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Appraisal of electrical wiring and installations status in Isoko area of Delta State, Nigeria

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ABSTRACT

Electricity is the prime mover of every economy; hence there is a need to maintain its generation, distribution and consumption. This study was carried out to appraise the status of electrical wiring in the Isoko area of Delta State, Nigeria. A total of 300 residential buildings, 200 makeshift shops and 100 artisan workshops were sampled and their structures, state of connection, overvoltage protection (cut-out fuse) and earthing were accessed. 100 questionnaires were distributed to electricians involved in electrical wiring and installations in the study area. Results obtained from the questionnaires revealed that only 71% of the residential buildings, 23% of the makeshift shops, and 8% of the artisan workshops made use of electric cables that met the NIS recommendations. For electric cable connections, it was observed that there was a lapse in the connections; mostly in the artisan workshops, as some service cables were not properly tightened to the distribution lines. Only 75% of the residential buildings, 53% of the makeshift shops, and 5% of the artisan workshops had approved rating cut-out fuse. It was observed that in artisan workshops, welding machines were connected directly to the service lines. Furthermore, the results revealed that 42% of the residential buildings, 87% of the makeshift shops and 99% of the artisan's workshops lacked proper earthing. These results revealed electrical risks in many makeshift shops and artisan workshops and the need for the relevant authorities to act fast to minimize power outrage and prevent electrical tragedies in the study area.

Keywords: Artisan, electrical wiring, energy theft, makeshift shops, residential buildings

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INTRODUCTION

Electrical wiring is the connection of low-voltage cables/wires, circuit breakers or fuses and other electrical accessories to create a lighting network, power system, etc (Bērziņa, 2019). According to International Electrotechnical Commission (IEC) prevailing environmental condition is a crucial factor that needs to be considered in using the design of the electrical wiring. The design must adhere to the national or regional regulations considering the electrical material used in the equipment as well as the dismantling of the installation at its end of life (Schneider Electric, 2016). Building wiring and installations involves various calculations based on several factors such as type of building, the purpose of building, physical building parameters etc. (Olatomiwa et al., 2012). According to the Nigeria Industrial Standards (NIS), all electrical wiring and electrical materials used must comply with the national approved regulations. Electrical wiring patterns can be divided into two main categories, which are: outside and inside wiring. The outside wiring ensured that electric power is supplied to the building or structure; while the inside wiring is located within the building or structure. Furthermore, inside electrical wiring can be grouped into surface wiring which exposes the electric cables and hidden wiring which hides the cables behind the plaster (Bērziņa, 2019). Hidden wiring is safer than surface wiring in residential buildings, but its main limitation is the difficulties involved when tracing a damaged wire.

Electric cables are used mostly in every electrical wiring and installation. These electric cables must be capable of delivering the required electrical energy efficiently without heating the cables, which can lead to electrical fires. Also, electric cables must be able to withstand the surrounding prevailing environmental conditions and mechanical forces, which they faced in the field (Tenega, 2008). According to the National Electrical Code (NEC), flexible cables are not allowed in permanent electrical wiring of structures; unless in special conditions, as stated by NEC 400.7 (Holt, 2010). Flexible cables must be protected from accidental damage in electrical installations; hence it is necessary to avoid the use of flexible cables in these locations: sharp corners, projections, and doorways, or other pinch points (Occupational Safety and Health

Figure 1: An artisan workshop.

Administration [OSHA, 2020]). According to Bērziņa (2019), when designing electrical wiring for buildings, it is necessary to design power for both the separate groups of switchgear and the feeding lead. Suitably rated circuit breakers or fuses must be installed in the installation, to protect it from overloading or short circuit effects. They must only be connected on the live conductors in single circuits; while in three-phase circuits, they are combined in one set of circuits (Tenega, 2008).
Misuse of electrical appliances is another major cause of electrical hazards. Hence, when electrical circuits are not properly secured, there is a great risk of electrical hazards, especially electrical shock (Ahmadi, 2010; Adekunle et al., 2016). According to Ringelectric (2013), weak (loose) cables connection in electrical wiring and installations has serious damaging effects. One of the major effects of loose connection is that it causes irregular high and low voltages within the structure's electrical wiring. It has been experimentally confirmed that loose cable connections cause electrical fires. If a loose cable connection is subjected to power loading, there is a high possibility of an electric arc being produced. Although this arc is brief, it has a very high temperature which can start an electrical fire and cause great damage to the surroundings (Ringelectric, 2013). Although the status of electrical wiring and installations have been discussed by previous studies, there is no literature on the status of electrical wiring and installation in Isoko area of Delta State. Hence, this study was carried out to evaluate the status of electrical wiring in various structures (residential buildings, makeshift shops and artisan workshops), to ascertain their compliance to international or Nigerian standards.

