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Assessment of House-Keeping Practices of Generators Used As Alternative Source of Power in Residential Buildings

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ABSTRACT: *Inadequate power supply from the national grid over the years has led to the ubiquitous use of various types of generating sets by the occupants of buildings. This study was carried out to identify and examine house-keeping practices adopted by occupants of residential building in Ibadan Metropolis, Nigeria before and during use of generating sets. The study area was stratified into core, transition and suburban residential zones. Data were obtained by carrying out field observations and administering questionnaires on the occupants of residential buildings. Descriptive and inferential statistical techniques were used to analyse the data collected. The findings revealed that the most adopted house-keeping practice by residential buildings occupants in the core and transition zone was provision of balanced rest position (HKPI = 0.6425, 0.7353), and in the suburban zone, it was putting the generator in a ventilated environment (HKPI = 0.8246). The mean distance of positioning generators from external walls of buildings in the core, transition and suburban residential zones were 2.09, 3.59 and 7.39m respectively. The variation in the mode and level of house-keeping practices adopted was significantly influenced by the socio-economic characteristics of the respondents, typology of buildings and their degree of compliance with statutory environmental and planning laws. The study recommended that in the face of poor power supply in the country, building occupants should beeducated and enforced to position their generating sets in well-designed outdoor enclosure features and at specified distance limits from external walls of their buildings.*

Keywords: *Power, Shortage, Buildings, Generators, Occupants, Practices*

I. INTRODUCTION

Buildings are constructed to serve as a unit of environment, meet housing and shelter needs and have much influence on the health and efficiency of the occupants. It is also considered as one of the three most fundamental human needs (Mabogunje, 2007; Adedokun *et al*., 2011). Buildings are really meant to provide shelter for the occupants, but there is need for the procurement and installations of engineering and service systems to give the occupants the required comfort. These installations depend mostly on the use of one form of energy or the other to power them (Komolafe, 2011). Energy is fundamental for the provision of basic needs of the populace. It is considered to be a very important substance for development and has been a vital and indispensable input for the economic needs of the present age. It is undoubtedly the driving force of industrialization (Onyegegbu, 2003); and a powerful engine of economic and social opportunity, such that no nation can manage to develop without ensuring access to the required amount of energy to power service systems to be used in buildings (Steer *et al*., 2000).

In spite of Nigeria's huge resource endowment in energy and enormous investment in the provision of energy infrastructure, performance of the power sector has remained poor in comparison with other developing economies. According to World Bank (2005), Nigeria had the highest percentage of system losses at 33 to 41% with the lowest generating capacity factor at 20%, the lowest average revenue at US dollars of 1.56 KWh, the lowest rate of return at 8%, and the longest average accounts receivable period of 15 months when compared with those of other developing countries. As a result of this fundamental problem, households, businesses and industrial premises rely on their self-produced electricity from generators that have attendant operating and capital costs (Idiata *et al., 2010*; Awofeso, 2011).

A constant power supply is a critical component of every successful modern business, and where power failure happens more often and takes more time to fix, a reliable standby generator is really essential to power all the equipment and systems (Pabla, 2003; Gross, 1986). Today, the most common form of off-grid electricity supply are generators running on diesel or gasoline. Generators are used not only by rural households, but also by the grid-connected households and industries as a more stable supplement to the grid power. The rural incidence of diesel generator in Nigeria is difficult to estimate, but 96 to 98% of the grid-connected firms are known for the ownership of private generators (Tyler, 2002). Previous studies on generators usage in Nigeria such as Ahmad and Abubakar, 2012; Sonibare *et al.* 2014; Godson *et al.* 2014 did not consider house-keeping practices of generators that involve its enclosure characteristics, distances of positioning of generators outdoor and points of locations of generators before or during its use in relation to indoor environment. In spite of this, the objectives of the study are to identify and examine house-keeping practices of generators used in buildings in Ibadan Metropolis, Nigeria.

