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Investigation of House-Keeping Practices of Electric Power Generators Used In Buildings in Ibadan Metropolis, Nigeria

Wahab, A.B.
Department of Building, Obafemi Awolowo University, Ile-Ife, Nigeria

ABSTRACT: *Energy crisis has been a long-standing problem in most parts of the country and building occupants have been using various types of generators as alternative source of power. This study was carried out to identify and examine house-keeping practices adopted by the users of electric power generators in the selected residential and commercial buildings in Ibadan Metropolis.The 59 political wards in the 5 local government areas of Ibadan Metropolis were stratified into core, transition and suburban residential zones.Multi-stage and quota sampling techniques were used to select 736 and 150 residential and commercial buildings respectively in the study area. Data collected were analysed using frequency distribution, relative importance index, chi-square and analysis of variance. The study showed that the House-Keeping Practice Index (HKPI) adopted by residential buildings occupants in the suburban zone (0.8246) was putting the generator in a ventilated environment while it was the provision of a balanced rest position in both core and transition zones with HKPI of 0.6425 and 0.7353, respectively. In the commercial buildings, provision of rest position was mostly adopted with HKPI of 0.6778. The mean distance (in metres) of positioning generators from external walls of residential buildings in the core, transition and suburban zones were 2.09, 3.59 and 7.39 while the corresponding distances for commercial buildings were 1.55, 2.54 and 2.87 respectively. The study recommended that in view of dependence of building occupants on generators as an alternative to electricity, its users should adopt best house-keeping practices by positioning them in properly built enclosure features (generator house) located at a minimum distance limit of 8 maway from external walls of their buildings. Efforts should also be made to institute policies through appropriate enlightenment and enforcement processes by relevant arms of government so as to foster effective management and sustainability of the built environment.*

Keywords: *Energy Crisis, Electricity, Electric Power Generators, Adoption, Mode of Use, Buildings*

I. INTRODUCTION

Availability of electricity is crucial for commercial activities, technological advancement and comfort drive of building occupants. Erratic power supply is a major challenge in Nigeria as its energy infrastructure has experienced series of ups and downs (Adewoye, 2007; Sambo, 2008; and Subair and Oke, 2008). According to World Bank Report (2001), in two decades' time, Nigeria's population will likely double. With modernization, electricity use has become an essential need for most people in developing countries. Most towns and cities in Nigeria are connected to the national power grid. However, supply from the national grid has become a major problem for about a decade and people have to seek for alternative sources of power supply. In 1999, the power generated in Nigeria was 1,500 MW, and currently about 2,030 MW which is far short of the projected energy demand of 107,600 MW by 2020 with the growth rate of the country at 13% (Sambo *et al*., 2009; TCN, 2016).
According to World Bank Report (2001), in two decades' time, Nigeria's population will likely double. In the absence of a comprehensive overhaul of energy policy and regulatory framework, more Nigerians, will in the future, be without electricity (Chidiezie and Igwiro, 2008). The unreliability of electricity supply in Nigeria has been a serious challenge to its economic development and environmental sustainability (Oyedepo, 2014). This has forced most Nigerians to look for alternative power supplies (Ibitoye and Adenikinju, 2007). Available statistics show that 60 per cent of Nigeria population lack access to electricity for their needs (Baker Institute Energy Forum, 2008). The shocks from the energy crisis in Nigeria have created some wedges in the national wheel of the effective management of industrial and other socio-economic programmes. Over 167 million people of Nigeria are depending on less than 3,000 to 5,000 MW of electricity with the recurrent multiple and unpredictable power outages. In view of this, there is a paradigm shift of building occupants to dependence on off-grid power supplies which involves the use of generators of different types and capacities. This development has made the country to be running "generator economy" (Ahmad and Abubakar, 2012).

While trying to address problems of electricity supply, building occupants across the globe have been adopting principle of off-grid power supplies, micro generation of power through the use of micro hydro plants, wind power plants, biogas plants, generators and photovoltaic (PV) plants (Harrison, 2008). In Nigeria, many people, companies and institutions supplement the grid system with their own generators. Indeed, those who could afford a generator own one. This is noticed in the use of different types of generators; petrol or diesel powered generators by occupants of different types of buildings and well over 90% of businesses in Nigeria have generators (World Bank, 2005).

House-keeping practices involve the general care, cleanliness, orderliness of a business or property and also depict management of duties involved in the running of a household (Bredenberg, 1998). When specifying a generator, it is essential to consider the application for which it is intended to be used. There is need to look into the area of ensuring effective application of generators through its proper sizing, location; whether a generator is to be located inside a building or outside (SDMO Users' Guide, 2001).The use of generating sets is prone to a number of hazards based on its mode of operation. The primary hazards to avoid when using a generator are carbon monoxide (CO), poisoning from the toxic engine exhaust, electric shock or electrocution and fire. Generators must not be used indoors, including homes, garages, basements, crawl spaces and other enclosed or partially-enclosed areas.The most common way to use a portable generator is to place it outdoors and then run the extrusion cord(s) through to the chosen appliance. The generators must not be run indoors, not even in the garage because of its emissions (Generator, 2012).An adequate foundation must be provided for a generating set, as it provides a rigid support that prevents deflection and vibration. The foundation should be 150-200 mm deep and at least wide and long as the generating set (Perkins Users' Handbook, 2000). Generating sets chassis should rest evenly on the ground (Generating Set Installation Guide, 1998). According to SDMO Users' Guide (2001), adequate ventilation is required for an effective functioning of generating sets, as without adequate ventilation, the engine system of generators can reach a temperature level that can lead to accidents or damage to the equipment and the surrounding items.

Studies on generating sets used in buildings in Nigeria such as Komolafe, 2011, Ana *et al.* 2014; Sonibare *et al*. 2014, and in particular, the study area have notfocused on the mode of use generators and house-keeping practice adopted by building occupants especially in residential and commercial buildings in Ibadan Metropolis, Nigeria on issues associated withits enclosure characteristics, points of positioningbefore or during use and distance limitsof its positioning from external walls of buildings. In view of the gaps identified, the specific objectives of the study were to identify and examine house-keeping practices adopted by the users of electric power generators in the selected residential and commercial buildings in Ibadan Metropolis.