MATERIALS AND METHODS

Study Area

This study was carried in the Isoko area of Delta State, Nigeria. Isoko's ethnic nationality is made up of two Local Government Areas (LGAs); Isoko South LGA with headquarters at Oleh and Isoko North LGA with headquarters at Ozoro. Isoko's ethnic nationality consists of 19 major towns and villages. The area covered a total landmass of about 1,181 km² and a population of 340,994 people. This ethnic group occupies the South Senatorial district of the State (NPC 2006; Agbi et al., 2020). Isoko can be considered as a mini-commercial area, due to the presence of crude oil exploring companies, University and Polytechnic campuses. Due to its fairly large population and business potential, there are hundreds of makeshift shops and artisans' workshops in the area.

Data Collection

Questionnaire, oral interview and field survey were the tools used for data collection.

Questionnaire

Questionnaires with the following questions were distributed to fifty (50) popular electricians that carried out electrical wiring within the study area.

i. Are the electrical materials you used in electrical wiring in the area comply with Nigeria Industrial Standards?

ii. What problems do you experience with your clients during electrical wiring and installation?

Field Survey

In 2020 a field survey was carried out on 300 residential buildings,100 artisans' workshops (Figure 1) and 200 makeshift shops (Figure 2) were selected from 13 villages out of the 19 towns/villages that make up the study area. These selected structures are the most common structures found within the study area. The majority of the traders and artisans make use of makeshift shops and substandard workshops. During

Figure 2:A makeshift shop.

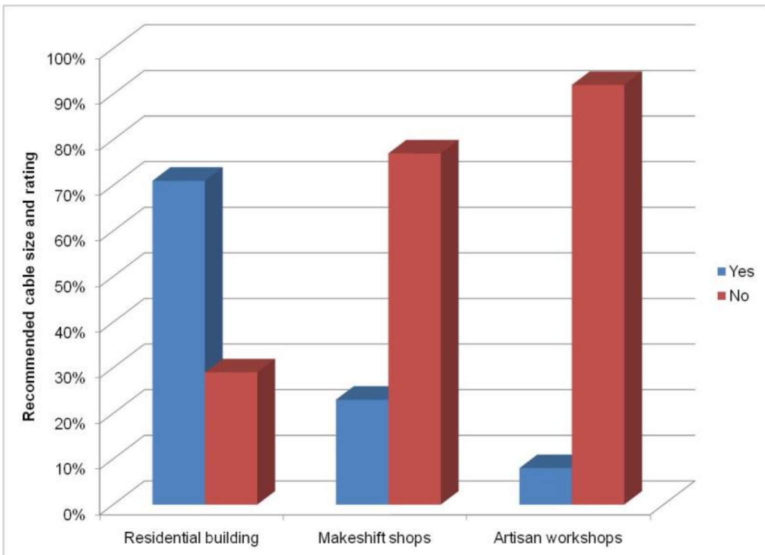

Figure 3: Cable size and rating.

the field survey, the size of electric wires, sockets, cut-out fuse, and other electrical appliances used for the electrical wiring was inspected. Also, the connection pattern of the service lines to the distribution lines was also inspected.

Data analysis

Data obtained from the questionnaires were presented in graphical form, to illustrate the adherence of the electrical wiring to international standards. In addition, the results from the field survey were presented in pictorial and graphical forms to ascertain their compliance with international standards.