II. REVIEW OF CONCEPT OF HOUSE-KEEPING PRACTICES OF GENERATORS

The most common way to use a portable generator is to place it outdoors and then run the extrusion cord(s) to the chosen appliance. The extension cords are rated by "gauges" and the power cords must be appropriately sized to carry the electric load. Otherwise, this might cause damage to the generator and appliances. This approach works well for smaller generators because it can plug in one or two items. The generators must not be run indoors, not even in the garage because of its emissions (Generator, 2012). When specifying a generator, it is essential to consider the application for which it is intended to be used. According to BS ISO 8528-1 and BS ISO 8528-7, 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 associated issues to consider include mounting arrangements, ventilation, vibration, pollution, protection from the elements (risk of flooding), security, fuel/lubricant leaks, connection to distribution boards and automatic transfer switching equipment. There is need for information on the prevailing site conditions, specifically, lower and upper levels of ambient air temperature, barometric pressure (or altitude above sea level), and humidity. In addition, specifiers are also required to include information confirming air quality (dusty or sandy), proximity to the coast (exposure to salt), whether the environment contains chemical pollution or radiation (including the nature and extent of any pollution), and if there is a requirement to continue to operate under conditions of external shock or vibration.

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. It must be kept dry and must not be used in rain or wet conditions. Users of generators must not power the house wiring by plugging the generator into a wall outlet, a practice known as "back feeding". This is an extremely dangerous practice that presents an electrocution risk to utility workers and neighbours served by the same utility transformer. There must not be storage of fuel of the generators in homes. Gasoline, propane and other flammable liquids should be stored outside of living areas in properly-labeled and non-glass safety containers. Before refueling the generator, it must be turned off and allowed to cool down as gasoline spilled on hot engine parts could ignite (SDMO Users' Guide, 2001).

According to Perkins Users' Handbook (2000), generating sets run smoothly when at least 75% of its total capacity is utilized. Therefore, adequately rated sets must be selected so as to satisfy this requirement. SDMO Users' Guide (2001) stated that some issues/guidelines must be followed when selecting an appropriate location for generators. Amongst the guidelines that must be followed are: adequate ventilation, protection from exposure to airborne contaminant such as abrasive dust, smoke; protection from impact from falling bodies, clearance around the generating set for cooling and access for service, access to move the entire generating set for cooling and access for service and limited access to any unauthorized personnel.

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. About a 1 m space around the set is considered as the minimum required for carrying out problem-free maintenance (Generating Set Installation Guide, 1998). According to SDMO Users' Guide (2001), no specific rules govern the choice of location of generating sets, other than its closeness to the electric distribution panel and avoidance of disturbances caused by noise and gases that are emitted. 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.

III. RESEARCH METHODOLOGY

The scope of this study was limited to Ibadan Metropolis because the study is urban based. Ibadan is the capital of Oyo State in the southwestern part of Nigeria (Ayeni, 1994). The study population was drawn from the residential buildings 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. Multi-stage sampling technique was used which eventually led to the sampling of 736 residential buildings through the selection of

25% sample in each residential zone of each local government. One occupant was taken in each of the residential buildings sampled in each of the zones of the local governments of the study area. Data were collected by administering structured questionnaires and interviews on the occupants of the residential buildings to collect information on the variables associated with the generators used by the respondents and house-keeping practices adopted. It was complemented by using field observations to depict the mode of use and positioning of generating sets indoor or outdoor; and before or during use of generating sets in the buildings sampled. The data collected were analysed by using descriptive and inferential statistical techniques such as crosstabs, chi-square, anova, relative importance index and spearman's rank order correlation.The analysis of the responses of the building occupants on the house-keeping practices adopted based on a Likert scale ranging from 1 to 5, "always employed to never employed", was carried out by using an index called House-Keeping Practices Index (HKPI). The relationship between house-keeping practices adopted by the users of the generators and the likely significance of its adoption by the respondents was analysed by using thespearman's rank order correlation.

IV. FINDINGS AND DISCUSSIONS

Questionnaires Distribution

Table 1 shows the number of questionnaires administered on the respondents in the residential buildings sampled. It was shown that out of the seven hundred and thirty six(736) questionnaires administered, four hundred and forty-three (443) wereproperly returned.Thus, this indicated a return rate of 60.19% that should be adequate enough to substantiate results of the research.

Table 1: Return Rate of the Questionnaires Administered

Questionnaire Administration	Frequency	Percentage (%)
Number unreturned/not properly completed	293	39.81
Number returned and properly completed	443	60.19
Total	736	100.00

Preliminary Information on the Respondents

Table 2 shows the preliminary information on socio-economic characteristics 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, 37.50%, across the zones belonged to the 31-40 age group and was followed by the 41-50 age group (33.80%) while 4.70% of the age group that was greater than 60 years had the least number of respondents. The implication of this is that, the respondents sampled in the study area were active, vibrant and ought to be in possession of fundamental household items like generating sets needed for occupants' comfort drive. It is shown that 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.

