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Electrocution, Accidents and Electrical Injuries in Nigerian Homes and Work Sites – Causes, Effects and Remedies

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Abstract
Most industrial and domestic accidents are not the product of unknown engineering principles, but the failure or wrong application of these principles.Safety therefore has become very important because each year a vast number of people die due to workplace and other domestic accidents. This paper reviewed safety as it concerns the usage and handling of electrical equipment and gadgets both in the homes and work sites. Results showed 112 deaths, 146 accidents and 73 injuries in 2017 alone and 259 deaths, 1,085 accidents and 126 injuries for the period under study 2014 to first and second quarters 2019. Consequent upon the rate of electrical accidents, remedies were proffered. A table to effects of electric current in the human body is included for more explanations.This study was principally conducted to identify possible risk factors for lethal electrical injury, and to provide recommendations for developing useful safety programs to decrease the threat of electrocution and other electrical injuries.The information and knowledge herein are to be used by safety regulatory bodies for the formulation and implementation of the safety reforms in order to save lives at workplace, homes etc.
Key Words: electrocution,shock, accident, safety, Injuries, Lethal.

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I. Introduction

Safety in engineering refers to any act of accident prevention or minimizing hazards that can result in a mishap with an expected severity and with a predicted probability [1] [2]. The major key to electrical safety is for those working with electrical energy and those responsible for electrical safety to be aware of standards and regulations that include safety best practices and to have the latest information at their fingertips [3].The thought of contemporary society without electricity is mind-boggling. As electricity has become an integral part of mankind, so have the incidents of electrocution due to electric current. Electrical wounds and burns have caused considerable morbidity and mortality [4] therefore; there is a serious need to reappraise the manner of safety. The safety reevaluation cannot yield positive results without the partial destruction of some advantages that such new electronic equipment has brought to education and commerce. Yet neither can it take place in enclosed enclaves of engineers torn between a responsibility to safety and one to profitability [5].

Electricity is a daily general servant to persons of different professions. Some of these professionals are in the know of the danger associated with non-protective contact with electricity, but a little number actually understands the exact quantity of electricity that can electrocute or cause injuries. The human body is controlled and activated by small electrical currents, passing from the human brain to the various muscles around the body [6] and this can cause electrocution or injuries. Electrocution is death caused by the passage of electric current. The main concern regarding electricity is that many believe that a normal household current is safe and insulated power lines do not pose a hazard. Electrocutions may result from contact with an object as seemingly harmless as a broken light bulb or as lethal as an overhead power line [7].

Most times, Nigerian manufacturers and importers are more concerned with their profits rather than safety, but [8]opine that safety irrespective of all odds is very important and that engineering cannot be complete without safety.Most oil servicing companies lose their multi million contracts just for recording one industrial mishap due to unsafe workplace or equipment. Report from International Association of Oil and Gas Producers found out that 16.1 per cent of all oil fatalities in 2010 were caused by an electrical accident, explosion or burn[9].This study was principally conducted to identify possible risk factors for lethal electrical injury, and to provide recommendations for developing useful safety programs to decrease the threat of electrocution and other electrical injuries.

It is very important that manufacturers of electrical appliances and gadgets, trade unions and supervisory bodies should show a more liable attitude in trying to bring to the consumer both a safe product and genuine information about the safety of electrical products and equipment. Nonetheless, traders association and other manufacturing dominated groups are likelyto arrive at a standard for safety which is not as stringent as

those which might come from groups that do not have a vested economic interest in the manufacturing and sales of electrical products. But far more dangerous than any flaws in the standards and codes is the ignorance or indifference of the users of electrical equipment. That safety stiff is too technical for me" seems to be the attitude of so many with the implications that "it is just up to make it safe." Yet equipment that is safe when it leaves the manufacture may become dangerous after period of usage, therefore, durability and reliability of the electrical products and equipment must be of paramount importance.

