Vanguard Newspaper, (26th January, 2009. Available: www.energy.gov.ng)]. Noise pollution that emanated from standby generators used at commercial centres and residential areas depicts higher risks to human's health and the environment owing to prolonged duration of use. The Nigerian Environmental Standards and Regulation Enforcement Agency (NESREA) classified noise as an offence to be punishable by law. According to the World Health Organization (WHO) recommendation, 90dB should be the maximum permissible noise level (Awofeso, 2010).

The small-scale business owners reported that the power supply from the national grid maximizes their profits unlike the use of electric generators. That means the use of generators pose lot of negativities on businesses. Despite the increasing cost of purchasing generators, increasing maintenance cost and once in a while hike in fuel price, prospective business personnel's are finding it difficult to come upstream. The influxes of more people into various businesses with the use of generators drastically increase the level of noise pollution. These lead to widespread use of generator and the major fall out in the study area. However, many people still do not care about the upsurge in electricity generators use despite the increasing noise pollution level and its negative

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consequences/impact on human health and the environment (Mbamali, Stanley, & Zubairu, 2012) and (Adinife & Babatope, 2013). Noise pollution effects and damages to humans' range from annoyance, disruption and distraction during communication, sleeping difficulties and increasing blood pressure etc (Mbamali, Stanley, & Zubairu, 2012). The World Health Organization (WHO) limits noise level to between 70 to 75dB for high blood pressure related cases, abnormal fetal development, extreme emotions and behavior. Gradual hearing impairments have also been reported to be caused by instantaneous and continuous noise generations. Heart related problems are not left out as one of the negative effects of noisy environments. This is because heart beat rate increases under the influence of sudden noise (Bisong, Umana, Onoyom-ita, & Osim, 2004).

Noise Induced Hearing Loss (NIHL) can be as a result of sudden noise likewise repeated exposure to various levels of noise over a prolonged period (WHO, 2010). NIHL is of less concern in developing countries like Nigeria due to poor attitude of enforcement agencies of noise pollution control laws. In the industrializing regions of the country, some factory workers are exposed to various noise levels with no protective measures and risks involved mindlessly.

Many individuals working in noisy environment may not discover the difficulties in hearing until it has become worse. Studies revealed that gaseous substances and particles emitted from generators ranges between 10.7 and 39.0ppm and that was above the National Guideline Limit of 9ppm (Olowolade, 2010). However, high desire to achieve financial sustenance makes individual to often neglect how important their health is as they work at a relatively close to running generators for long hours. Knowledge on occupational hazards of noise from electric generators is suggested to be a predictor of preventive measure at work. Knowledge, experience, and individual perception on effects of noise pollution take an important role on the use and maintenance of generators. Therefore, this study was strictly aimed at qualitative assessment on the effects of widespread use of standby electric generators and environmental pollution.

II. METHODOLOGY

A comparative cross-sectional design was used to develop well-structured questionnaires, administered and distributed to volunteer respondents (generator users). A structured interviewer administered questionnaire has been drafted in to obtain information on the knowledge and perception of respondents with regards to consequences and hazards associated with the use of fossil fuel generators.

a) Questionnaire

The distributed questionnaire is divided into seven (7) sections namely: **Section A**: Socio-demographic Information, **Section B**: Reasons for the Widespread Use of Generator, **Section C:** Environmental Pollution, **Section D**: Generator Maintenance History, **Section E**: Operational History of the Generator and **Section F**: Maintenance Schedule Section **G**: Death Rate. Each questionnaire was carefully reviewed for completeness and appropriateness of responses.

b) Study Area

Gbadebo, Mokola islocated in the city of Ibadan, the capital of Oyo State inNigeria. The Mokola business area is situated adjacent to the overhead bridge and is a high commercial activity area encouraging small and medium scale businesses.

c) Surveys

50 respondents, that is, the generator users were surveyed. Useful Information on socio-demographic characteristics, consequences of the widespread use of generator were obtained from 37 respondents with a pretested interviewer-administered questionnaire.

d) Statistical Analysis

Analysis was done by entering data into Microsoft Excel, manage and analyzed using the Statistical Package for Social Sciences (SPSS) version 15. Data were analyzed using descriptive statistics, Chi-square test and logistic regression at 5% level of statistical significance. The formula used for the hypothesis is given as: $z = (x - u)/(\frac{SD}{\sqrt{n}})$

Where;

x = sample mean
u = population mean
SD = standard deviation
n = sample size

The null and alternate hypothesis conditions were used either to determine or reject the obtained statistical values.