The educational status of respondents in residential buildings revealed that 44.20% of respondents in the transition zone had senior secondary education, 43.50% had post-secondary education and 7.20% had postgraduate qualification. In the suburban residential zone, 34.70% had postgraduate education which indicated that they were most educated. Comparably, in the core residential zone, 14.70% and 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. Table 2 shows that bulk of respondents in the suburban residential buildings, 29.09% earned more than 120,000 naira monthly while respondents in the transition residential zone had reduced response rate of 2.94%. It also indicated that, it was in the core residential zone, where its majority, 63.07% of its respondents earned below 30,000 naira monthly, and 36.93% of its respondents earned between 30,000 to 60,000 naira monthly. However, in the transition and suburban zones, 50.74% and 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.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 52.81%, 65.47% and 57.72% for core, transition and suburban residential zone respectively. It further revealed that fewer number of respondents were tenants in the buildings selected as the core zone had the highest frequency rate of 47.19% followed by suburban zone-42.28% and transition zone-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.

Table 2: Socio-Economic Characteristics of Respondents Sampled in the Buildings

Characteristics	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)

House-Keeping Practices Adopted in the Buildings Sampled

The study investigated house-keepings' practices of the residents based on the level of adoption of the identified practices in the literature. This was carried out by using Likert scale of five levels, ranging from (1 to 5) "always employed to never employed". The analysis of the responses from the respondents led to the determination of an index called House-Keeping Practices Index (HKPI). In view of this, the HKPI of each of the respective buildings sampled in the three residential zones, and that of the totality of the study area in the residential buildings respectively was computed as shown in Tables 3 to 6. This was with a view to ascertaining compliance of the respondents with the best practices differentially and totally in the study area.

The house-keeping practices adopted by respondents in the residential buildings of the core zone in the study area shown in Table 3 indicates 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 4 reveals 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 5, 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.

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. Plates 1, 2 and 3 show the mode of positioning of generators in few of the buildings sampled in the core, transition and suburban zone respectively.

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 6, 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.

Table 3: House-Keeping Practices of Generators Used in Residential Buildings in the Core Zone

House-Keeping Practice Adopted	**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 4: House-Keeping Practices of Generators Used in Residential Buildings in the Transition Zone

House-Keeping Practice Adopted	**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 5: House-Keeping Practices of Generators Used in Residential Buildings in the Suburban Zone

House-Keeping Practice Adopted	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)

Table 6: House-Keeping Practices of Generators Used in All the ResidentialBuildings

House-Keeping Practice Adopted	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)

Plate 1: House-Keeping Practice of Generator in Residential Buildings in the Core Zone

Plate 2: House-Keeping Practice of Generators in Residential Buildings in the Transition Zone

Plate 3: House-Keeping Practice of Generators in Residential Buildings in the Suburban Zone

Distance of Positioning Generators from External Walls of the Buildings Sampled

The study investigated the relative distance at which generating sets of the respondents were positioned from external walls of their buildings. The data of this section were obtained from the questionnaires administered on respondents in the buildings sampled. Table 7 shows that majority of the respondents, 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, 44.03% in the transition zone positioned theirs at 2.1 to 4 m distance limit and majority of the respondents, 34.48% in the suburban zone, positioned their generating sets at a relative distance limit of 8.1 to 10 m and 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, 12.94%, in the suburban zone positioned their generating sets was 4.1 to 6 m while 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 7 shows 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 relationship in the distance at which generating sets were positioned in residential buildings in each of the zones of the study area ($F = 1543$, $p < 0.001$).

Table 7: Distance of Positioning Generators Used in the Residential Buildings

Distance Limit of Positioning of Generators (m)	Residential Buildings						Total	
	Core Zone		Transition Zone		Suburban Zone		F	(%)
	F	(%)	F	(%)	F	(%)		
0 - 2	111	(62.36)	30	(22.39)	0	(0.00)	141	(32.94)
2.1 – 4	50	(28.09)	59	(44.03)	16	(13.79)	124	(29.21)
4.1 – 6	15	(8.43)	32	(23.88)	15	(12.94)	62	(14.49)
6.1 – 8	0	(0.00)	7	(5.22)	26	(22.41)	33	(7.71)
8.1 – 10	1	(0.56)	4	(2.99)	40	(34.48)	45	(10.51)
> 10	1	(0.56)	2	(1.49)	19	(16.38)	22	(5.14)
Total	178	(100.00)	134	(100.00)	116	(100.00)	428	(100.00)

Point of Location of Generators by the Respondents in the Buildings Sampled

The study investigated points of location or positioning generating sets during and after its use by respondents in the sampled buildings. The result of the study as contained in Table 8 shows that a significant proportion, 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, 48.15% and 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 26.55% of its respondents had generator house as a type of enclosure feature, but in the transition and core zone respectively, 12.59% and 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 ($\chi^2 = 108.121$, $p < 0.001$).