II. Causes of Accidents due to unprotected contacts with Electricity

Many of the electrical accidents normally occur due to one of the following factors, which include but not limited to; inadequate knowledge of the electrical gadgets, information and ignorance on the part the consumers and operators, improper and non-existent earthing system. A properly designed earthing system is of utmost importance in ensuring safety in homes and work sites becausemost of the devastating effects produced by faults in a system include loss of power, annihilation of equipment, and injuries to operating personnel, each of which can be considerably reduced by proper earthing of the electrical system [10].Many other erudite medical scholars have researched deeply and discovered that electrically conductive contact of the human body with the surface of the grounding or earthing system of an electrical gadget or equipment produces intriguing effects on physiology and health [11], [12].A properly designed earthing system therefore is defined as a safety valve for leakage current and should have; a low electrical resistance to earth, high corrosion resistance and continuous high current carrying capacity [13].Amongst the causes aresystem protection equipment failures, absence of protection devices in some cases, poor and aging transmission lines, aging distribution networks, pitiable response to complaints of damaged facilities and lines by operators and managers of the transmission Company (TCN) and distribution companies (DISCOs). Others are non-compliance to safety rules and guidelines, non-enforcement of safety standards by regulatory agencies, unrelenting existence of inferior materials, schemes and distribution systems, unwillingness of the Discos to improve on obsolete assets inherited.

III. Effects of Unprotected contacts with Electricity (Electric Shock);

The general effects of electric current differ for man, woman and child [14]. For the same amount of current, women generally have worse symptoms then men. Unprotected contact with electricity may cause outright electrocution or injury depending on the severity of the electric shock. Electrocution may result as a matter of accidental contact with exposed electricalsources, such as exposed wires, accidental contact with a faulty power line or electrical arc flash. On the contrary, the contact or shock may result in only an injury that does not result to death. The fact is that consequential harm or injury still depends on the severity of the shock. Most electrical shock victims suffer from the following injuries such as; amputation, severe burns, cardiac arrest and/or arrhythmia and/or heart muscle damage, brain and other nerve damage, memory loss, permanent heart damage, hearing loss, seizures, respiratory failure, spine injury, deformity at point of contact, cataracts, loss of kidney function, and secondary injuries caused by post-shock falls [15]. Table 1, shows in details the various types of effects electric shock can cause in human body depending on the amount or quantity of electric current it comes into contact with for one (1) second.

Table 1: Different effect of electric shock on human body

Electric current (contact for 1s)	**Effect**
Below 1 mA	Not perceptible
1 mA	Threshold of feeling, tingling
5 mA	Slight shock. Not painful. Average individual can let go. Involuntary reaction can lead to indirect injuries
6-25 mA (women)	Painful shocks. Loss of muscle control
9 to 30 mA (men)	Freezing current, "can't let go". The person may be thrown away from the power source. Individual cannot let go. Strong involuntary reaction can lead to involuntary injuries
50 to 150 mA	Extreme pain, Respiratory arrest. Muscles reactions. Possible Death.
1 to 4.3 A	Fibrillation of the heart. Muscular contraction and nerve damage occur. Likely death.
10 A	Cardiac arrest, severe burns. Death is probable

Source:[14]

IV. Empirical Study of Effects of Electrocution, Electrical accidents and injuries

Many deaths and injuries have been recorded due to electrocution in some areas and a report from some distribution companies (Discos) in 2017 isas shown in table 2. Table 2 is used to plot figures 1-7.

Table 2: Death and Injury Statistics 2017 in the Eleven Discos in Nigeria

S/N	DISCO	Death	Injury	Staff	Non-Staff	Accident
1	Abuja	26	-	-	26	21
		-	13	3	10	9
2	Kano	17	-	-	17	15
		-	21	7	14	12
3	Jos	14	-	7	7	12
		-	6	5	1	6
4	Ibadan	11	-	-	11	11
		-	5	3	2	6
5	Benin	8	-	2	6	8
6	Ikeja	2	-	1	1	3
			11	9	2	10
7	Port-harcourt	17	-	-	17	8
		-	11	1	10	2
8	Kaduna	6	-	2	4	6
		-	3	2	1	3
9	Yola	4	-	1	3	4
		-	1		1	1
10	Eko	4	-	2	2	4
		-	1		1	1
11	Enugu	3	-	2	1	3
		-	1	1	-	1
	Total	112	73	48	137	146

