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RESEARCH ARTICLE

ELECTRICITY CABLE PRODUCTION ASSESSMENT IN LAGOS METROPOLITAN CITY, NIGERIA

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ABSTRACT

This study applied t-distribution statistical analysis to evaluate the quality of electrical cables produced in Lagos metropolitan city, Nigeria, with a focus on the standard conductor resistance and sample resistance. The aim of this work is to determine the conformity of thecables produced in Lagos to established standards and identify areas for improvement in the production process. The population mean and standard deviation of the sample data were estimated. These metrics were employed in evaluating the level of compliance of the sample resistance values obtained against the Nigeria Industrial Standard/International Electrotechnical Commission (NIS/IEC) standard resistance of the cable sizes. The t-tests were conducted at two different confidence levels: 90% and 95%. The findings from the outcome of the cable samples indicated that the overall resistance values complied with the laid down industry requirements. This means that quality assurance and quality control policies implemented in the production of the products are adequate in guaranteeing quality, reliability, and safety of the products. The t-tests confirmed adherence of the sample resistances to the population mean on which cable samples with considerable deviations were flagged. An average of 4 was obtained as the conformity measurements meaning that slight deviation exists in the values of resistance. Such variations indicate areas requiring improvement to enhance the standardization and quality utilized in the manufacturing line. Electricity cables produced in Lagos have good compliance with the quality measures in its production as depicted in the standard procedures, however, the need to constantly assess and update the manufacturing processes in a bid to meet and improve on the required product quality is important.

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INTRODUCTION

Production of power and control cables plays significant role in the augmentation of modern structures, through the transmission of power and proper functioning of control systems in different industries (U-Dominic *et al*., 2021a). When countries are striving hard to develop their industries and improve the structures of their infrastructure the timely demand for cables will increase. The setting for this research is the manufacturing environment in Nigeria with specific reference to Lagos. Consequently, this research intends to bring out the facts and argue for the cable manufacturing industries' improvement in Nigeria as an auxiliary angle to the industrialization and technology sectors (U-Dominic *et al*., 2021b). Electricity cables such as power cables, control cables, instrumentation cables, building wires and specialty cables manufactured in Lagos satisfy the demand of electrical cables in Nigeria and in the whole West African region. Therefore, cable manufacturing is part of the core industrial systems that supports several industries including construction, telecommunications and power, oil and gas, and others. Evaluating the production activities reveals the strength, the effectiveness, and the viability of the cables' production industry in Nigeria (Arief and Nusraningrum, 2021). This research can make recommendation for improvement of control over the production processes of the company, which can, in its turn, lead to the increase of production efficiency, decrease of the costs, and the improvement of the competitiveness of the Nigerian-made cables on the world market (Egbetokun *et al*., 2012). Due to growing needs of various industries, the sector involved in manufacturing of cables has recorded increased demand. Society's need for advanced cables has birthed astonishing innovations in the cables industry to ensure that cables deliver the needed performance and reliability in different uses. Cables are very useful in today's society and meet numerous needs of societal infrastructure. They act as the framework for electrification supplying power to people's homes and businesses after generation from utility power stations. In telecommunication context cables are important in the transmission of data over large distances so as to facilitate communication and access to the internet. High-performance cables are used by data centers, which can be described as the control centers of the digital universe given the task of processing and distributing a large volume of information. In the same regard, the automotive industry relies on these developed cables to enhance supporting electronics in advanced automobiles (Antony *et al*., 2018). Both power and control cables' manufacturing entail complex procedures

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and quality standards to undertake prevention against product failure. The company's products conform to international standards or norms like the IEC and is an ISO 9001 company. This research work will look into the degree with which the company conceives to the abovementioned standards, it technological profile and its quality assurance systems, which will offer a distinctive picture of its operational efficiency and areas of possible improvement (Dziuba *et al*., 2015). The assessment of electrical wires and cables therefore entails important quality parameter, which makes it necessary for these wires and cables to safely and efficiently provide adequate lighting and equipment to households, industries, and the society in general. Electrical cables and wires should meet the required standard, quality, and specification so that the installation will perform the intended task in a convenient manner without posing risk to electric shock. These cables need to transmit electricity effectively, at a low cost, and without a risk of fire outbreak. In recent decade, it is observed that the number of electrical Wire and Cable companies belonging to the indigenous sources has increased a lot due to the change from the conventional artifacts to the Industrial Modernization and the growing needs in the different sectors. This growth calls for evaluation of the products so as to determine if they meet the set statutory requirements. Bhat *et al*. (2016) assessed the quality of wires and cables manufactured by Denki Wire and Cable Limited, an indigenous company located in Akure which deals in the manufacturing of wires and cables that include; interracial wires and cables, electrical cables, overhead conductors, control cables and cable joints among others.