Table 8: Point of Location of the Generators During Use in the Residential Buildings

Point of Location of Generators During Use	Residential Buildings						Total	
	Core Zone		Transition Zone		Suburban Zone		F	(%)
	F	(%)	F	(%)	F	(%)		
Indoor	2	(1.14)	0	(0.00)	0	(0.00)	2	(0.47)
Generator House	2	(1.14)	17	(12.59)	30	(26.55)	49	(11.56)
Basement	0	(0.00)	3	(2.22)	9	(7.96)	12	(2.83)
Crawl	12	(6.81)	10	(7.41)	12	(10.62)	34	(8.02)
Outdoors (away from doors and windows)	65	(36.93)	65	(48.15)	51	(45.13)	181	(42.69)
Outdoors (close to doors and windows)	95	(53.98)	40	(29.63)	11	(9.74)	146	(34.43)
Total	176	(100.00)	135	(100.00)	113	(100.00)	424	(100.00)

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 9 shows 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 9). 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.

Table 9: Point of Location of the Generators After Use in the Residential Buildings

Point of Location of Generators After Use	Residential Buildings						Total	
	Core Zone		Transition Zone		Suburban Zone		F	(%)
	F	(%)	F	(%)	F	(%)		
Inside Building	138	(78.41)	28	(20.74)	0	(0.00)	166	(39.15)
Outside Building	38	(21.59)	107	(79.26)	113	(100.00)	258	(60.85)
Total	176	(100.00)	135	(100.00)	113	(100.00)	424	(100.00)

Relationship between House-Keeping Practices Adopted and its Significance

The study examined relationship between house-keeping practices adopted by the users of the generators and the likely significance of its adoption by the respondents. The correlation analysis carried out on the relationship between the house-keeping practices adopted by the users of the generators and the importance placed on them among occupants of residential buildings in the core zone is shown in Table 10. It was revealed that there was weak relationship between provision of mounting arrangement ($r = 0.395$, $p = 0.000$), provision of limited access to unauthorized personnel ($r = 0.378$, $p = 0.000$) and protection from airborne contaminant ($r = 0.312$, $p = 0.000$). Also, there was very weak relationship in the provision of trunking for the cable ($r = 0.159$, p

=0.0034), provision and use of funnel in pouring fuel into the tank (r = 0.183, p = 0.015) and protection from impact of falling objects (r = 0.211, p = 0.005). The trend of the correlation analysis is shown in Table 11. It was found that there was weak relationship (r = 0.431, p = 0.000) in the provision of trunking for the cable; whilst there was a very weak relationship in the provision of mounting arrangement (r = 0.398, p = 0.000) and clearance around the generator (r = 0.378, p = 0.000). In the suburban zone, Table 12 shows that there was weak relationship in the provision of a mounting arrangement (r = 0.458, p = 0.000), provision and use of a funnel in pouring fuel (r = 0.436, p = 0.000) and protection from airborne contaminant (r = 0.405, p = 0.000).

Table 10: Correlation Analysis of House-keeping Practice Adopted in Residential Buildings in the Core Zone

House-Keeping Practice	Rho	P-Value	N
Provision of a mounting arrangement	0.395	0.000	177
Putting the generator in a ventilated environment	0.287	0.000	172
Protection from the elements of flooding	0.369**	0.000	176
Protection from airborne contaminant like abrasive or conductive dust	0.312**	0.000	176
Provision of weather-proof enclosure	0.372**	0.000	175
Provision and use of a funnel in pouring fuel into the generator tank	0.183*	0.015	177
Putting the generator in off position and allowing it to cool down before refuelling	0.298**	0.000	176
Clearance around the generator for maintenance work	0.364**	0.000	176
Protection from impact of falling objects	0.211**	0.005	176
Provision of very limited access to unauthorized personnel	0.378**	0.000	178
Connection to distribution boards and transfer switching equipment	0.254**	0.001	175
Adequate rating of the extension cords	0.260**	0.001	174
Provision of trunking to accommodate generator cable from the change-over to its location	0.159*	0.034	178
Provision of a balanced rest position for the generator	0.215**	0.004	178