II. THE STUDY AREA

Ibadan is the capital city of Oyo State in the southwestern part of Nigeria. Its geographical location of Ibadan falls between coordinates $7^o\ 22^{'}\ 47^{''}$ North of the Equator and $3^o\ 53^{'}\ 0^{''}$ East of the Greenwich Meridian. The total population of Ibadan according to FGN (2009) is 2,559,853 including population of the surrounding towns and villages. The city ranges in elevation from 150 m in the valley area to 275 m above sea level on the major north-south ridge which crosses central part of the city. The city is characterized by a warm rainy season between 100 mm to 200 mm of annual rainfall extending from March to October, and a constantly high temperature of 24 ^oC to 27 ^oC. The entire area of Ibadan is largely well-drained, though many of its rivers are seasonal. Developed land increased from only 100 ha in 1830 to 12.5 Km^2 in 1931, 30 Km^2 in 1963, 112 Km^2 in 1973, 136 Km^2 in 1981 and 214 Km^2 in 1988 (Mabogunje, 1968). Ibadan consists of eleven local government areas, five in the city and six in the suburb. The five local governments that form the city cover about 15% of the total land areas of Ibadan, while the remaining 85% is for the remaining six local governments in the suburb (Oyo State Ministry of Local Government and Chieftaincy Matters, 2012).

III. RESEARCH METHODOLOGY

The scope of this study was limited to residential and commercial buildings that existed in Ibadan Metropolis. Ibadan metropolis was chosen because the study was urban based. The study population was made up of residential and commercial buildings occupied for residential and commercial purposes; where generating sets were used that existed in each of the three residential zones; core, transition and suburban respectively in each of the five local governments that made up Ibadan Metropolis. A reconnaissance survey was carried out and the study area was divided into a list of different residential/political wards determined and used for the purpose of the 2011 general elections by the (Oyo State Independent Electoral Commission, 2013). Multi-stage sampling technique was used which led to the sampling of 736 residential buildings The first stage involved delineation of residential areas in Ibadan Metropolis into different zones based on age and other criteria. The technique of delineating residential areas in Nigeria involves the use of historical and physical attributes. It takes into consideration, period of the emergence of a city or a section of a city, housing characteristics, environmental qualities and population per square kilometer (density) among others (Afon, 2008; Wojuade, 2012; Adigun

2013). Faniran (2012) among other authors had identified three (3) residential zones in Ibadan. These are: core, transition and suburban residential zones and were thus adopted for this study. The stratification made the heterogeneous nature of the study population to be reduced into residential/political wards of similar and homogeneous features. In the second stage, stratified random sampling technique was used. According to Singleton *et al*. (1988), stratified random sampling technique requires fewer cases because each stratum is homogeneous. Out of the 59 residential/political wards in all the local governments, a 25% sample, representing 15 political/residential zones and 3 political wards (representing core, transition and suburban area respectively) in each of the selected local governments were used for the study. In the third stage, systematic sampling technique was used whereby 2% of the total number of buildings in the selected wards was sampled in accordance with Singleton *et al*. (1988) which stated that the greater the heterogeneity of the population, the larger the sample needed to achieve a given level of reliability.

Pockets of commercial buildings that were along the road networks and close to the residential buildings were purposively selected as its sample population. According to Esan and Okafor (1995), quota sampling has no definite probability law associated with the selection procedure which is aimed at providing some "balance" in the selected sample. In view of this, quota sampling technique was used to determine number of commercial buildings sampled and it served as representation of the stock of commercial buildings that existed in the study area. Thus, ten commercial buildings were selected in each of the three residential zones in the study area. Hence, a total of 150 commercial buildings were sampled.

In all, 886 residential and commercial buildings were selected (Table 1). The first building sampled was selected randomly between the 1st and the 20th building; and starting with that number, every 20th building was subsequently selected following the line of accessibility. This technique eliminates bias of the researcher and gives each unit of investigation equal chance of being chosen in the complete list of the population (Blalock, 1969). One occupant was taken in each of the residential and commercial buildings sampled in each of the zones of the local governments of the study area.Data were collected by administering questionnaire and interviews on the occupants of the selected residential and commercial buildings in order to obtain information on the mode of use of generators. This was complemented by employing site observations to investigate the house-keeping practices adopted, enclosure features provided and the mode/distances of positioning of generators by the building occupants. The data collected were analysed by using frequency distribution, Chi-square, ANOVA and relative importance index (House-keeping Practice Index) which was based on a likert scale of 1 to 5.

IV. RESULTS AND DISCUSSIONS

Table 1 showed that out of the 886 questionnaires administered on the users of generators in the residential and commercial buildings sampled, 537 questionnaires were returned and found useful for the analysis of the data collected. This indicated a return rate of 60.61%. According to Babies (2005), a response rate of 40% was adjudged adequate for studies in built environment related researches, and this implies, that the 60.61% return rate of the studyshould be adequate to uphold results of the analysis.

Table 1: Response Rate of the Questionnaires Administered

Respondents/ Users of Generator	Number Administered by Building Type	Number Collected by Building Type	Percentage Collected by Building Type (%)	Percentage Collected in All Buildings Sampled (%)
Residential Building	736	443	60.19	60.61
Commercial Building	150	94	62.67	
Total	886	537		