Electrical wires are thin slender rods that are used as conductors while electrical cables are conductors made up of two or even more wires that are enclosed with an insulating material and covered by an outer jacket. These wires and cables usually comprise strongly conductive metals such as copper and aluminum with a plastic such as polyvinyl chloride (PVC) as the insulation material. A cable typically comprises four main components: Conductor, insulation, mechanical protection commonly known as Jacket and filler although the Later one may not be used in all different types of cable. Copper has the highest ductility as well as conductivity next to silver; for this reason, it is widely used in electrical wires and cables, as well as plating. Out of all materials, aluminum is mostly applied as overhead electric cables owing to its light weight and relatively good conductivity (Zhang *et al*., 2009). It is clear in Tripathy (2011) that there is a significant need to control quality in the manufacture of cables. If the manufacturers apply testing, statistical validation, and new technologies, they will be able to make high-quality products that will be safe to use. Apart from improving product reliability, these practices also impact the economy and the development of industries. Information acquired from researches that have been undertaken on such industry players as Lagos metropolitan city may be of beneficial use in future advancements of the industry. Enumerating the problems affecting the growth of manufacturers and capitalizing on the integration of the developments are critical objectives that help industries in the cable manufacturing sector to remain competitive and foster innovation. The quality of electrical cables is significant otherwise they do not attain the necessary qualities as their quality is checked for their mechanical as well as electrical characteristics before use. This evaluation is crucial because the hazards accompanied by substandard products cannot be overlooked. Cable samples were received from five cable companies in Nigeria as undertaken by the researcher. Such samples were subjected to several tests in order to determine their quality, consistency and compliance to the set standards. The conformity of the tested cables above was statistically confirmed using t-tests in two different confidence levels, the 90% and the 95% confidence levels. This process of evaluation is a true reflection of the cable manufacturing industry where quality assurance is critical in the development of safety and quality electrical systems. Technology has heavily enhanced the quality of control of cable production and has enhanced the major chances for manufacturers. Advanced technologies in testing such as using systems and statistics to do the testing have increased the accuracy in quality testing. Using such sophisticated instruments (Egbetokun *et al*, 2012) explained how better and effective the approaches of detecting the defects as well as the adherence to the relevant industrial standards that are important for ensuring the reliability and quality of cables used on such vital facilities. Industry associations play a pivotal role in fostering innovation and ensuring quality within the cable manufacturing sector. These associations facilitate knowledge sharing and promote best practices among manufacturers, enhancing the overall quality and competitiveness of the industry.Sadhu and Das (2020) highlighted that well-organized industry associations are crucial for driving innovation and maintaining high standards in cable manufacturing. Quality assurance in cable manufacturing involves implementing and documenting control measures throughout the production process. This includes regular inspections during various production stages, ensuring compliance with relevant standards and regulations, and consistent application of industry best practices. Data collection methods include reviewing quality control documents, interviewing quality control personnel, and analyzing historical quality control records. These methods provide a comprehensive overview of the quality control measures in place and identify areas for potential improvement (Maurya *et al*., 2024).

This paper seeks to uphold that the cable manufacturing industry plays a crucial role in the economy and industrialization. Improving standardization can decrease expenses resulted from the production of poor-quality products and improve the position on the market. The potency of quality control in cable manufacturing as an economic variable were also explained by Egbetokun *et al*. (2012) as work pointed the fact that strict quality checks fundamental in manufacturing processes help to save cost and increase the reliability of products through controlling of variation hence supporting industrial growth. It has also been noted that quality assurance in cable manufacturing requires the putting in place and documentation of controls at every stage of production. This entails conducting checkups at different production phases, enforcement of standards and guidelines, and adherence to the best practices. Consequently, the assessment of quality control documents, surveys of the quality control personnel, and scrutinies of historical quality control records are common collection methods. These methods give a systemic picture of the existing quality control measures and points out the possibilities of enhancement. Like any other company in other climes, several cable companies in Lagos have overcome certain challenges that affect the production process, the product quality, and the market competition. Some of these challenges include; Complexity of manufacturing process, likely hitches in production process, technological discrepancies, disruption of the supply chain and market competition (Castle *et al*., 2005). It is important to tackle these problems for the desired improvement in organizational performance and sustenance of growth. This research seeks to investigate the details of production methods used at this company, analyze the extent of quality assurance, assess technological experience and practice supply chain management. In this regard, the research aims at identifying the opportunities for the company's development, proposing specific recommendations, which would enable cable industries in Lagos to enhance their performance, control and guarantee the quality of products, as well as to maintain a competitive advantage in the context of rapidly advancing rivals. Thus, technological capacities are instrumental in rendering cable manufacturing faster and of better quality. The application of unibodies, computer controlling of manufacturing and other state of the art techniques in production can greatly improve the quality of the products and organizational effectiveness. Improvements in materials and processes can result to production of cables that can raise manufacturers to higher performance levels and hence gaining competitiveness in the international market. Technological competence will be defined and assessed in this study to define how the firms in the discrete manufacturing industries can take advantage of the technological novelties to enhance production processes and enhance product quality.