Source: [16]

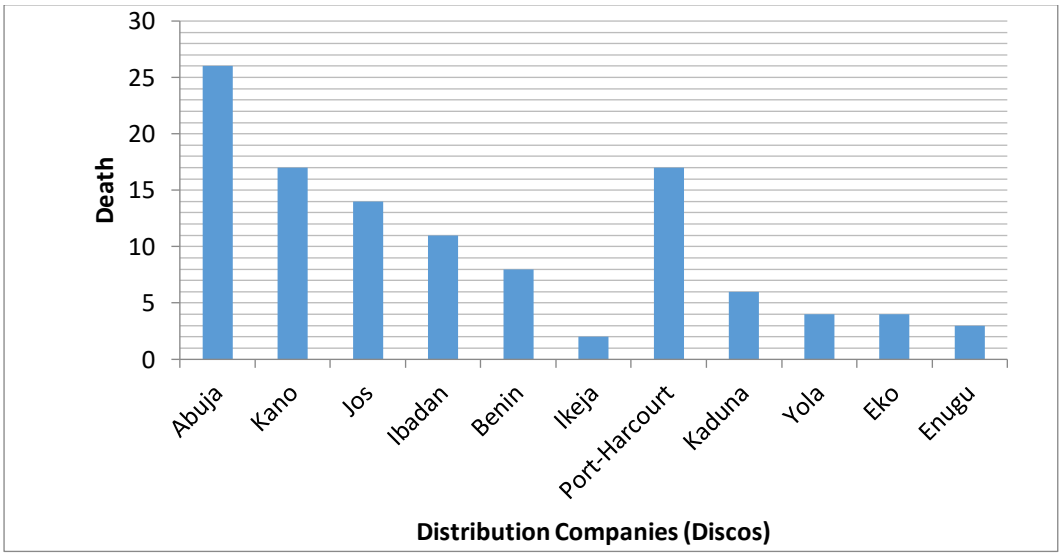

Figure 1: Discos verse Death

In figure1, it is clear that the highest number of deaths was recorded in Abuja Distribution Company while the least occurred in Ikeja Distribution Company in 2017. This is not encouraging since safety is paramount in engineering work places and sites. It equally shows that the management of the distribution companies is not very serious with safety regulations and something urgent must be done about it by both the Nigerian Society of Engineers(NSE) especially the NigerianInstitution of Safety Engineers (NISafetyE) and the Council for Regulation of Engineering in Nigeria (COREN).