Profile of the Respondents Sampled

Table 2 showed the profile of respondents sampled in residential buildings in the study area. The age distribution of the respondents showed that bulk of respondents in the residential buildings across the zones belonged to the 31-40 age group (37.50%) and was followed by the 41-50 age group (33.80%) while the age group that was greater than 60 years (4.70%) had the least number of respondents. Table 3 showed that majority of respondents in the commercial buildings across the zones belonged to the 21-30 age group (52.20%) and was closely followed by the 31-40 age group (24.40%). This implies that bulk of the respondents sampled in the residential and commercial buildings were in their youthful ages and ought to be in possession of service items needed for comfort needs and performance of tasks indoor. It is shown in Table 2 that in the residential buildings, 55.88% of the users were self-employed, 35.05% were employed and 9.07% were senior citizens who had retired from either private or public service. It was obtained that employed respondents existed across the three residential zones of the study area as there were 24.84% in the core, 38.46% in the transition and 45.30% in the suburban residential zone. However, majority of respondents (100.00%) in the commercial buildings were self-employed since they used the facilities they occupied as means to earn their livelihood (Table 3). The educational status of respondents in residential buildings as shown in Table 2 revealed that 61(44.20%) of respondents in the transition zone had senior secondary education, 60(43.50%) had post-secondary education and 10(7.20%) had postgraduate qualification. In the suburban residential zone, 41(34.70%) had post graduate education which indicated that they were mostly educated. Comparably, in the core residential zone, 25(14.70%) and 108(63.50%) of its respondents had adult/primary and senior secondary school education respectively. Since it was found that it was in the suburban residential zones where the respondents were mostly educated, this indicates that the level of education of respondents which was most significant in the suburban residential zone in the study area would affect their socio-economic characteristics, particularly on the type and rate of the use of generating sets in their buildings. Contrastingly, Table 3 showed that majority of respondents in commercial buildings, 59(66.30%) across the zones had senior secondary school education and 23(25.80%) had post-secondary school education. Similarly, 23(74.20%), 24(66.70%) and 12(54.55%) of respondents in the core, transition and suburban zone respectively had senior secondary school education. The Table further indicated that a large proportion of the commercial buildings' respondents did not possess post graduate education. This could have effect on their socio-economic status.

Table 2 showed that bulk of respondents in the suburban residential buildings 32(29.09%) earned more than 120,000 naira monthly while respondents in the transition residential zone had reduced response rate of 4(2.94%). It also indicated that, it was in the core residential zone, where its majority, 111(63.07%) of its respondents earned below 30,000 naira monthly, and 65(36.93%) earned between 30,000 to 60,000 naira monthly. However, in the transition and suburban zones, 69(50.74%) and 14(12.73%) of their respondents respectively earned between 30,000 to 60,000 naira. This implies that earning power of respondents in the suburban residential buildings was significantly higher than others in the transition and core residential zones. Contrastingly, Table 3 showed that 23(62.16%) of respondents in commercial buildings in the transition zone earned most with a monthly income range of 61,000 and 90,000 naira followed by 16(72.72%) and 21(61.76%) of respondents in the suburban and core residential zone that earned 61,000 to 90,000 and below 3,000 naira respectively. There was unequitable occupancy status of respondents sampled in the residential buildings as bulk of respondents in all the zones were landlords in their personal buildings with response rate of 94(52.81%), 91(65.47%) and 71(57.72%) for core, transition and suburban residential zone respectively (Table 2). It further revealed that fewer number of respondents were tenants in the buildings selected as the core zone had the highest frequency rate of 84(47.19%) followed by suburban 52(42.28%) and transition zone 48(34.53%) respectively. It is thus expected that, with the majority of the respondents being landlords in the selected buildings, their propensity to use building service items ought to be very high. However, tenancy status of respondents of commercial buildings in the study area varied disproportionately from what obtained in the residential buildings. It is shown in Table 3 that majority of the respondents, 64(68.82%) in commercial buildings in different zones of the study area were tenants in the facilities/buildings used based on the terms stated in their tenancy agreement.

Table 2: Profile of Respondents Sampled in the Residential Buildings

Profile	Residential Buildings							
	Core Zone		Transition Zone		Suburban Zone		Total	
	F	(%)	F	(%)	F	(%)	F	(%)
Age (Yrs)								
21-30	22	(12.50)	22	(16.40)	5	(4.20)	49	(11.40)
31-40	73	(41.50)	50	(37.30)	38	(31.90)	161	(37.50)
41-50	56	(31.80)	41	(30.60)	48	(40.30)	145	(33.80)
51-60	18	(10.20)	15	(11.20)	21	(17.60)	54	(12.60)
> 60	7	(4.00)	6	(4.50)	7	(5.90)	20	(4.70)
Total	176	(100.00)	134	(100.00)	119	(100.00)	429	(100.00)
Employment								
Employed	40	(24.84)	50	(38.46)	53	(45.30)	143	(35.05)
Self Employed	107	(66.46)	70	(53.85)	51	(43.59)	228	(55.88)
Retired	14	(8.70)	10	(7.69)	13	(1.11)	37	(9.07)
Total	161	(100.00)	130	(100.00)	117	(100.00)	408	(100.00)
Education								
Adult/Primary	25	(14.70)	4	(2.90)	0	(0.00)	29	(6.80)

Junior Secondary	23	(13.50)	3	(2.20)	0	(0.00)	26	(6.10)
Senior Secondary	108	(63.50)	61	(44.20)	19	(16.10)	188	(44.10)
Post Secondary	14	(8.20)	60	(43.50)	58	(49.20)	132	(31.00)
Post Graduate	0	(0.00)	10	(7.20)	41	(34.70)	51	(12.00)
Total	170	(100.00)	138	(100.00)	118	(100.00)	426	(100.00)
Income								
< N30,000	111	(63.07)	49	(36.03)	13	(11.81)	173	(40.99)
N30,000-N60,000	65	(36.93)	69	(50.74)	14	(12.73)	148	(35.08)
N61,000-N90,000	0	(0.00)	12	(8.82)	24	(21.82)	36	(8.53)
N91,000-N120,000	0	(0.00)	2	(1.47)	27	(24.55)	29	(6.87)
> N120,000	0	(0.00)	4	(2.94)	32	(29.09)	36	(8.53)
Total	176	(100.00)	136	(100.00)	110	(100.00)	422	(100.00)
Occupancy								
Landlord	94	(52.81)	91	(65.47)	71	(57.72)	256	(58.19)
Tenant	84	(47.19)	48	(34.53)	52	(42.28)	184	(41.81)
Total	178	(100.00)	139	(100.00)	123	(100.00)	440	(100.00)