** Correlation is significant at the 0.05 level (2-tailed).
* Correlation is significant at the 0.01 level (2-tailed).

Table 11: Correlation Analysis of House-keeping Practice Adopted in Residential Buildingsin the Transition Zone

House-Keeping Practice	Rho	P-Value	N
Provision of a mounting arrangement	0.398**	0.000	140
Putting the generator in a ventilated environment	0.193*	0.023	139
Protection from the elements of flooding	0.166*	0.049	140
Protection from airborne contaminant like abrasive or conductive dust	0.255**	0.002	139
Provision of weather-proof enclosure	0.161	0.062	136
Provision and use of a funnel in pouring fuel into the generator tank	0.257**	0.002	139
Putting the generator in off position and allowing it to cool down before refuelling	0.120	0.158	139
Clearance around the generator for maintenance work	0.378**	0.000	139
Protection from impact of falling objects	0.121	0.169	131
Provision of very limited access to unauthorized personnel	0.132	0.124	138
Connection to distribution boards and transfer switching equipment	0.253**	0.003	139
Adequate rating of the extension cords	0.322**	0.000	138
Provision of trunking to accommodate generator cable from the change-over to its location	0.431**	0.000	140
Provision of a balanced rest position for the generator	0.234**	0.006	139

** Correlation is significant at the 0.05 level (2-tailed).
* Correlation is significant at the 0.01 level (2-tailed).

Table 12: Correlation Analysis of House-keeping Practice Adopted in Residential Buildings in the Suburban Zone

House-Keeping Practice	Rho	P-Value	N
Provision of a mounting arrangement	0.458**	0.000	123
Putting the generator in a ventilated environment	0.353**	0.000	122
Protection from the elements of flooding	0.373**	0.000	123
Protection from airborne contaminant like abrasive or conductive dust	0.405**	0.000	122
Provision of weather-proof enclosure	0.266**	0.004	116
Provision and use of a funnel in pouring fuel into the generator tank	0.436**	0.000	123
Putting the generator in off position and allowing it to cool down before refuelling	0.376**	0.000	123
Clearance around the generator for maintenance work	0.366**	0.000	123
Protection from impact of falling objects	0.285**	0.002	116
Provision of very limited access to unauthorized personnel	0.328**	0.000	122
Connection to distribution boards and transfer switching equipment	0.135	0.138	122
Adequate rating of the extension cords	0.253**	0.005	121
Provision of trunking to accommodate generator cable from the change-over to its location	0.326**	0.000	122
Provision of a balanced rest position for the generator	0.315**	0.000	122

** Correlation is significant at the 0.05 level (2-tailed).
* Correlation is significant at the 0.01 level (2-tailed).

V. CONCLUSION AND RECOMMENDATIONS

The study found that dependence of residential buildings occupants on generators in the study area as alternative source of energy supply in the face of unstable electricity supply was as a result of their different socio-economic status. Results obtained on the house-keeping practices of respondents in the residential buildings across the zones indicated that there were significant differences in the type of enclosure features, points and distance limits of positioning generating sets by the respondents. Largely, socio-economic profile of the respondents evident in the type of residential buildings occupied, area of the land on which their buildings were constructed and nature of planning/serenity of the neighbourhood were the major indicators. The house-keeping practices of the users of generators in the residential buildings varied sharply across zones of the study area. Provision of a rest position with an HKPI of 0.7150 was the mostly adopted house-keeping practice across zones of the study area. A Sharp variation was found in the distance limits at which generating sets were positioned from the external walls of buildings in the residential buildings. The study found that the distances of positioning of generators in the buildings was significantly dependent on the available land area and on the plots where the buildings were constructed.In view of the fact that there has not been a paradigm shift to an era of stable power supply in the country, building occupants should be properly enlightened and enforced not to locate their generating sets indoor either before or during use. They should also be educated and enforced through built environment planning and institutional framework to position their generating sets away from their external walls by having well-designed outdoor enclosure features located at a distance limit of at least 8 m from external walls of their buildings so as to ensure fair compliance with the ordinance of the National Standards of Environmental Regulation (NESREA).

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