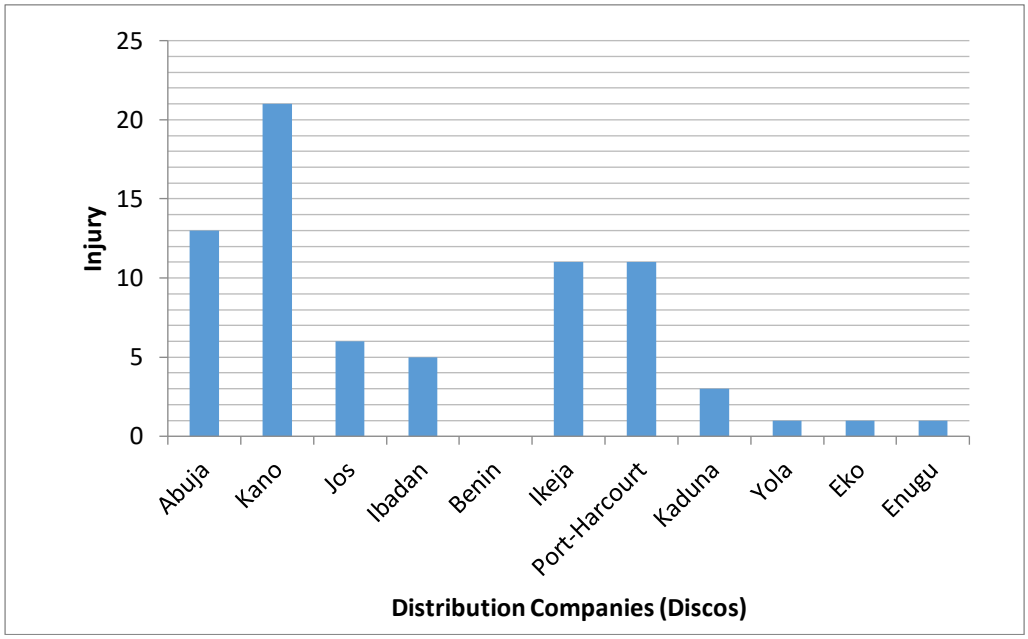

Figure 2: Discos verse Injury

Figure 2 depicts the rate of injuries in the respective distribution companies with Kaduna Distribution Company takingthe lead while the least number of electrical injuries occurred in Yola, Eko and Enugu Distribution Companies respectively with Benin Distribution Company recording exemplarily none.

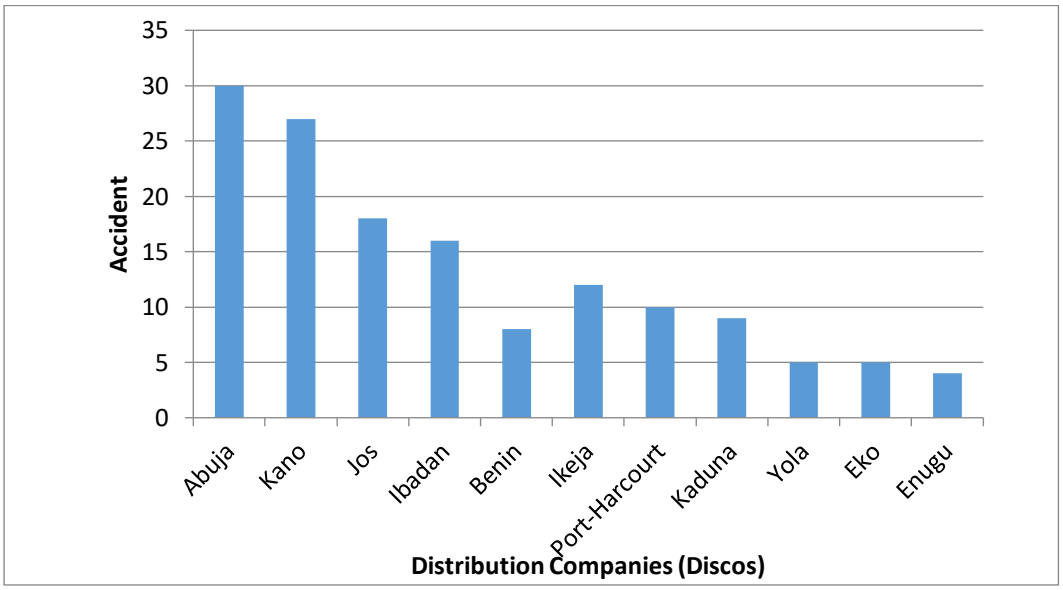

Figure 3: Discos verse Accident

Rate of occurrence of other types of accidents in electrical engineering in respective Discos in 2017 is clearly shown in figure 3. Abuja Distribution Company leads while Enugu Distribution Company recorded the least in the year under study. The rate is also shown in a graph as could be seen from figure 4.