Table 3: Profile of Respondents Sampled in the Commercial Buildings

Profile	**Commercial Buildings**							
	Core Zone		**Transition Zone**		**Suburban Zone**		**Total**	
	F	**(%)**	**F**	**(%)**	**F**	**(%)**	**F**	**(%)**
Age (Yrs)								
21-30	21	(61.80)	15	(44.10)	11	(50.00)	47	(52.20)
31-40	5	(14.70)	12	(35.30)	5	(22.70)	22	(24.40)
41-50	5	(14.70)	5	(14.70)	6	(27.30)	16	(17.80)
51-60	2	(5.90)	2	(5.90)	0	(0.00)	4	(4.44)
> 60	1	(2.90)	0	(0.00)	0	(0.00)	1	(1.10)
Total	34	(100.00)	34	(100.00)	22	(100.00)	90	(100.00)
Employment								
Employed	0	(0.00)	0	(0.00)	0	(0.00)	0	(0.00)
Self Employed	32	(100.00)	33	(100.00)	23	(100.00)	88	(100.00)
Retired	0	(0.00)	0	(0.00)	0	(0.00)	0	(0.00)
Total	32	(100.00)	33	(100.00)	23	(100.00)	88	(100.00)
Education								
Adult/Primary	3	(9.70)	1	(2.80)	0	(0.00)	4	(4.50)
Junior Secondary	1	(3.20)	1	(2.80)	0	(0.00)	2	(2.20)
Senior Secondary	23	(74.20)	24	(66.70)	12	(54.55)	59	(66.30)
Post Secondary	4	(12.90)	10	(27.80)	9	(40.90)	23	(25.80)
Post Graduate	0	(0.00)	0	(0.00)	1	(4.55)	1	(1.10)
Total	31	(100.00)	36	(100.00)	22	(100.00)	89	(100.00)
Income								
< N30,000	21	(61.76)	10	(27.03)	3	(13.64)	34	(36.56)
N30,000-N60,000	13	(38.24)	3	(8.11)	3	(13.64)	19	(20.43)
N61,000-N90,000	0	(0.00)	23	(62.16)	16	(72.72)	39	(41.94)
N91,000-N120,000	0	(0.00)	1	(2.70)	0	(0.00)	1	(1.07)
> N120,000	0	(0.00)	0	(0.00)	0	(0.00)	0	(0.00)
Total	34	(100.00)	37	100.00)	22	(100.00)	93	(100.00)
Occupancy								
Landlord	14	(41.18)	6	(16.67)	9	(39.13)	29	(31.18)
Tenant	20	(58.82)	30	(83.33)	14	(60.87)	64	(68.82)
Total	34	(100.00)	36	(100.00)	23	(100.00)	93	(100.00)

INVESTIGATION OF HOUSE-KEEPING PRACTICES ADOPTED

The thrust of this section is focused on the identification and examination of the various house-keeping practices adopted by respondents in both residential and commercial buildings in the identified zones that this study covered. The interrelated issues of house-keeping practices which consisted of enclosure characteristics, positioning, platforms provided and distance limits were analysed by using frequency distribution, ANOVA, Chi-square and House-Keeping Practice Index (HKPI) based on a five-point likert scale.

House-Keeping Practices Adopted by Users of Generators in the Residential Buildings

The house-keeping practices adopted by respondents in the residential buildings of the core zone in the study area shown in Table 4 indicated that out of all the practices identified that building occupants could adopt, residential buildings' occupants in the core zone mostly adopted provision of a balanced position for the generator with a HKPI of 0.6425, followed by the provision of a mounting arrangement (HKPI = 0.6379) and protection from the elements of flooding (0.6271). It was further revealed that respondents in the core zone maintained provision of trunking to accommodate generator cable from the change-over to its location (0.5542) as the least ranked house-keeping practice. This was closely preceded by protection from airborne contaminant like abrasive or conductive dust (0.5978) and adequate rating of the extension cable/cord (0.6022). The pattern of house-keeping practice adopted in the core zone by the users of the generators fell grossly below best practices stipulated in the guidelines.

The respondents in the transition zone also exhibited a seemingly equal pattern of house-keeping practice as obtained in the core zone. Table 5 revealed that provision of a balanced rest position (0.7353) was ranked as the most widely adopted practice, followed by the provision of protection from elements of flooding (0.7171) and adequate rating of extension cords (0.7050) while provision of weather-proof enclosure was the least ranked house-keeping practice with an HKPI of 0.6221. It was also found that a fairly different trend was obtained in the suburban zone. As obtained in Table 6, it was revealed that putting the generator in a ventilated environment (0.8246) was ranked as the most widely adopted house-keeping practice by respondents in the suburban zone. It was closely followed by provision of trunking to accommodate generator cable from the change-over switch to its location (0.8033), while protection from airborne contaminant (0.7262) was ranked least.

Table 4: House-Keeping Practices of Generators Adopted in Residential Buildings in the Core Zone

House-Keeping Practices	Rating						
	5	**4**	**3**	**2**	**1**	**HKPI**	**Rank**
Provision of a mounting arrangement	1	50	110	18	0	0.6379	2
Putting the generator in a ventilated environment	0	36	115	23	0	0.6149	4
Protection from the elements of flooding	0	43	115	19	0	0.6271	3
Protection from airborne contaminant	0	35	106	37	0	0.5978	13
Provision of weather-proof enclosure	1	43	96	38	0	0.6077	9
Provision and use of a funnel in pouring fuel into the generator tank	1	40	103	35	0	0.6078	10
Putting the generator in off position and allowing to cool down before refuelling	1	37	109	31	0	0.6089	8
Clearance around the generator for maintenance work	0	41	109	28	0	0.6146	5
Protection from impact of falling objects	0	37	108	34	0	0.6034	11
Provision of very limited access to unauthorized personnel	1	34	117	27	0	0.6100	7
Connection to distribution boards and transfer switching equipment	1	33	118	26	0	0.6101	6
Adequate rating of the extension cords	0	45	90	43	0	0.6022	12
Provision of trunking to accommodate generator cable from the change-over to its location	0	25	90	62	2	0.5542	14
Provision of a balanced rest position for the generator	1	54	112	15	0	0.6425	1

(HKPI = House-keeping Practice Index)

Table 5: House-Keeping Practices of Generators Adopted in Residential Buildings in the Transition Zone