III. RESULTS FROM THE FIELD SURVEY

a) Socio-demographic Information

The age of participants in the commercial centers visited ranged from 19 to 59 years. Majority of them, 30 (81.12%) were below 39 years of age while those above 39 years of age were 7 (18.92%).

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According to the questionnaire administered, the commercial areas comprised 28 (75.68%) male and 9 (24.32%) female. Among the respondents 20 (54.05%) had tertiary education, 13 (35.13%) had secondary education, 3 (8.11%) had primary education and 1 (2.71%) had no formal education.

b) Reasons for the Widespread Use of Generator

Majority of the respondents (97.29%) agreed that Inadequate or unreliable power supply has been a major reason for the use of generator has been rampant for a very long time. 94.59% of them also made it known that the erratic supply of low voltage of electricity has an effect on the widespread use of generator while 5.41% disagreed. Since all respondents engage in business in order to make a living, then having a great productivity is one of their main goals, 81.08% of the respondents agreed that the use of generator has improved the quality of production rather than waiting for the general power supply while 18.92% doesn't believe it as causative factor for the widespread. Under the same section, there was a partial agreement that human satisfaction and comfortability increase the use of generator in commercial centers. Majority of the generators users, 89.19% of respondents affirmed or agreed on generators use in order to prevent company's losses whereas 10.81% disagreed. In addition, most of the respondents (83.78%) agreed that the use of generators has enabled their businesses provide better services to the customers.

Table 1: Reasons for the Widespread Use of Standby Generators as Claimed by the Respondents

Reasons for the widespread of generator	Features	Commercial Centers	
		Frequency	%
Inadequate power supply	*True*	*36*	*97.29*
	False	*1*	*2.71*
The erratic supply of low voltage of electricity	*True*	*35*	*94.59*
	False	*2*	*5.41*
The quest to improve quality of production	*True*	*30*	*81.08*
	False	*7*	*18.92*
Human's satisfaction and comfortability	*True*	*28*	*75.67*
	False	*9*	*24.33*
For industries to support their facility's needs	*True*	*33*	*89.19*
	False	*4*	*10.81*
To prevent company's income loss	*True*	*29*	*78.38*
	False	*8*	*21.62*
To provide better service to customers	*True*	*31*	*83.78*
	False	*6*	*16.22*

Source: Field Survey, (2021)

c) Environmental Pollution

i) Air Pollution (fumes from the Generator)

Few of the respondents (29.73%) have generator that produces visible smoke. All the respondents (100%) were aware that fumes are dangerous to health. Since only few of them have generator that produces fumes, they are the only ones exposed to fumes for little hours of 2-4hours. Ten of the respondents (4%) have experienced ill-health.

In order to curtail the fumes from the generator, 62.16% of the respondents always observe routine maintenance while 29.73% of them do that occasionally and others never bother about routine maintenance. 56.76% of the respondent only does the exhaust system inspection occasionally.

However, to prevent direct inhale of fumes, most of the respondents (70.27%) always run their generator outdoor. But they do not tamper with their working hours most of the time, (i.e, shut them down only if some circumstances warrants). Majority of the respondent (70.27%) neither bothered to use a catalyst to curtail the fumes from their generator nor use a protective device during operation. 48.65% of them use protective devices occasionally and 24.32% never used it before.

ii) Noise Pollution

Majority of the participants (67.57%) affirmed that the use of generator caused slow deafness sometimes. A large proportion of participants in commercial centers complained that the noise of the generator has made it hard to hear from afar. They would have to move closer for conversation among themselves comfortably. Sometimes, 51.35% of the respondents would have to strain their ears before they could hear or listen to conversations. The produced noise from the generator caused somehow a temporal effect in hearing until the generator stops working.