RESULTS AND DISCUSSION

Quality of Electrical Cables Used in Electrical Wiring

The feedback obtained from the questionnaires distributed to the electricians on the status of the electric cables used in electrical wiring within the study area is presented in (Figure 3). The results showed that only 71% of residential buildings within the study area were wired with electric cables which meet the NIS recommended cable size and rating. While 29% of the electric cables failed to meet the NIS recommendation. The results further depicted that the electric cables used in wiring 23% of the makeshift shops meet the NIS requirement while the remaining 77% of the makeshift shops within the study area failed to meet the NIS requirement. Furthermore, the results also showed that only 8% of the artisan workshops used electric cables which meet the NIS standard, while 92% of the artisan workshops failed to meet the NIS recommendation for electrical wires used for mini-industrial electrical wiring. The electricians attributed the poor quality of cables used in the electrical wiring to the inability of their clients to buy the NIS-

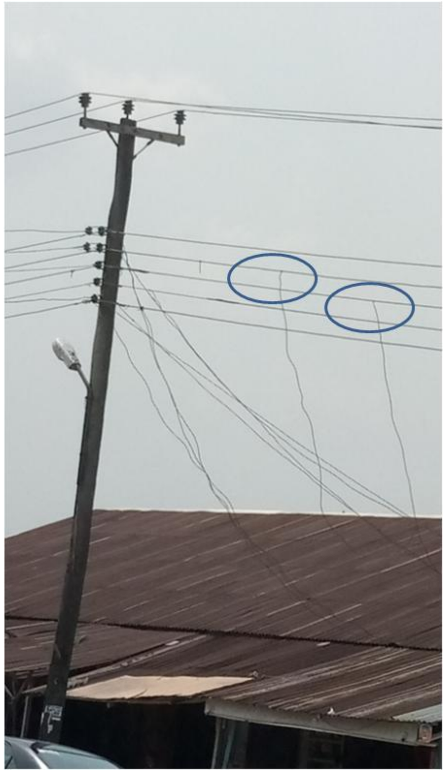

Figure 4: Hanging service cables.

recommended cables due to their high cost. In contrast, the clients/consumer blamed the electricians for their insincerity during electrical wiring and installation as they paid for standard cables in the quote given to them by the electricians.

In the field survey, it was observed that most of the electric cables used in the wiring of the artisans' shops were 2.5 mm^2 copper cables, which fall short of the international recommendation of 4.0 mm^2-6.0 mm^2 copper cables for moderate power demand for electrical appliances like, cooker unit, hair drier, electric iron, water heater, etc. From the field survey, it was observed that most of the connections, mostly in the makeshift shops used flexible cable exceeding 3 m for permanent wiring, contravening international recommendations which stated that: flexible cables cannot be used for permanent wiring and if it becomes necessary it must not exceed 3 m length (Tenega, 2008).

Hanging Service Cables and Weak Cable Connections

From the field survey, it was observed that some service cables were not properly secured (tighten) to the distribution lines (Figure 4). This was common with the artisans' workshops mostly in the welding and fabrication workshops. It was a common scene in the rural communities of Isoko. Feedback obtained from the oral interview revealed that it is the easiest way to “tap” electricity from the distribution lines as they are not financially buoyant to register their workshop with the electric power distributing company and the same time paying electricity bills regularly. From the respondent, they can easily connect their lines back to the distribution lines using a dried wooden stick, after they are disconnected by distributing company monitoring team. This is a clear case of illegal connections and energy theft with its consequent effects on the power system. Electricity theft is an economic saboteur and damages to the grid infrastructures. This normally leads to anomalies in electric power supply. It had been reported that electricity theft is a major cause of the epileptic electricity supply in Nigeria (David, 2018).

These loose connections can create an electric arc or electric spark which can generate a lot of heat in the process that can burn down the cables. In addition, partial contacts cause by the loose connections can be dangerous to electrical equipment inside the workshop or building. According to Ringelectric (2013), electric arc is produced when cables do not make consistent contact. This can be caused by several factors such as the swaying of the service cable due to wind, changes in temperature, electrical load or mechanical disturbance of the cable. Electric cables and other electrical appliances designed to carry the rated currents can dissipate any heat generated at the joints. In condition of weak connection, the heat generated at this joint is more than the dissipation capacity of the cable; hence resulting in temperature increment of the cable (Gore and Gore, 2018). Zhou and Schoepf (2011) reported that overheated electrical joints caused by loose cable connection are often the forerunners of electric fires, arc faults and arc flash in electrical systems.