House-Keeping Practices	Rating						
	5	4	3	2	1	HKPI	Rank
Provision of a mounting arrangement	29	28	43	38	2	0.6629	7
Putting the generator in a ventilated environment	22	41	61	15	0	0.7007	4
Protection from the elements of flooding	15	67	45	11	2	0.7171	2
Protection from airborne contaminant	9	34	73	22	1	0.6403	12
Provision of weather-proof enclosure	11	35	51	36	3	0.6221	14
Provision and use of a funnel in pouring fuel into the generator tank	11	40	64	23	2	0.6500	9
Putting the generator in off position and allowing to cool down before refuelling	17	50	49	22	1	0.6863	5
Clearance around the generator for maintenance work	11	37	63	27	1	0.6432	10
Protection from impact of falling objects	8	37	65	22	2	0.6403	11
Provision of very limited access to unauthorized personnel	14	32	73	19	1	0.6561	8
Connection to distribution boards and transfer switching equipment	16	40	62	20	1	0.6719	6
Adequate rating of the extension cords	17	52	58	11	1	0.7050	3
Provision of trunking to accommodate generator cable from the change-over to its location	15	34	56	34	1	0.6400	13
Provision of a balanced rest position for the generator	14	75	42	7	1	0.7353	1

(HKPI = House-keeping Practice Index)

Table 6: House-Keeping Practices of Generators Adopted in Residential Buildings in the Suburban Zone

House-Keeping Practices	Rating						
	5	4	3	2	1	HKPI	Rank
Provision of a mounting arrangement	37	38	37	11	0	0.7642	8
Putting the generator in a ventilated environment	32	74	15	1	0	0.8246	1
Protection from the elements of flooding	26	48	31	18	0	0.7333	13
Protection from airborne contaminant	26	48	26	21	1	0.7262	14
Provision of weather-proof enclosure	28	51	28	10	1	0.7610	10
Provision and use of a funnel in pouring fuel into the generator tank	34	41	32	16	0	0.7512	11
Putting the generator in off position and allowing to cool down before refuelling	34	56	22	10	1	0.7821	7
Clearance around the generator for maintenance work	27	51	29	15	1	0.7431	12
Protection from impact of falling objects	39	44	29	6	0	0.7966	4
Provision of very limited access to unauthorized personnel	31	47	34	10	0	0.7623	9
Connection to distribution boards and transfer switching equipment	34	54	28	7	0	0.7870	6
Adequate rating of the extension cords	37	51	29	5	1	0.7919	5
Provision of trunking to accommodate generator cable from the change-over to its location	40	52	23	6	1	0.8033	2
Provision of a balanced rest position for the generator	41	48	24	9	0	0.7984	3

(HKPI = House-keeping Practice Index)

House-Keeping Practices Adopted by Users of Generators in the Commercial Buildings

The study also examined house-keeping practices adopted by respondents in the commercial buildings across zones of the study area. Tables 7 to 9 showed the house-keeping practices adopted by respondents in the commercial buildings of each of core, transition and suburban zone in the study area. Out of all the practices identified that building occupants could maintain, it was found that provision of a balanced rest position was ranked as the most adopted house-keeping practice in core, transition and suburban zone with HKPI of 0.6824, 0.6778 and 0.7130 respectively. The next ranked practice was provision of weather-proof enclosure, provision of trunking for the cable and provision of weather-proof enclosure with HKPI of 0.6485, 0.6722 and 0.6957 respectively. However, the least ranked house-keeping practice in the core and suburban zones was provision of a mounting arrangement with an HKPI of 0.4941 and 0.5652, while provision of weather-proof enclosure was the least ranked house-keeping practice in the transition zone with an HKPI of 0.5778 (Tables 7 to 9).

Table 7: House-Keeping Practices of Generators Adopted in Commercial Buildings in the Core Zone

House-Keeping Practices	Rating						
	5	4	3	2	1	HKPI	Rank
Provision of a mounting arrangement	0	4	8	22	0	0.4941	14
Putting the generator in a ventilated environment	1	8	18	4	2	0.6121	7
Protection from the elements of flooding	1	8	10	12	2	0.5636	12
Protection from airborne contaminant	0	5	15	14	0	0.5471	13
Provision of weather-proof enclosure	2	14	7	10	0	0.6485	2
Provision and use of a funnel in pouring fuel into the generator tank	1	6	14	12	1	0.5647	11
Putting the generator in off position and allowing to cool down before refuelling	1	8	12	11	1	0.5818	10
Clearance around the generator for maintenance work	0	12	11	9	2	0.5941	9
Protection from impact of falling objects	1	10	16	6	0	0.6364	3
Provision of very limited access to unauthorized personnel	1	10	12	11	0	0.6059	8
Connection to distribution boards and transfer switching equipment	1	8	19	6	0	0.6235	5
Adequate rating of the extension cords	2	11	11	9	0	0.6364	3
Provision of trunking to accommodate generator cable from the change-over to its location	2	9	15	7	1	0.6235	5
Provision of a balanced rest position for the generator	3	10	19	2	0	0.6824	1

(HKPI = House-keeping Practice Index)

Table 8: House-Keeping Practices of Generators Adopted in Commercial Buildings in the Transition Zone

House-Keeping Practice	Rating						
	5	4	3	2	1	HKPI	Rank
Provision of a mounting arrangement	2	11	12	11	0	0.6222	5
Putting the generator in a ventilated environment	2	10	14	9	1	0.6167	7
Protection from the elements of flooding	1	11	14	7	2	0.6114	11
Protection from airborne contaminant	1	12	13	9	1	0.6167	7
Provision of weather-proof enclosure	0	8	17	10	1	0.5778	14
Provision and use of a funnel in pouring fuel into the generator tank	0	13	9	11	2	0.5886	13
Putting the generator in off position and allowing to cool down before refuelling	0	13	15	8	0	0.6278	4