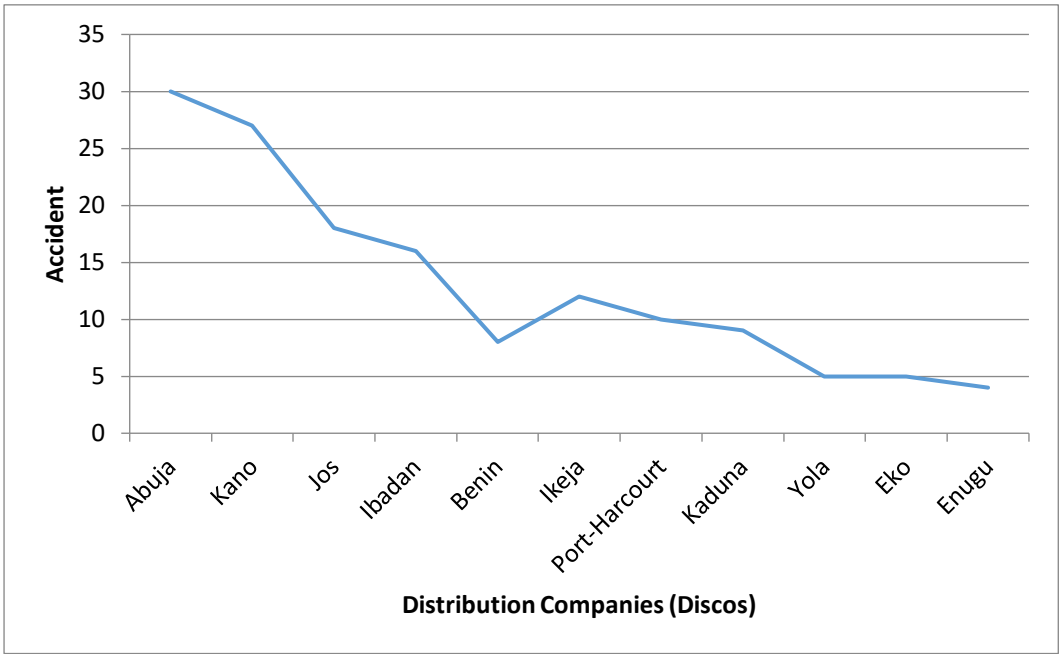

Figure 4: Discos verse Accident

The study was further taken between 2014 and 2019; a six year range. The analysis of details obtained from Nigerian Electricity Management Services Agency (NESA) is clearly stated in figures(5–7).