Similar to other related work, the quality of cables manufacture has also been seen here as a key factor to be controlled. Such investigations generally comprise extensive tests of cables' mechanical and electrical characteristics, such as tensile strength, dielectric strength, and conductivity. As a result of this, several testing methods and statistical analysis have been employed by several researchers in carrying out investigation on cables, to check if they conform to industrial standards and adequate safety measures to forestall the dangers from substandard products. It has been revealed in the current literature how testing technologies and associated methodologies have evolved. Modernization including automated testing systems and superior statistical analytical tools enhanced the quantitative and qualitative analysis of quality control results. Some works have also focused on the comparative analysis of cables of different manufacturers when identifying the level of repeatability and stability of products in the industry (Arief and Nusraningrum, 2021). Gathering information from Cable and Wire manufacturing industries in Nigeria could help to discover the crucial factors that are influential in spurring the manufacturing sequence in this sector. Firm-level leadership and technology proactivity especially in the deployment of information and communications technologies (ICTs) has a special role and importance in boosting up the innovation performance. Interactions with outside entities involving customers and suppliers of equipment's and raw material are critical. Taking into consideration external factors, it is possible to focus on the main impact of the industry's association. This discovery calls for proper establishment of industry associations that boost the innovation capacities. Cable manufacturing and sales industries in Lagos undergo various difficulties that affect its production performance, quality of products and the firm's market positioning. Since cable manufacturing is highly elaborate, variation in the efficiency of production process and a lack of appropriate technologies in relation to manufacturing could also spike the costs, result in delays and inconsistent quality of the cables. Moreover, factors, such as supply chain disruptions and more significant competitors' pressure, deepen these problems and challenge a company's leadership in the industry (Castle *et al*., 2005). The above challenges are very relevant for one to address if the company is to improve on its performance and sustain growth as a player in the market. The purpose of this research is to assess working processes, conduct an overview of quality management, estimate the level of technological adoption, and review the supply chain operations. Thus, the objective of this research is to reveal factors that hinder the performances of cable factories in Lagos and suggest ways to improve it, maintain quality, and consolidate the company's position in the context of heightened competition. The findings in the study would assist Lagos metropolitan cable manufacturing companies to enhance its efficiency, cut costs, and increase product quality and thereby create a base model for other manufacturers, thus enhancing the economy of Nigeria and West Africa. The work is concentrated on innovations in the policies and procedures of quality assurance for cables that guarantees safe and quality products for the consumers. It also includes strategies particularly to enable the organization to compete within a given market segment within a keenly contested market. Therefore, by acting as an enabler of relevant technologies and creativity, the research contributes to the company's market competitiveness, and industry health. The scope of this study encompasses assessment of power and control cable production in Lagos metropolitan city. It will investigate the manufacturing processes, quality control measures, and material usage to determine compliance with industry standards.

MATERIALS AND METHODS

Cable Manufacturing Process: The fabrication of power cables through the cable companies entails a series of operations to ensure the final product conforms withstandard.

Raw Material Preparation: The first stage is the creation of the basic materials – high-porosity copper and aluminum, which are received by purchasing the purest metal (99, 99%). These materials are crucial for the proper functioning in regards to conveying electric current, along with the construction resilience. Both copper and aluminum are purchased in large reels or rods and are kept in proper enclosures in order to avoid contamination of the wires or any degrading of the metals.

Melting and Casting: The raw copper and aluminum are then moved to melting furnaces to melt the raw material to its melting point of copper 1150°C and aluminum, 450°C. The metals are cast into continuous rods of approximately 8mm diameter by means of continuous casting process. This makes it easy to have standard and backbone of the fluid that produces the layers hence the film industry.

Rod Breakdown: These cast rods are further fed into a Rod Breakdown Machine. Essentially, this concerns a device containing several synthetic diamond or carbon dies towards which the rod is to be drawn to achieve the necessary degree of shrinkage. The process involves a significant degree of deformation along with the generation of heat and to reduce and minimize die wearing and also for creating fine surface finishing on the drawn wire, lubricants are used.

Annealing: After drawing, the wires are annealed so as to reduce internal stress and to increase their ability to be drawn further. This procedure involves an increase of the temperature of the desired section of the wire to the required value and then followed by a gradual decrease of the temperature. Annealing also enhances the ductility of the wire which makes it convenient for handling during wire interfacing in different uses.

Stranding: The next procedure is called stranding in which several wires are contained in one conductor through twining. Stranding also enhances the ability of the cable to bend and also enhances mechanical capability of the cable. This is done by using the stranding machines that winds the wires in circular manner around each other. The number of wires and amount of twist depends on the stated electrical and or mechanical characteristics to be met.

Insulation: Originally connected by bridges, the conductors are then varnished to avoid direct leakage of electricity. It is done by an extruder machine that adds an insulating coat on the cable, which may be from PVC or XLPE among others. The extruder melts the plastic pellets and then shove it through a die to apply the conductor on it in an even manner.