Clearance around the generator for maintenance work	1	7	17	11	0	0.5889	12
Protection from impact of falling objects	0	14	15	7	0	0.6389	3
Provision of very limited access to unauthorized personnel	0	12	16	8	0	0.6222	5
Connection to distribution boards and transfer switching equipment	0	9	21	6	0	0.6167	7
Adequate rating of the extension cords	0	12	16	7	1	0.6167	7
Provision of trunking to accommodate generator cable from the change-over to its location	0	16	17	3	0	0.6722	2
Provision of a balanced rest position for the generator	1	18	11	6	0	0.6778	1

(HKPI = House-keeping Practice Index)

Table 9: House-Keeping Practices of Generators Adopted in Commercial Buildings in the Suburban Zone

House-Keeping Practices	Rating						
	5	4	3	2	1	HKPI	Rank
Provision of a mounting arrangement	0	4	11	8	0	0.5652	14
Putting the generator in a ventilated environment	0	14	5	4	0	0.6870	3
Protection from the elements of flooding	0	9	9	5	0	0.6348	9
Protection from airborne contaminant	0	7	10	6	0	0.6087	13
Provision of weather-proof enclosure	1	11	9	2	0	0.6957	2
Provision and use of a funnel in pouring fuel into the generator tank	2	7	11	3	0	0.6696	5
Putting the generator in off position and allowing to cool down before refuelling	0	12	6	5	0	0.6609	7
Clearance around the generator for maintenance work	0	9	13	1	0	0.6696	5
Protection from impact of falling objects	0	11	5	7	0	0.6348	9
Provision of very limited access to unauthorized personnel	0	6	13	4	0	0.6174	11
Connection to distribution boards and transfer switching equipment	0	11	10	2	0	0.6783	4
Adequate rating of the extension cords	0	8	9	6	0	0.6174	11
Provision of trunking to accommodate generator cable from the change-over to its location	0	8	12	3	0	0.6435	8
Provision of a balanced rest position for the generator	3	11	6	2	1	0.7130	1

(HKPI = House-keeping Practice Index)

Comparison of House-Keeping Practices Adopted in Residential and Commercial Buildings

The outlook of house-keeping practices adopted by all the occupants of residential buildings across the zones of the study area was also determined. As shown in Table 10, the most widely adopted house-keeping practice by all the occupants in the residential buildings sampled was provision of a balanced rest position with an HKPI of 0.7150 followed by adequate rating of the extension cords (HKPI = 0.7145). This indicates that HKPI of buildings in the core zone had overbearing influence on the HKPI of the entire study area. The ANOVA test also established that there was no significant variation in the mode of adoption of house-keeping practices by the users of generators in residential buildings across the zones of the study area. This was due to the little variation in the rankings of the house-keeping practices adopted by the respondents. Similarly, the aggregated house-keeping practice of all the commercial buildings sampled indicated that provision of a balanced rest position was rated most with an HKPI of 0.6882 in the study area (Table 11). The ANOVA also indicated that there was significant variation only in the house-keeping practices adopted between commercial buildings respondents in core and suburban zones while there was no significant variation between other zones. This was also due to the variation in the rankings of the house-keeping practices adopted in each zone. The variation in the type of house-keeping practice maintained by the respondents across the zones of the study area was found to be closely related to land area where the buildings were constructed. The residential buildings in the suburban zone were located in the highbrow of the study areas where respondents lived in neighbourhood characterized by well-planned serenity and other associated physical planning indicators. This, coupled with socio-economic status of the occupants influenced the appreciable conformity to the best practices adopted by the occupants in the suburban residential buildings. Contrastingly, the unplanned nature of most areas in the core zone and low socio-economic status of its respondents were found to equally influence the high rate of non-compliance with the best practices.

Table 10: House-Keeping Practices of Generators Adopted Across All ResidentialBuildings

House-Keeping Practices	Rating						
	5	4	3	2	1	HKPI	Rank
Provision of a mounting arrangement	67	116	190	62	2	0.4494	14
Putting the generator in a ventilated environment	54	151	191	39	0	0.7011	4
Protection from the elements of flooding	41	158	191	48	2	0.6855	5
Protection from airborne contaminant	35	117	205	80	2	0.6469	13
Provision of weather-proof enclosure	40	129	175	84	4	0.6542	11
Provision and use of a funnel in pouring fuel into the generator tank	46	121	199	74	2	0.6611	9
Putting the generator in off position and allowing to cool down before refuelling	52	143	180	63	2	0.6818	6
Clearance around the generator for maintenance work	38	129	201	70	2	0.6595	10
Protection from impact of falling objects	47	118	202	62	2	0.6677	7
Provision of very limited access to unauthorized personnel	46	113	224	56	1	0.6668	8
Connection to distribution boards and transfer switching equipment	51	128	208	53	1	0.7034	3
Adequate rating of the extension cords	54	148	177	59	2	0.7145	2
Provision of trunking to accommodate generator cable from the change-over to its location	55	111	169	102	4	0.6503	12
Provision of a balanced rest position for the generator	56	174	178	31	1	0.7150	1

(HKPI = House-keeping Practice Index)

Table 11: House-Keeping Practices of Generators Adopted AcrossAll CommercialBuildings

House-Keeping Practices	Rating						
	5	4	3	2	1	HKPI	Rank
Provision of a mounting arrangement	2	19	31	41	0	0.5613	14
Putting the generator in a ventilated environment	3	32	37	17	3	0.6326	5
Protection from the elements of flooding	2	28	33	24	4	0.6000	11
Protection from airborne contaminant	1	24	38	29	1	0.5892	13
Provision of weather-proof enclosure	3	33	33	22	1	0.6326	5
Provision and use of a funnel in pouring fuel into the generator tank	3	26	34	26	3	0.6000	11
Putting the generator in off position and allowing to cool down before refuelling	1	33	33	24	1	0.6196	8
Clearance around the generator for maintenance work	1	28	41	21	2	0.6108	10
Protection from impact of falling objects	1	35	36	20	0	0.6369	3
Provision of very limited access to unauthorized personnel	1	28	41	23	0	0.6150	9
Connection to distribution boards and transfer	1	28	50	14	0	0.6344	4

switching equipment							
Adequate rating of the extension cords	2	31	36	22	1	0.6239	7
Provision of trunking to accommodate generator cable from the change-over to its location	2	33	44	13	1	0.6473	2
Provision of a balanced rest position for the generator	7	39	36	10	1	0.6882	1