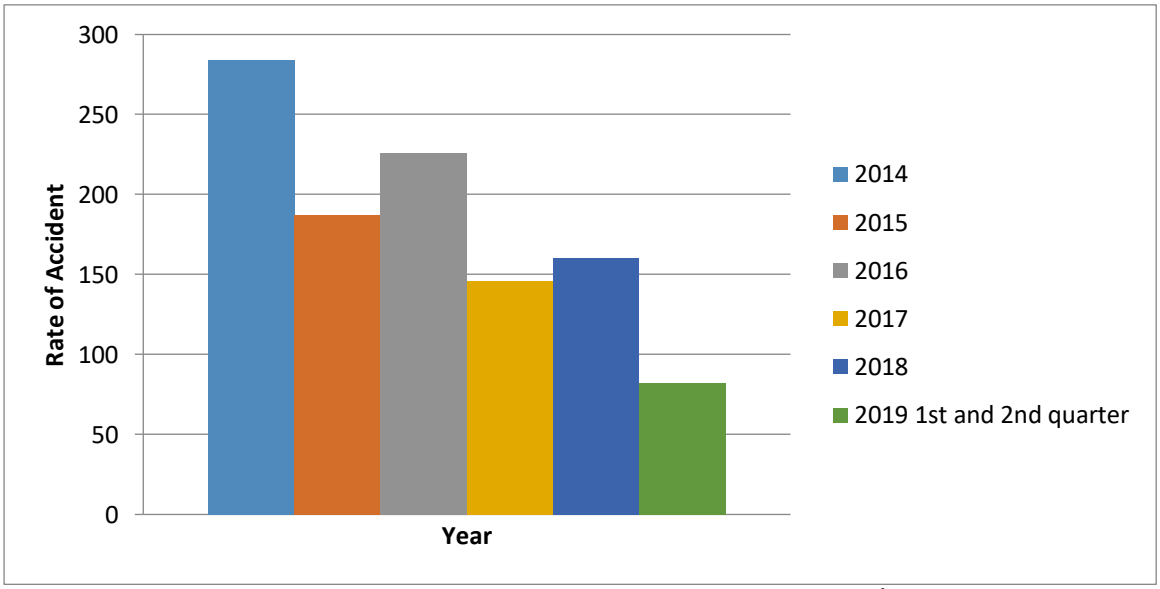

Figure 5: DISCOs Accident Report from 2014 to 2019 1st and 2nd quarters

Figure 5 shows NEMSA year-end report on DISCOs accident report. It is evident from figure 5 that accidents occurrence within the six years study period was high. In 2014, a total number of 284 accidents occurred in the network; 187 accidents occurred in 2015; 226 accidents occurred in 2016; 146 accidents occurred in 2017; 160 accidents occurred in 2018 and a total of 82 accidents occurred in the 1st and 2nd quarters of 2019.

However, the highest number of accidents occurred in 2014 while the lowest occurred in the 1st and 2nd quarters of 2019 put together. Although the rate of accidents in the last two years has been considerably low but it can be inferred from the foregoing that the DISCOs have failed substantially in ensuring the health and safety of their staff and the Nigerian populace at large, which is a paramount consideration in every nation's electricity value chain.

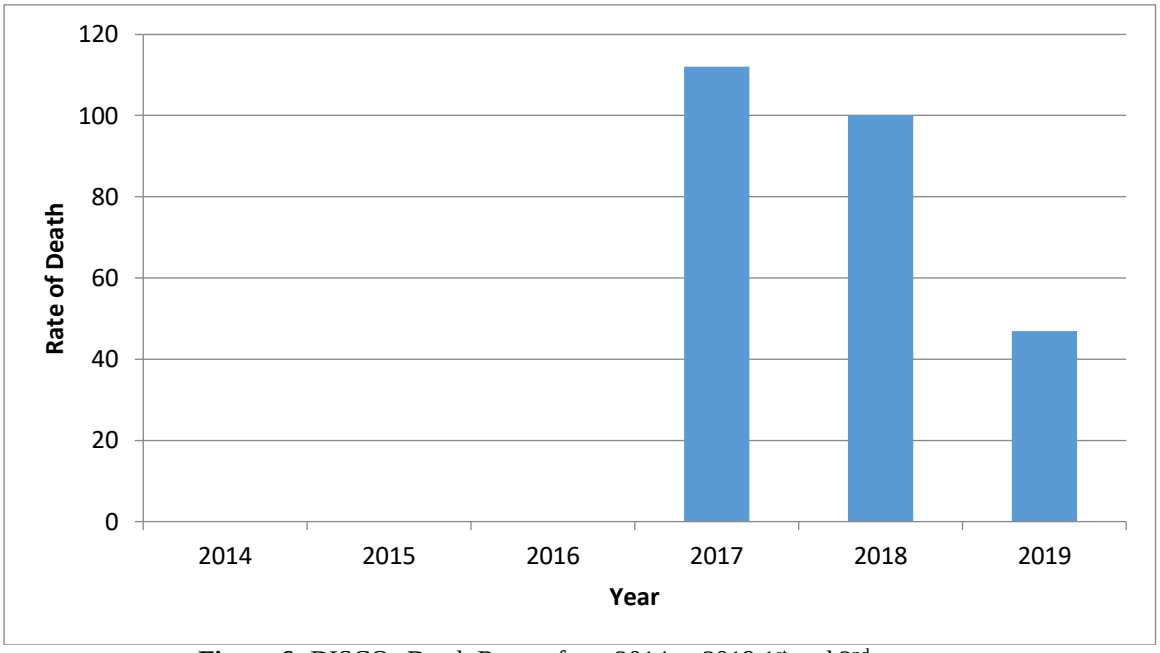

Figure 6: DISCOs Death Report from 2014 to 2019 1st and 2nd quarters

Figure 6 shows NEMSA year-end report on DISCOs death report. It can be seen from figure 6 that no death was recorded/occurred as a result of accidents in the DISCOs within the first three years of this study (from 2014 to 2016). In 2017, out of the 146 electrical accidents (refer to figure 5) that occurred in the DISCOs; exactly 113 lives were lost in 95 cases of accidents. Out of 160 DISCOs electrical accident in 2018, exactly 100 fatal cases were recorded, while 47 death cases were recorded out of 82 accidents in the 1st and 2nd quarters of 2019. In comparison it can be deduced that more DISCOs staff and Nigerians put together died in 2017 than other years within this study period and a total of 160 persons died in all.