Sheathing: Following the insulation process, the cables are covered in order to prevent such factors such moisture, some chemicals and mechanical abuses from coming into contact with the cables. The next step is to sheath the core with an outer layer of PVC or another similarly suitable material by the use of another extruder. In case of additional mechanical protection for the cable, then before outer sheath metal wires or tapes might be applied to the armoring.

Testing and Quality Control: Quality control is considered to be important at every step of the creation process for a product. The finished cables when sent for testing to check their electrical conductivity, insulation resistance, mechanical strength and fire resistance among other constraints. These are electrical tests such as high voltage test, mechanical tests such as tensile test and other tests such as environmental stress testing. In case there are deviations from the required specifications they are corrected almost simultaneously.

Packaging and Dispatch: The cables are then wound on to drums or reels and identified for dispatch from the factory. The packaging that the cables come in is in a way that will help protect them should there be mishandling during transportation or when they are being stored. A record is kept for traceability and to make sure that high quality work is done. Figures 1, 2 and 3 depict the process flow chart of power cable manufacturing, single/multi core domestic cable manufacturing, PVC compound manufacturing respectively.

Data Collection on Cable Manufacturing Process: In the process of manufacturing, quality of the raw materials, the parameters of the process, and the performance indices of the manufactured products are gathered. The appropriate data is collected and Statistical Quality Control (SQC) tools like control charts and histograms are used in analyzing this data to come up with an appropriate improvement plan. A feedback system helps to detect any complications which are immediately addressed while the system continually helps to identify the most efficient and effective means of production.

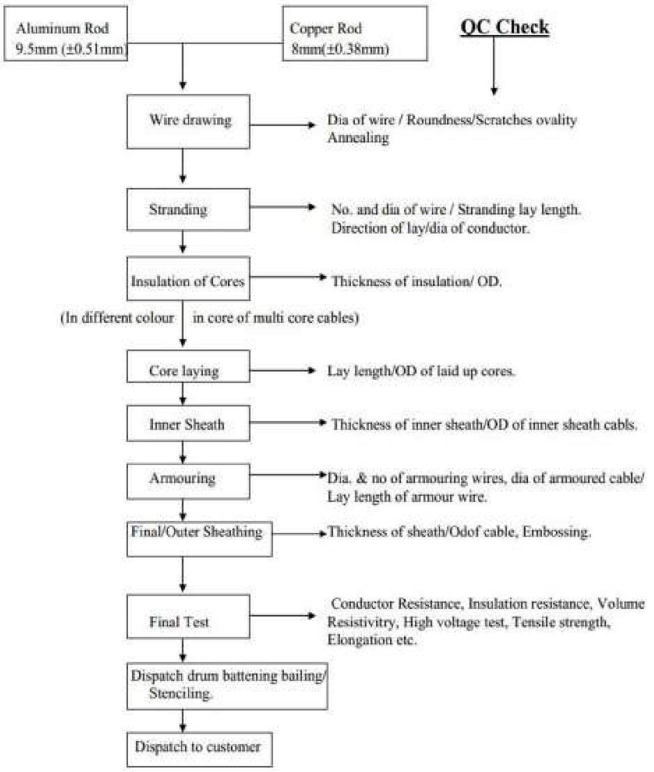
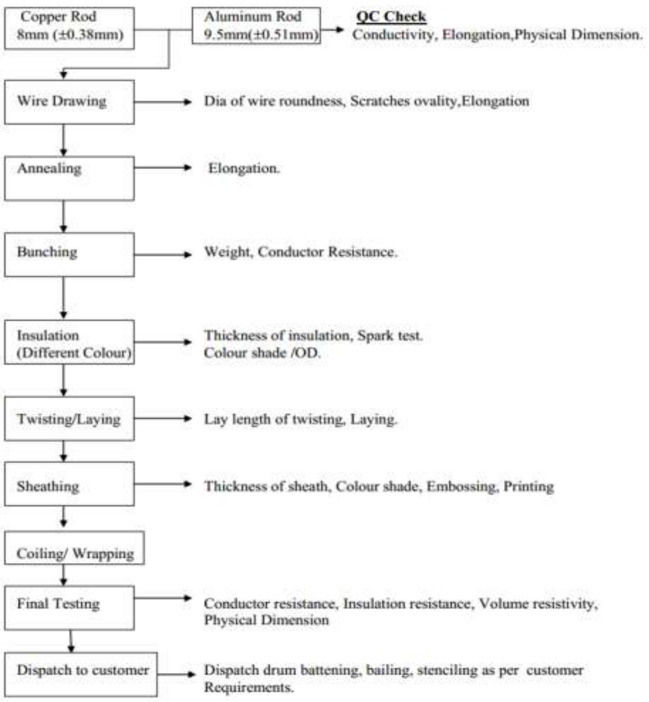


Figure 1. Process flow chart of power cable manufacturing



Collection of data on cable processing includes identification of specifications of different variables and aspects in the production process. These requirements encompass the materials utilized, manufacturing process variables, quality assurance activities, and the product's properties.