(HKPI = House-keeping Practice Index)

Distance Limits of Positioning of Generators from External Walls of ResidentialBuildings

Table 12 showed that majority of the respondents 111(62.36%) in the core zone's residential buildings positioned their generating sets at the distance limit of 0 to 2 m from external walls of their buildings, while majority of respondents 59(44.03%) in the transition zone positioned theirs at 2.1 to 4 m distance limit and majority of the respondents 40(34.48%) in the suburban zone positioned their generating sets at a relative distance limit of 8.1 to 10 m and 19(16.38%) of the zone's respondents also placed it at distance limit greater than 10 m from external walls of their buildings. The sharp disparity in the distance limit at which most of the respondents positioned their generating sets in each of the zones sampled was found to be dependent on the available land area on which the residential buildings were constructed. The study discovered that most buildings in the core zone had relatively small land area coupled with the type of buildings that were constructed restricted the available distance at which the generating sets were positioned. Also, the relative large area on which buildings in the suburban zone were constructed also accounted for the distance at which their generating sets were placed. At large, the relatively vast area coupled with the socio-economic status of the bulk of respondents in the suburban zone were found to be responsible for the farthest distance (8.1 to 10 m) at which their generating sets were positioned.

However, the least distance limit at which the respondents, 15(12.94%), in the suburban zone positioned their generating sets was 4.1 to 6 m while 30(22.39%) of respondents in the transition zone placed theirs at 0 to 2 m from the external walls of their buildings. The mean distances at which generating sets were placed from external walls of residential buildings in core, transition and suburban zone respectively were 2.09 m, 3.59 m and 7.39 m. Largely, result of the study as contained in Table 12 showed that a large number of respondents in the suburban zone significantly placed their generating sets at appreciably far distances (34.48%: 8.1 – 10 m; 22.41%: 6.1 – 8 m) and fairly complied with the best house-keeping practice. This reflected relationship between the compliance with the principles of development control on the percentage of area that a proposed development could occupy on the plot of land where a proposed building would be constructed and other facilities to be placed therein affected distances of positioning of generators. The occupants of residential buildings in the transition zone maintained an appreciably reduced distance of positioning their generating sets (44.03%: 2.1 – 4 m) while the shortest locational distance house-keeping practice was found in the core zone (62.36%: 0 -2 m). Also, further analysis of the results in each zone sampled indicated that ANOVA test established a significant variation in the distance at which generating sets were positioned in residential buildings across zones of the study area ($F = 1543$, $p < 0.001$).

Distance Limits of Positioning of Generators from External Walls of Commercial Buildings

Table 12also revealed that 24(75.00%), 17(48.57%) and 11(50.00%) of respondents in the commercial buildings positioned their generating sets at 0 to 2 m distance limit from external walls in the core, transition and suburban zone respectively. It was also indicated that 4(11.43%) and 7(31.82%) of respondents in the transition and suburban zone respectively positioned their generating sets at 4.1 to 6 m from their external walls. However, the mean distance at which generating sets were being positioned from external walls of commercial buildings were 1.55 m, 2.54 m and 2.87 m in the core, transition and suburban zone respectively. The contrasting result obtained in the distance limit that generating sets were positioned was found to be significantly dependent on the limited areas of land available to the users of the commercial buildings.

Table 12: Distance Limits of Positioning Generators

Distance Limits of Positioning Generators (m)	Residential Building			Total	Commercial Building			Total
	Core Zone F (%)	Transition Zone F (%)	Suburban Zone F (%)	F (%)	Core Zone F (%)	Transition Zone F (%)	Suburban Zone F (%)	F (%)
0 – 2	111	30	0	141	24	17	11	52

	62.36	22.39	0.00	32.94	75.00	48.57	50.00	58.43
2.1 – 4	50 28.09	59 44.03	16 13.79	125 29.21	8 25.00	12 34.29	3 13.64	23 25.84
4.1 – 6	15 8.43	32 23.88	15 12.94	62 14.49	0 0.00	4 11.43	7 31.82	11 12.36
6.1 – 8	0 0.00	7 5.22	26 22.41	33 7.71	0 0.00	2 5.71	1 4.54	3 3.37
8.1 – 10	1 0.56	4 2.99	40 34.48	45 10.51	0 0.00	0 0.00	0 0.00	0 0.00
> 10	1 0.56	2 1.49	19 16.38	22 5.14	0 0.00	0 0.00	0 0.00	0 0.00
Total F (%)	178 100.00	134 100.00	116 100.00	428 100.00	32 100.00	35 100.00	22 100.00	89 100.00

Points of Location of Generators During Use by Respondents in the Residential Buildings

The result of the study as contained in Table 13 showed that a significant proportion, 95(53.98%), of residential buildings' respondents in the core zone positioned their generating sets outside their buildings (close to doors and windows) during use. Whilst a sizeable, 65(48.15%) and 51(45.13%) of respondents in transition and suburban zones positioned their generating sets outside (away from doors and windows) during use. It was also shown that the use of generator house was significantly employed in the suburban zone whereby 30(26.55%) of its respondents had generator house as a type of enclosure feature; but in the transition and core zone respectively, 17(12.59%) and 2(1.14%) of their respondents had it within their premises. The appreciable compliance of the respondents in the suburban zone to the best house-keeping practice was found to be directly related to the socio-economic status of the respondents, the available land area and the type of buildings constructed. The Chi-square test carried out revealed that there was a significant relationship between points of location of the generating sets/ the type of buildings constructed and the socio-economic level of the respondents across different residential buildings and zones in the study area (χ^2 = 108.121, p < 0.001).