For the negative social behavior of and annoyance reaction to generator, 37.84% of the respondents (14) agreed that they are always upset whenever they hear the noise coming from the generator while 20 of them said it only happens seldomly. 12 numbers of the respondents always get annoyed and 23 of them said it only happens sometimes while 2 respondents never get annoyed with the noise.

High percentage of the respondent (67.57%) agreed that generator noise irritates sometimes when it's in use and also that they (81.08%) never feel comfortable at it. 12 of the respondents agreed that the noise always cause distraction while others (54.05%) affirmed it only happens sometimes. Only few (7) of the respondents agreed that the noise always cause fatigue.

16 of the participants agreed that the noise of the generator always alter their bed time. While sleeping, they

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(24) confirmed that the noise always disturbs their sleep as well. But majority claimed that it has not really reached the level of Insomnia.

Most of the respondents (17) complained they always have to move closer to their colleagues at any point of physical discussion, 19 agreed that they always shout during such conversation while 13 said it happens sometimes and 5 never shouted in such scenario.

For Cardiovascular Disturbances, only 35.14% always feel the vibration and 56.75% feel it sometimes while others have never felt it. Majority (56.75%) has not experienced high blood pressure due to the generator noise and also it never increases their (67.57%) heart rate.12 of the participants agreed that the generator noise always make it difficult for them in reading attentively while 23 agreed that it only happens sometimes. 17 of the respondents agreed that the noise always make it difficult for them to concentrate in a task while it only happens to others sometimes. Apparently, they all agreed that it always affect the efficiency of their operation.

d) Generator Maintenance History

48.65% of the respondents always employ the corrective maintenance and 43.24% does it sometimes. 21 (56.76%) of the respondents employs the preventive maintenance always and 27.03% of them does it sometimes while 16.21% has never practice any type of maintenance.

On the effect of maintenance, majority of the respondents (86.29%) agreed that maintenance increases the efficiency and lifespan of the generator and it also minimizes the amount of harmful fumes. 28 participants (75.68%) agreed that the maintenance of generator cools the sound and also reduces the generator noise. Most of them agreed that regular maintenance reduces the spillage of oil.

e) Maintenance Schedule

For types of maintenance schedule were employed by the respondents, 51.35% of them always observe the Routine General Inspection and 43.24% of them do that sometimes and the rest have never tried such before. In case of lubrication service, 32.43% of the respondents always do this while 51.35% of them only observe it occasionally and others do not try it at all. Ten (10) of the respondents, which represents 27.03%, will always inspect the exhaust system and 59.46% do that occasionally while the rest never tried it. 24.32% of the respondents always inspect the cooling system and 45.95% of them will only inspect it occasionally while 29.73% has never inspected the cooling system.

In case of the frequency of the maintenance, 21.62% of the respondents did the full inspection once in 6months, 45.95% of them did that twice, and 16.22% did it thrice and others never done it at all. 27.03% of the respondents underwent the routine inspection once in a month and 32.43% of them did that twice, 21.62% thrice and 18.92% doesn't try it at all in a month.

48.65% of the respondents used the generators between 2-4hours and 13.51% used it between the hours of 0-2 while 37.84% used their generator for 4hours and beyond.

f) Ageing of the Generator

Majority of the respondents (81.08%) agreed that lack of proper maintenance has been the cause of generators ageing fast. Also, they agreed that overloading decreases the lifespan as well. Using the generator until the fuel drains was also mentioned as the cause of ageing by a respondent.

For the effect of generator ageing, 75.68% agreed that it reduces the efficiency of the generator and it also pollutes the environment in form of noise, smoke or oil spillage. 67.57% of the respondents agreed that repairing and replacement can bring solution to the quick ageing of the generator.

g) Death Rate

Only few respondents (10) has experienced a report of death case due to the use of generator and the death is between the range of 1 to 3 (60%) and 3 – 5 (40%).