Materials Analysis: The types and chemical makeup of the raw materials that go into the manufacturing process of cables play unique roles in dictating the final quality. Details concerning the utilized copper and aluminum rods usually of 8.00mm diameter. These materials have to be checked for purity and Electrical Conductivity as per the standards specified by IEC 60502. PVC and XLPE details; chemical contents of the insulation and physical strengths; S.W.A details; tensile strength and abilities to resist corrosion.

Manufacturing Parameters: Parameters associated with cable's geometry and material are critical to determining if it conforms to the intended design. This means that important parameters comprise diameter, length, and weight of the cables. This also include constructions details like the number and type of conductors, insulation used and their details, shielding used and protective jackets.

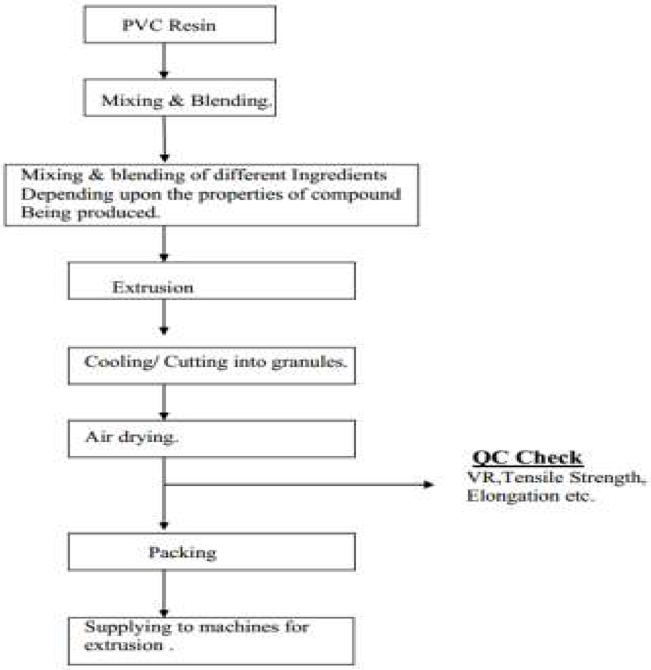


Figure 3. Process flow chart of PVC compound manufacturing

Process Parameters: Recording the cable manufacturing data at different production points is important in maintaining quality. The parameters of interest with respect to the different aspect of this process include:

- **Extrusion:** Extrusion temperature, pressure, and speed of insulation as well as sheathing materials all have to be taken into consideration.
- **Twisting and Braiding:** Velocity, stress, and the number of turns or coils per a certain number of centimeters.
- **Armoring:** The kind of metal wires / tapes used in the armoring process plus the tensions that are exerted.

Quality Control Measures: Records of the quality control tests and inspections made on the items in the different stages of production promote quality. This involves carrying out electrical test on conductors such as those made of copper, and these tests include the resistance tests as well as the conductivity tests particularly for standardized sizes of solid conductor such as the 2. 5mm². Insulation resistance is aimed at confirming that the insulation material applied will not allow 'leakage' of the electrical current. Such physical characteristics as strength of tension, flexibility and durability trials to check up the cables with indicatives of physical pressure. Performance Testing is carried out with an aim of testing the ability of the cable to perform under certain conditions of usage such as temperature changes, humidity, and mechanical stress.

Environmental Conditions: Information on the environmental conditions in production process and storage can affect the functionality of cables. Ambient conditions of the manufacturing facility and storage areas to determine whether the items being processed are not affected. Further, concentrations of dust and other materials might compromise the process of manufacturing.

Performance Testing Data: The qualifying tests are done with an intention to mimic the real-life service conditions so that the cables meet the needed metrics. Information acquired entails load testing which involves determination of the amount of electrical power that can be transmitted through it without posing a threat to a short circuit or a fire outbreak. An endurance test is the test that helps in determining how the cable will perform over and over in the future. This determines the ability of the cable to withstand negative effects from such factors as ultraviolet radiation, chemicals and other factors considered under environmental factor.

Quality Assurance Data: Quality assurance involves reviewing all collected data to ensure the final product meets all specifications and standards. Compliance records documentation of all tests and inspections to ensure they comply with relevant standards. Records of any changes or deviations in the manufacturing process and how they were addressed. Data on customer satisfaction and any reported issues with the product, used to continuously improve quality. By systematically collecting and analyzing data on these variables, cable companies in Lagos can ensure that their power cables are manufactured to the highest standards of quality and performance. The electrical conductivity has to do with the size of cables. Take for instance a solid conductor of 2.5mm^2.

$$\text{C.S.A} = \frac{\pi d^2}{4} \times \text{No of wire} \tag{1}$$

where: C.S.A. = Cross sectional area and d = diameter.