Points of Location of Generators During Use by Respondents in the Commercial Buildings

However, another trend was found among respondents in the commercial buildings in the study area. Table 13 also indicated that 16(55.17%), 17(50.00%) and 11(50.00%) in core, transition and suburban zone respectively positioned their generators (close to the outside doors and windows) of their commercial buildings during use. This result had significant relationship with the earlier result which showed that majority of respondents in the commercial buildings positioned their generating sets at 0 to 2 m distance limits from the external walls of their buildings (Table 12). Similarly, site observation carried out revealed that the seemingly positioning of generating sets being outdoor, and also close to doors and windows was informed by the design features and the space available to users of the commercial buildings in either core, transition or suburban zone. The result of the study also showed that 31.82% of respondents in the suburban zone located their generating sets in the house structure constructed for them while 5.89% in the transition zone had such enclosure feature. A further analysis of this result revealed that profile of the respondents across the zones sampled influenced the disparity in the points of locations of the generating sets. The result of ANOVA test showed a significant variation in the point of location of the generating sets across the sampled buildings in the study area (F = 139.137, p < 0.001).

Table 13: Points of Location of the Generators During Use

Points of Location of Generators	Residential Building: Core Zone F (%)	Residential Building: Transition Zone F (%)	Residential Building: Suburban Zone F (%)	Total F (%)	Commercial Building: Core Zone F (%)	Commercial Building: Transition Zone F (%)	Commercial Building: Suburban Zone F (%)	Total F (%)
Indoor	2 1.14	0 0.00	0 0.00	2 0.47	0 0.00	0 0.00	0 0.00	0 0.00
Generator House	2 1.14	17 12.59	30 26.55	49 11.56	0 0.00	2 5.89	7 31.82	9 10.59
Basement	0 0.00	3 2.22	9 7.96	12 2.83	0 0.00	0 0.00	0 0.00	0 0.00
Crawl Spaces	12 6.81	10 7.41	12 10.62	34 8.02	0 0.00	0 0.00	0 0.00	0 0.00
Outdoors (away from doors and windows)	65 36.93	65 48.15	51 45.13	181 42.69	13 44.83	15 44.11	4 18.18	32 37.65
Outdoors (close to doors and windows)	95 53.98	40 29.63	11 9.74	146 34.43	16 55.17	17 50.00	11 50.00	44 57.76
Total F (%)	176 100.00	135 100.00	113 100.00	424 100.00	29 100.00	34 100.00	22 100.00	85 100.00

Points of Location of GeneratorsAfter Use by Respondents in the Residential Buildings

The study found a completely different scenario in the points of location of generating sets after use by respondents in residential buildings across all the zones sampled. Table 14 showed that 78.41% of respondents in the core zone positioned their generating sets and the associated fuel inside their buildings after its use. Also, 20.74% of respondents in the transition zone positioned their generators inside their buildings after use while 0.00% positioned them inside buildings in the suburban zone (Table 14). It was found that the socio-economic characteristics and appreciable compliance with the best house-keeping practices influenced why the suburban zone's respondents provided enclosure features to position their generating sets and its associated fuel/oil.

Points of Location of Generators After Use by Respondents in the Commercial Buildings

The study also found as shown in Table 14 that 84.71% of respondents in commercial buildings located their generating sets after use (at the close of commercial activities/work) inside their facilities (shops). Also, it was found that 93.10%, 88.24% and 68.18% positioned their generating sets inside shops (commercial buildings) in core, transition and suburban zone respectively. This was found to be a gross violation of best house-keeping practice required of generating sets in buildings because of the likelihood of fire disasters.

Table 14: Points of Location of the Generators After Use

Points of Location of Generators	Residential Building: Core Zone F (%)	Residential Building: Transition Zone F (%)	Residential Building: Suburban Zone F (%)	Total F (%)	Commercial Building: Core Zone F (%)	Commercial Building: Transition Zone F (%)	Commercial Building: Suburban Zone F (%)	Total F (%)
Inside Building	138 78.41	28 20.74	0 0.00	166 39.15	27 93.10	3 88.24	15 68.18	72 84.71
Outside Building	38 21.59	107 79.26	113 100.00	258 60.85	2 6.90	4 11.76	7 31.82	13 15.29
Total F (%)	176 100.00	135 100.00	113 100.00	424 100.00	29 100.00	34 100.00	22 100.00	85 100.00

V. CONCLUSION AND RECOMMENDATIONS

The socio-economic profile of the respondents in both residential and commercial buildings across zones of the study area influenced the significant variation that existed in the house-keeping practices adopted by the users of generators. The study showed that provision of rest position with HKPI = 0.6425 was ranked as the most significant house-keeping practice adopted in residential buildings in the core zone. It was followed by provision of a mounting arrangement with HKPI = 0.6379 and protection from the elements of flooding with HKPI = 0.6271. In residential buildings in the transition zone, provision of a balanced rest position with HKPI = 0.7353, protection from the elements of flooding with HKPI = 0.7171 and adequate rating of the extension cords with HKPI = 0.7050 were mostly adopted. The most adopted practices in the suburban zone were putting the generator in ventilated environment with HKPI = 0.8246, provision of trunking to accommodate cable from the change-over to its location with HKPI = 0.8033 and provision of balanced rest position with HKPI = 0.7984. Furthermore, respondents in the commercial buildings maintained glaringly different house-keeping practices. The most ranked house-keeping practice in the core, transition and suburban zone was provision of a balanced rest position with HKPI of 0.6824, 0.6778 and 0.7130 respectively.

A sharp variation was found in the distance limits at which generating sets were positioned from the external walls of buildings particularly among respondents of residential buildings across the zones studied. The findings established that 62.36% of respondents in the core zone placed their generating sets during use within a distance limit 0 to 2 m from external walls of their buildings. In the transition zone, 44.03% of respondents placed their generating sets within a distance limit of 2.1 to 4 m from their buildings' external walls while 34.48% of respondents in the suburban zone placed their generators within a distance limit of 8.1 to 10 m. However, 75.00% of respondents in the commercial buildings positioned it at a distance limit of 0 to 2 m from their external walls. The study found that the distance limits of the positioning of generators in the buildings were significantly dependent on the available land area where the buildings were constructed. The study therefore recommended that in the face of probable effects that generating sets could subject building occupants to, its users should adopt best house-keeping practices by positioning them in properly built enclosure features (generator house) located at a minimum distance limit of 8 m away from external walls of their buildings. This should be complemented by instituting policies through appropriate enlightenment and enforcement processes by relevant arms of government saddled with the sustainability and management of the environment.

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