Overvoltage protection devices

Figure 5 shows the results of the field inspection of the structures with overvoltage protection devices (cut-out

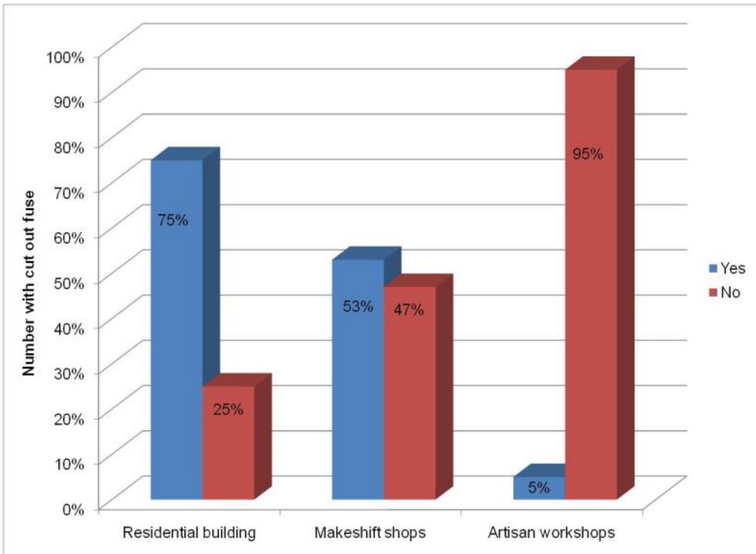

Figure 5: Structures with cut-out fuse.

Figure 6: Hanging cut-out fuse.

fuse) within the study area. 75% of the residential buildings have a cut-cut fuse of the approved rating, according to the size of the building. Some buildings have either poorly secure or smaller rating cut-out fuse (Figure 6); thus putting the lives of occupants in danger of electric shock. In the case of the makeshift shops, the field survey revealed that only 53% of the makeshift shops visited have cut-out fuse, with the remaining 47% without cut-out fuse. It was also observed that only 5% of the artisan's workshops had the approved rating cut-out fuse. 95% connected their welding machines directly to the service lines (Figure 7). These direct connections are not only dangerous to the workmen but also harmful to the well-being of the distribution lines and transformer. Protection devices protect the electrical installations from dangers caused by electrical currents, such as over current, earth leakage current, short circuit, lightning, etc to the wiring system, electrical equipment or consumer (Tenega, 2008). Tenega (2008) stated that the main function of a circuit breaker is to open a particular circuit if there is a malfunction within the particular circuit, without interfering with other circuits in the system. Schneider Electric (2016) recommended that high voltage protective devices are very essential in every electrical installation. This is because high voltages that occurred due to direct or indirect conditions such as lightning strikes, voltage surges, transient and industrial frequency over-voltage, can cause an electrical fire or electrical equipment damage many kilometers away from the source. Therefore, it is necessary to install protective devices against high voltage in electrical connections.

Earthing of the Electrical Wiring

Figure 8 showed that 58% of the residential buildings, 13% of the makeshift shops and 1% of the artisan's

Figure 7: Direct connection.

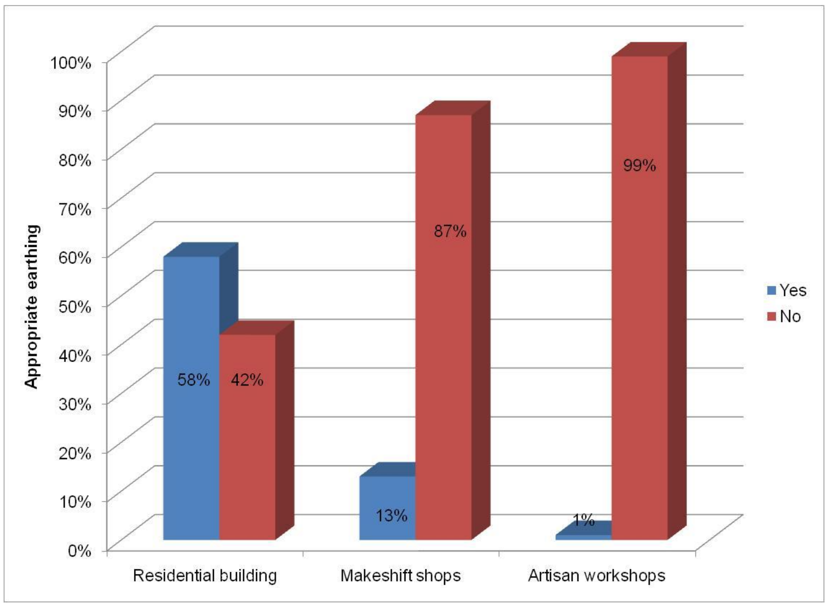

Figure 8: Structures with appropriate earthing.