The cable resistance per unit length and per unit cross-sectional area is influenced by several factors; nature of material, sample temperature, and sample dimensions. Often, the change in resistance due to temperature is minimal and can be ignored unless under extreme conditions. Mathematically, resistance (R) is directly proportional to the length (L) and inversely proportional to the cross-sectional area (A) of the conductor (that is $R \propto L$ and $R \propto \frac{1}{A}$).

$$R = \frac{\rho L}{A} \tag{2}$$

where: R is resistance, ρ is resistivity of the material, L is length of the material, A is the area.

Producing a cable with a 2.5mm² round solid conductor requires careful consideration of the conductor size. The conductor should have a diameter of 1.78mm^2 to meet the desired specifications. If the conductor size is smaller than this, it will result in higher conductor resistance. When current flows through a conductor, it generates heat. Higher resistance increases this heat, potentially causing the conductor to overheat. Excessive heat can cause the premature failure of the cable's insulation, leading to risks of fire or short circuits. High resistance lowers the current flow, impacting the cable's efficiency and performance. Conductivity (or electrical conductivity) measures the extent of current flow through a material when a potential difference is applied at a specific temperature. Conductivity is the inverse of resistivity. Electric current conduction in a metal increase with decrease in resistance to the flow of current. The higher the resistance of a conductor the lower is conductivity, resulting in a lower rate of current flow and conversely. This is given by ohm's law:

$$I = \frac{V}{R} = \frac{E}{R+r} \tag{3}$$

Here, all the above said factors will cause an increase in resistance if conductors are damaged resulting from burning or corrosion. High resistance causes such problems as overheating; therefore, the conductor size should be properly selected. In a case of a stranded conductor of 2. The label of '5mm²' therefore requires a configuration like '7 stranded conductor' for which each strand is of '0.' 67mm. Depending on the necessity, stipulated by standards (for instance, IEC 60502), tests are carried out throughout the cable manufacturing process.

Quality Assurance (QA) Data in Cable Manufacturing: Quality control in the manufacture of cable is a sensitive process which deals with the final product in order to ensure that it meets the required specifications. It is a method that applies a set of structures controls ranging from acquiring raw materials to issuing finished products. Appropriate QA strategies are beneficial in the detection and elimination of possible defects on the cables thereby enhancing the quality of the cables produced.

Inspections: As mentioned above, inspections are one of the basic components of the quality assurance. They entail the carrying out of frequent and routine inspections at different times of the manufacture process.

- ***Incoming Inspections*:** Checking if the received product is of high quality before it mixes with other components. This involves testing for the quality of conductive metals–main being copper and aluminum, plus the quality and physical characteristics of insulation material.
- ***In-Process Inspections***: Carried out at different points in the manufacturing process to check whether different activities are done efficiently as planned and in the right manner. These are characteristics such as measurement of the extruded cables and spacings between the insulation layers as well as ensuring that armoring as well as sheathing is properly applied.
- ***Final Inspections***: Stringent examinations of the final goods to confirm they are acceptable according to certain criteria. This includes electrical conductivity test, insulation resistance test, tensile strength test and other performance characteristics.

Certifications: Certification is important in ascertaining that the products meet the standards required in the industry and the legal requirements. The process certification involves:

- ***Testing and Validation***: Carrying out some severe tests on the cables to confirm that they are in compliance with the set standards by IEC and other related bodies.
- ***Documentation***: Keeping proper records of all the tests and inspection done, the techniques used and the outcome of the test.
- ***Compliance Audits***: Their practice of submitting their activities to external auditors at least once a year to check on their level of conformity to the standards and the regulations.

Analysis of Data Gathered from Cable Production Samples: The data gathered is administered after sampling the cables randomly from different batches and different time periods, which assists in achieving an enhanced coverage of the various productions and aspects of variations hence providing a broader coverage to the assessment of quality. For such key characteristics as physical dimensions, chemical content, electrical characteristics of the cables, special instruments and equipment are used, including micrometers, spectrographs, and electrical measuring devices. The measured parameters are later compared with the standard set by bodies such as the International Electrotechnical Commission Industrial Products (IEC IP) 60502. The analysis on the data collected will be made with the help of t-distribution statistical test. The tolerance value of the sampled data for mean and standards deviation is evaluated from statistical analysis such as t-test. This comparison helps in establishing that the products conform to the international standards as well as the local standards. This analysis is useful in identifying the causes of any quality problems, thus giving a clear picture of its gain and loss account of its production process. The selected cable manufacturing industries provided several power cable samples of various sizes for the study and the data pertaining to essential parameters like conductor resistance and insulation resistance is summarized in Table 1. One of the main factors that define the cable's ability to prevent the leakage of the current is insulation resistance.

RESULTS AND DISCUSSION

Discussion of Result on Cable Samples Assessed: Table 2 shows the Nigeria Industrial Standards (NIS) as spelt out by (NIS, 2009) for cables and wire. These standards offer the needed information on the physical features and quality characteristics that cables and wires should have to serve the purpose of these industry standards. The data generated from the questionnaires distributed and retrieved from cable factories in Lagos are presented in Table 1. Such data includes the dimensions of the samples of cables including their electrical resistance and the quality of their insulation.