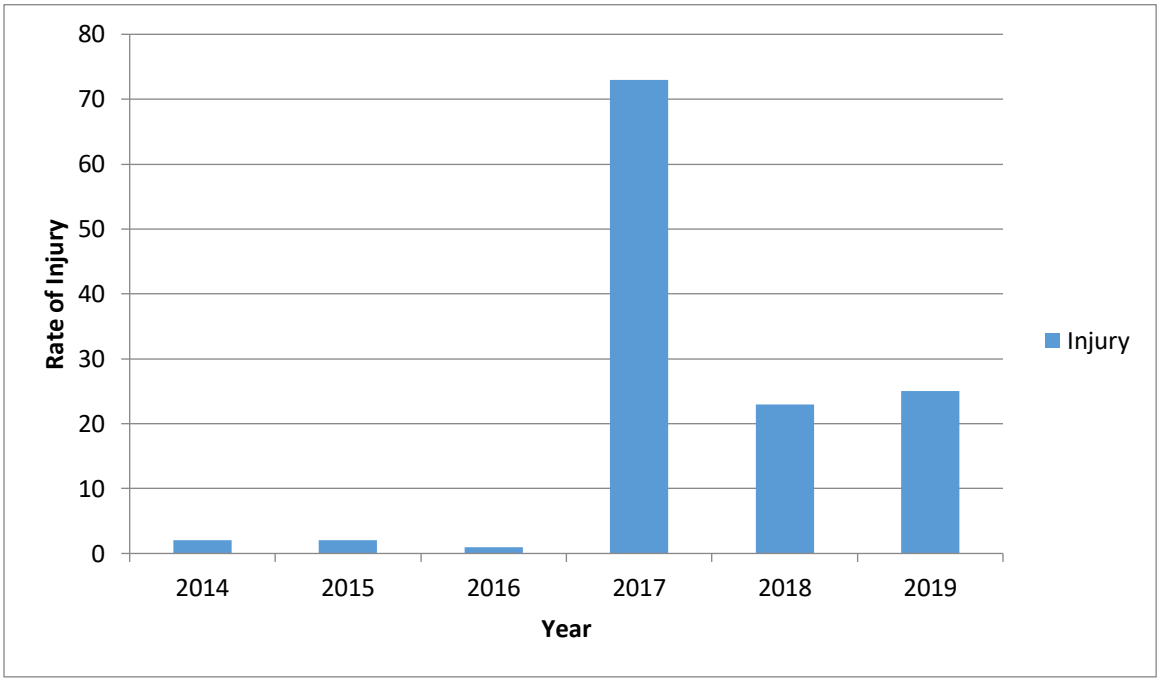

Figure 7: DISCOs Injury Report from 2014 to 2019 1st and 2nd quarters

Figure 7 shows NEMSA year-end report on DISCOs Injury report. It can be deduced from figure 7 that a total of five Injury cases occurred as a result of accidents in the DISCOs within the first three years of this study (from 2014 to 2016). In 2017, out of the 146 electrical accidents (refer to figure 5) that occurred in the DISCOs; exactly 73 persons suffered injury in 51 cases of accidents. Out of 160 DISCOs electrical accident in 2018, exactly 23 injury cases were recorded, while 25 injury cases were recorded out of 82 accidents in the 1st

and 2nd quarters of 2019. In comparison it can be inferred that more DISCOs staff and Nigerians put together sustained injury in 2017 than other years within this study period and a total of 126 persons were injured in all.