Table 2: Table of Possible Death Cases due to the Use of Generators

Questions	Variables	Commercial Centers	
		N	%
Has there been report of death?	Yes	10	62.16
	No	27	37.84
If yes, how many has been reported?	1 - 3	6	60
	3 – 5	4	40
	5 and above	0	0

Source: Field Survey, (2021)

IV. HYPOTHESIS RESULTS AND DISCUSSION

The findings of this study revealed that, the mean age of participants in Mokola was 30.9±1.9 years. A previous study of this type conducted among Nigerian traders revealed a mean age of 24 ± 1.3 years (Ighoroje, Marchie, & Nwobodo, 2014). Similarly, another study conducted among operators of grinding machine revealed mean age of 31.2 ± 1.83 (Bisong, S. A.; Umana, A. N; Onoyom-Ita, V; E., Osim E., 2004). There is a high level of knowledge and awareness of the rampant use of generators due to power outages, the quest to improve the quality of product and other reasons backed with

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some facts. Most of the respondents are well aware of the harm the rampant generator use possesses to health. Similar findings were observed in a study conducted among generator users in Ilorin, which revealed high level of awareness that generator use is hazardous (Makinde, 2008).

High level of awareness observed among generator users in Mokola on the danger associated with fumes coming from the exhaust of the generators was surprising as most of them didn't bother to use a protective device. Also, the respondents only put measures to curtail the fume in place occasionally and not always. Measures such as routine maintenance exhaust system inspection, outdoor operation and reduction of working hours were stated to be effective in reducing the fumes of the generator exhaust.

The respondents are also aware of the health and psychological effects of the noise from generators, most of them agreed that it caused some kind of deafness whenever it's in use and also make them to hear conversation only at close range. Only few agreed that they strain their ears before they could hear. Generally, there was an agreement to the temporal effect the noise has on human health and psychological well-being.

Effective behavioral change is facilitated by greater knowledge, experience, and personal risk Perception. The findings of this present study revealed that majority of the respondents in Mokola considered or perceived noise as a phenomenon that could cause a serious harm to their health such as Deafness (hearing loss). A Swedish study involved a sample of workers (majority: males) in manufacturing industry and measured perception almost the same way as we did (item: I think it would be big problem if I lost my hearing). It reported that the majority (90%) of respondents considered hearing loss to be a serious health problem (Svensson, 2004). The implication of this is that nobody wants to go deaf, but their actions speak otherwise. This may be associated to the insidious nature of noise effects.

Although none of the respondents knew the actual sound level detrimental to health, but they were aware high noise levels could cause a serious problem to the health. More than half of the respondents agreed that generators could cause sleep disturbance which alters bed time in a residential settlement since sleep disturbance is one of the most serious effects of exposure to noise.

A generator can last for decades but it needs proper maintenance. Just like it's important to eat healthy and exercise, a generator also needs maintenance to prevent it from breaking down. But this was not the case of most of our respondents, they understand the importance of maintenance but they were not employing it. Only few of them carry out the proper maintenance schedule and some of them do theirs when there is a fault (corrective type). Meanwhile, the better the maintenance, the longer the generator will function without the need for extensive repairs cost and the lesser the health hazard it poses.

V. RESEARCH HYPOTHESES

To test the reason for the widespread use of generator statistical packages for social science was used to input the data and inferential statistics was used to analyze the result of hypotheses of the study as shown below, data are analyzed from a sample to make inferences in the larger collection of the population. The purpose is to answer or test the hypotheses. A hypothesis is a proposed explanation for a phenomenon. Hypothesis tests are thus procedures for making rational decisions about the reality of observed effects.

In inferential statistics, the term 'null hypothesis' (H_0 '*H-naught*,' '*H-null*') denotes that there is no relationship (difference) between the population variables in question while alternative hypothesis (H_1 and H_a) denotes that a statement between the variables is expected to be true.

The *P* value (or the calculated probability) is the probability of the event occurring by chance if the null hypothesis is true. The *P* value is a numerical between 0 and 1 and is interpreted by researchers in deciding whether to reject or retain the null hypothesis.

Table 3: Results of the Hypotheses on Reasons for the Widespread Use of Generator

SN	Reasons for the Widespread Use of Generator	Df and Level of Sig.	Chi square and P-Values	Decision
1.	Inadequate power supply	6(5%)	16.496 (2.072)	Accept
2.	The erratic supply and low voltage of electricity	9(5%)	10.782 (4.315)	Accept
3.	The quest to improve quality of production	13(5%)	9.189 (3.220)	Accept
4.	Human's satisfaction and comfortability	29(5%)	21.189 (0.019)	Reject
5.	For industries to support their facility's needs and also provide better service to customer	21(5%)	15.423 (3.311)	Accept

Source: Field Survey, (2021)

From result of table 3, all null hypotheses were rejected, while all alternative hypotheses were accepted, all at 5% level of significance, but with different Degree of Freedoms (Df).