Figures 4 to 15 exhibit the correlation between the actual insulation as well as conductor resistance of cables of different size manufactured by these factories with the standard values of the same as under the NIS/IEC 60502 code for cable rating. The types of cable are common as follows; 1. 5mm, 2.5mm These activities are inclusive of 5mm, 4mm, 6mm, 10mm, 16mm, 25mm, as well as 50mm, 70mm, 95mm, 120mm as well as 150mm. The insulation resistance together with the conductor resistance were also recorded for each of the cable sizes before they were plotted using the NISIEC 60502 code standards. This comparison employs a visual way of showing how well the cables manufactured by Kable Metal complied with the set quality standards.

Table 1. Conductor and insulation resistance test data of power cable samples obtained from Lagos metropolitan city

	Conductor Resistance (Ω)			Insulation Resistance (Ω)		
Cable Size (mm^2)	Measured Value	Desired Value	Measured Value @ 20℃	Measured Value	Desired Value	Measured Value
1.5	5.531	12.1	10.45	35700	1000	18386
	5.684	12.1	10.74	36400	1000	18746
	5.644	12.1	10.66	31300	1000	16120
2.5	7.593	7.41	7.35	21100	1000	21206
	7.550	7.41	7.31	11700	1000	11759
	7.622	7.41	7.38	13400	1000	13467
	7.581	7.41	7.34	10900	1000	10955
	7.477	7.41	7.24	11300	1000	11357
	7.564	7.41	7.32	9950	1000	10000
	7.532	7.41	7.29	10200	1000	10250
	6.879	7.41	6.67	10600	1000	10611
	6.844	7.41	6.63	10700	1000	10711
	7.342	7.41	7.11	10300	1000	10310
	9.559	7.41	7.17	4680	1000	6051
	8.443	7.41	6.33	5740	1000	7422
	8.832	7.41	6.63	5080	1000	6568
	1.534	7.41	6.81	91500	1000	19673
	1.536	7.41	6.82	63500	1000	13653
	1.664	7.41	7.39	71400	1000	15351
	4.197	7.41	6.71	52400	1000	31283
	4.200	7.41	6.72	42900	1000	25611
	4.552	7.41	7.28	47600	1000	28417
	0.697	7.41	7.12	60700	1000	5827
	0.683	7.41	6.98	53500	1000	5136
	0.683	7.41	6.98	48100	1000	4618
	0.720	7.41	7.36	44800	1000	4301
	0.685	7.41	7.00	49100	1000	4714
	0.687	7.41	7.02	46300	1000	4445
	0.688	7.41	7.03	42900	1000	4118
	2.875	7.41	7.07	25500	1000	10175
	2.784	7.41	6.85	15700	1000	6264
	2.787	7.41	6.85	16800	1000	6703
	2.950	7.41	7.25	15700	1000	6264
	2.787	7.41	6.85	15200	1000	6065
	2.794	7.41	6.87	14900	1000	5945
	2.795	7.41	6.87	15300	1000	6105
	3.474	7.41	6.75	14200	1000	7057
	3.477	7.41	6.76	17100	1000	8499
	3.477	7.41	6.76	14800	1000	7356
	3.464	7.41	6.76	16700	1000	8267
	3.465	7.41	6.76	15700	1000	7772
	3.466	7.41	6.76	15500	1000	7673
4.0	0.786	4.61	4.30	18700	1000	3291
	0.784	4.61	4.29	19700	1000	3467
	0.796	4.61	4.35	18700	1000	3291
	0.800	4.61	4.37	19200	1000	3379
	13.276	4.61	4.17	737	1000	2241
	13.665	4.61	4.29	810	1000	2643
	13.594	4.61	4.27	739	1000	2248
	2.575	4.61	4.10	4720	1000	2832
	2.570	4.61	4.09	2890	1000	1734
				14800	1000	4632
				16700	1000	5227
				16900	1000	5290
				16300	1000	5102
				16300	1000	6862
				1530	1000	644
				18500	1000	7789
				18200	1000	7662