workshops were properly earthed. The 42% of residential buildings that lack earthing installation were mostly old buildings found mostly in the villages. Although 58% of the residential buildings were earthed, the integrity of the earthing procedure was questionable. Results obtained from the questionnaires showed that only 72% of the residential buildings' earthing was properly done (Figure 9). The electricians attributed the problem to the unwillingness of the property developers to buy standard earthing materials. The capacity of an earthing conductor must be selected in accordance with the electrical load the building is to carry (Cronshaw, 2005). This study results further showed that 99% of the artisans and 87% of the makeshift shops' owner “refused” to properly earth their electrical wiring. It was a common sight that most of the sockets were not earthed, as only the life and neutral terminals were connected. This showed the negligence of the artisans and makeshift shop owners in complying with electrical safety recommendations. One of the major purpose of earthing electrical wiring and electrical materials is to set up a common reference potential between the power supply system and the communication system; hence to accomplish this purpose an appropriate low resistance connection to earth is required (Olowofela, 2020). Electrocution is the second leading cause of work-related deaths among other causes in the construction industries in Nigeria. According to the electrical safety authority in Nigeria, there were 120 electrocutions in Nigeria from 2000 to 2012 and the most common cause of occupational electrocution is the use of improper procedures (Aliyu, 2012). Earthing is a protective means in electrical wiring, between the metallic parts of the electrical wiring and the earth. It provides an easy pathway with little impedance or resistance to earth enabling the

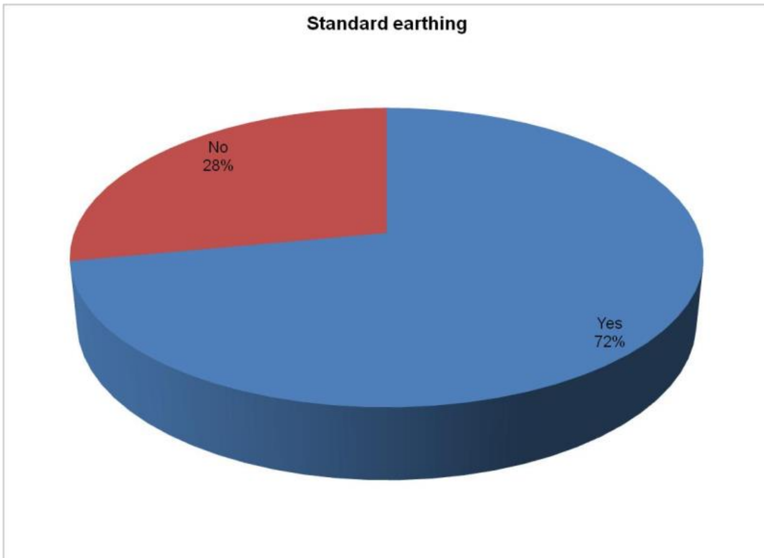

Figure 9: Residential buildings earthed with standard materials.

protection system to operate effectively. Earthing ensures the safety of human beings within the electrical installation from electric shocks (Cronshaw, 2005; Electrical Technology, 2015).

CONCLUSION

The status of electrical wiring and installation within the Isoko area of Delta State, Nigeria was evaluated in this study. This was to establish the compliance level of electrical wiring in the study area to international standards. Results obtained showed that most of the structures' electrical wiring and installation failed to meet NIS recommendations. It was observed that only 71% of the residential buildings, 23% of the makeshift shops and 8% of the artisan workshops met the NIS recommended cable size and rating for electrical wiring of the different structures. While 29% of the electric cables failed to meet the NIS recommendation. The results also showed that the electric cables used in wiring 77% of the makeshift shops within the study area failed to meet the NIS recommended standard. The field survey revealed that there was a significant amount of loose and illegal connections, with service cables hanging on top of the distribution lines. Additionally, the study revealed that only 75% of the residential buildings, 53% of the makeshift shops and 5% of the artisan's workshops had the approved rating cut-out fuse. The other structures either had defective cut-out fuse or lack cut-out fuse completely. Furthermore, the results showed that most of the makeshift shops and artisan workshops lack proper earthing. 28% of residential buildings earthed were done with substandard materials. The non-compliance of the electrical wiring of these structures to international standards exposes the occupants of these structures to possible electrical shock. It is recommended that the government should set up an inspection and regulatory body to regulate and monitor electrical wiring in the area to avoid electrical catastrophes.

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