From the first hypothesis, the p-value = (2.072). Since p-value = 2.072 > 0.05, we accept the alternative hypothesis and

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reject null hypothesis that inadequate power supply has been one of the reasons for the widespread use of generator.

The second hypothesis has a p-value = 4.315. Since p-value = 4.315 > 0.05, we reject the alternative hypothesis and accept the null hypothesis that the erratic supply and low voltage of electricity has an effect to the rampant use of generator in commercial centers.

However, hypothesis 3 has a p-value = 3.220 and since the p-value = 3.220 > 0.05, we accept the alternative hypothesis and reject the null hypothesis that the quest to improve quality of production is one of the reasons for the widespread use of generator in Nigeria of today. In addition, hypothesis 4 has a p-value = 0.019 and since the p-value = 0.019 < 0.05, we reject the null hypothesis and accept the alternative hypothesis that human satisfaction and comfortability is one of the major reasons for the widespread use of generator in commercial centers.

Lastly, hypothesis 5 has a p-value = 3.311 and since the p-value = 3.311 > 0.05, we accept the alternative hypothesis and reject the null hypothesis that the need for industries to support their facility's needs and also provide better service to customer can be regard as part of the reasons for the widespread use of generator in the commercial center.

VI. CONCLUSION

This study showed heavy reliance of commercial centers on standby generator as their alternative power supply since the country's power supply can never be trusted. Despite the high level of education observed in Mokola environ, majority were not aware that widespread use of generator is detrimental to their health. Therefore, an intervention seminar could be carried out to train workers on harmful effects of rampant use of generators by stating the level at which it enhances environmental pollution which involves noise pollution, air pollution and oil spillage. The level at which noise is considered dangerous to the health should be stated because the present study shows respondents had poor knowledge about the harmful level of noise at work and also the danger which the fumes of generator pose to the atmospheric condition should not be left out. A dichotomy between knowledge and practice was observed in this study as it can be deduced that the majority of the respondents knew the effects of maintenance on generator but only few of them does the needful often.

Contribution to knowledge

In the course of this study, our own understanding on how to reduce the effect of generators' noise in such an environments is as follows:

- Mitigating the effect of the generator use in the centre is by ensuring distance that will cushion the level of noise. The close the generator users are, the higher the noise level.
- The use of sound proof case or house for a running generator could also reduce the noise level. This may be an additional cost of establishment but it's a way to go.
- Decentralization of such a large business centres. Relocation of some business owners to another location probably far away to their residential area may be another way forward.

VII. RECOMMENDATION

Given the nature and rapidity of urbanization in this part of the country, Nigeria, it is expected that these ugly scenario or menace of environmental pollution through the widespread use of generator and its adverse consequences will be deepened in the future. Thus, there is need for the government of Nigeria to not just expand and improve power supply from the national grid, but to also create awareness and policies to enhance energy-efficient building development on the use of solar power generation options, other Renewable energy options and more environmentally friendly options, to ensure and enhance quality productivity and urban livability (Nnodu, Obiegbu, & Eneche, 2017).

Future intervention study should also address the training of generator users on the use of adequate personal protective devices such as nose masks, ear muffs, and ear plugs while working with electric generators as this will reduce the rate at which the pollution penetrate their body system. The use of noiseless generators such as solar inverters use should be encouraged. Likewise, the use of fueless and fumeless generators (invented generators using water) to prevent and reduce the exhausted and percentage composition of greenhouse gases in the atmosphere.

Therefore, Public enlightenment programs on effects of regular generator maintenance and enforcement agencies are needed in commercial areas. Government agencies such as the Nigerian Industrial Standards and the National Environmental Protection Agency should wake up to the task of enforcing the acceptable noise threshold level(s) in our society and prohibition of turning our country into a dumping ground for substandard electrical products, standby generators in particular.

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