Table 3: Accident table for 2014 – 2019

Year	Accident	Death	Injury
2014	284	-	2
2015	187	-	2
2016	226	-	1
2017	146	112	73
2018	160	100	23
2019 only 1&2nd Quarters	82	47	25

Source: [17]

V. Ways to Prevent Electric Shock

Though electrocution is fatal, electrical shock is not as harmful as electrocution but the consequential injuries from electric shock are usually very significant therefore, prevention of both is a goal that everyone should pursue because of the serious and life-altering injuries that can be associated with both. Adequate arrangements must therefore be made to protect ourselves, our families, our friends/relatives and our communities from dangers of an unsafe electrical system or equipment[18].However, since electricity can also constitute a very dangerous hazard, an electrical safety resource has been created. Consequent upon associated dangers, here are a few electrical safety tips and precautions electrical equipment and gadget users should know to prevent an electrical shock injury from happening to them both domestically and industrially. These are; turning off light switches before changing out dead light bulbs, keeping cords untangled and away from heaters, avoid electronic use if you're wet or near water, avoid using your cellphone when it is charging, placing drinks away from game consoles and other electronics, do not swim during a thunderstorm, do not bath under a water heater that is on, stay at least 10 meters (35 feet) away from downed power lines, never climb utility poles or the trees around them, stay away from transformers, avoid flying anything near a power line (kite, drone, etc.)., do not overload sockets with plugs [19].

There are many other ways by which people will be prevented from the possibility of electric shock and most of them are normally regarded as simple a matter of common sense. Normally, insulation and grounding are two known or recognized means of preventing injury or shock during usage or operation of electrical gadgets where no "cowboy" installation is assured. Conductor insulation may be provided by placing non-conducting material such as plastic around the conductor. Grounding may be achieved through the use of direct connection to a known ground such as a metal, cold water pipe. Take example of the metal housing a monitor or the metal box in which gadgets like switches, circuit breakers and electrical controls are placed. Such an enclosure protects the equipment from dirt and moisture even prevents accidental contacts with exposed wiring. However, there are hazards associated with such housing or enclosure, like deteriorated insulation which may cause electric shock. In this situation, metal enclosures must be connected to a ground to eliminate the shock hazard. Insulation may deteriorate or damage due to hard usage or aging exposing users to hazards of shock, burns and fire. In this case, double insulation may be used as additional protection but double insulationdoes not provide protection against defective cords and plugs.Furthermore, vigilance of adults and parents to eliminate possible electric shock dangers, non-usage of cell phone, computer and other electronic appliances during rain, properearthling or grounding are ensured. Regular testing of electrical gadgets like portable electrical equipment by experts and proper use of leakage circuit breakers is encouraged. Good use of good quality and maintained rubber gloves, mats and any other protective equipment's are also advised.

Finally, always use and test the Ground Fault Circuit Interrupters (GFCI) domestically and the use of barriers and safe working practices by maintenance workers are seriously advised. This includes the use of "locking off" and "permit to work" systems to avoid "live working" wherever possible. Ensure you apply the first principle of electrical safety which is isolating (switch off) before work. Summarily, good planning, regular maintenance, good education and vigilance would reduce electrical hazards to barest minimum.

VI. Conclusion

Electrical power or electricity is a good servant but a very bad master or teacher[20]. It is very essential in both homes and at work places. Electricity, if properly treated and used with respect works perfectly for us but treated with complacency, or used in ignorance of the potential dangers it presents, can often cause serious and fatal accidents both in homes and work places.Electrical shocks commonly cause immediate damage to the heart, nervous system and musculoskeletal system [21]. In some cases, the injury from electrical shock is most times misleading; therefore the electric shock victim is normally advised to receive continuous care or treatment as the injuries arise. The rate of recovery is dependent on the severity of the shock. In a bid to assist an electric

shock victim, certain professional tips are necessary like; the rescuer makes sure he turns off the power from source, making sure the victim is no more in contact with the electrical source, makes use of non-conductive material like fiberglass or dry wood etc. to separate the victim from the contact and finally alerts the necessary medical experts or professionals immediately.

Judging from the period under study, the rate of deaths, accidents and injuries is on the high side and very serious attention should be given to it by various managements of the DISCOs, TCN, and the professional and regulatory bodies.It is therefore recommended that proper and regular safety lectures are given to all workers

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