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6.0	3.360	3.08	3.06	16900	1000	18032
	3.334	3.08	3.04	18100	1000	19313
	3.249	3.08	2.96	16500	1000	17606
	3.360	3.08	3.06	18600	1000	19846
	2.936	3.08	3.03	10500	1000	9912
	2.922	3.08	3.01	10800	1000	10195
	2.839	3.08	2.93	10000	1000	9440
	2.775	3.08	2.86	10600	1000	10006
	3.120	3.08	3.02	10700	1000	10743
	3.098	3.08	3.00	10200	1000	10241
	3.114	3.08	3.02	11000	1000	11044
	3.000	3.08	2.91	10900	1000	10944
	2.399	3.08	2.88	3150	1000	2526
	2.391	3.08	2.87	3650	1000	2927
	2.412	3.08	2.89	3430	1000	2751
	2.959	3.08	2.78	15300	1000	15667
	3.075	3.08	2.89	16200	1000	16589
	3.096	3.08	2.91	16600	1000	16950
10.0	2.317	1.83	1.81	15000	1000	18540
	2.323	1.83	1.82	16600	1000	20518
	2.334	1.83	1.82	15400	1000	19034
	2.316	1.83	1.81	16500	1000	20394
16.0	1.903	1.83	1.81	19600	1000	19914
	1.889	1.83	1.80	18500	1000	18796
	1.903	1.83	1.81	18300	1000	18593
	1.885	1.83	1.79	18400	1000	18694
	1.062	1.83	1.77	23900	1000	13671
	1.060	1.83	1.77	24600	1000	14071
	1.069	1.83	1.78	14800	1000	8466
	0.250	1.15	1.07	20300	1000	4588
	0.251	1.15	1.08	23400	1000	5288
	0.250	1.15	1.07	22700	1000	5130
	0.667	1.15	1.10	18200	1000	10647
	0.665	1.15	1.09	22100	1000	12929
	0.667	1.15	1.10	16800	1000	9828
25.0	0.173	0.524	0.487	79500	1000	26792
	0.176	0.524	0.495	72000	1000	24264
	0.173	0.524	0.487	78800	1000	26556
	0.241	0.727	0.678	77600	1000	26151
	1.201	0.727	0.691	23900	1000	39817
	1.199	0.727	0.690	26100	1000	43483
	1.209	0.727	0.696	27800	1000	46315
	0.746	0.727	0.701	28300	1000	28866
	0.745	0.727	0.700	30100	1000	30702
	0.745	0.727	0.700	31500	1000	32130
50.0	0.0442	0.387	0.377	148000	1000	16872
	0.0452	0.387	0.386	125000	1000	14250
	0.0432	0.387	0.369	135000	1000	15390
				4110	1000	4077
				3970	1000	3938
				3300	1000	3274
				3660	1000	3693
				4120	1000	4157
				3160	1000	3188
				4120	1000	4066
				4610	1000	4550
				4100	1000	4047
				4770	1000	4725
				4600	1000	4554
				4210	1000	4168
				15000	1000	15450
				10600	1000	10918
				10200	1000	10506
				8450	1000	8704
				3840	1000	3955
				3360	1000	3461
				10100	1000	10403
70.0	0.0460	0.268	0.285	62900	1000	11825
	0.0474	0.268	0.243	58000	1000	10904
	0.0474	0.268	0.243	62100	1000	11675
	0.0423	0.268	0.242	69200	1000	13009
				3020	1000	3005
				3320	1000	3303
				3260	1000	3244
				3810	1000	3760
				3550	1000	3504
				3420	1000	3376

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				16900	1000	3414
				17100	1000	3454
				17700	1000	3575
				18300	1000	3697
				4340	1000	4301
				4160	1000	4123
				3960	1000	3924
				5060	1000	5019
				3540	1000	3512
				4130	1000	4097
95.0	0.0043	0.193	0.188	200000	1000	4400
	0.0042	0.193	0.184	185000	1000	4070
	0.0043	0.193	0.188	205000	1000	4500
	0.0042	0.193	0.184	192000	1000	4224
120.0	0.0236	0.0754	0.0713	29700	1000	9385
	0.0236	0.0754	0.0713	31200	1000	9859
	0.0236	0.0754	0.0713	24000	1000	7584
	0.0468	0.0153	0.141	30000	1000	9480
150.0				93.1	1000	21.04
				74.4	1000	16.81
				16800	1000	3797
				17600	1000	3978
				15600	1000	3526
				17000	1000	3842
				14800	1000	3345
				16300	1000	3684
				36300	1000	4066
				272	1000	30.46
				140	1000	15.68
				40900	1000	4581
				34100	1000	3819
				31200	1000	3494
				14000	1000	1568
				24500	1000	2744
				16600	1000	3718
				15000	1000	3360
				15100	1000	3382
				15200	1000	3405
185.0	0.0309	0.0991	0.0942	30600	1000	9761
	0.0309	0.0991	0.0942	31200	1000	9953
	0.0309	0.0991	0.0942	29400	1000	9379
	0.0309	0.0991	0.0942	29200	1000	9315

Table 2. NIS standard values for cables and their properties (NIS/IEC 60502)

Cross sectional (mm^2)	Diameter (mm)	Radial thickness of insulation (mm)	Cable resistance at 20°C (Ωmm)	Insulation resistance (Ωmm)
1.5	1.38	0.70	12.1	1000
2.5	1.78	0.80	7.41	1000
4.0	2.25	0.80	4.61	1000
6.0	2.76	0.80	3.08	1000
10	3.57	1.00	1.83	1000
16	4.51	1.00	1.15	1000
25	5.64	1.20	0.524	1000
50	7.98	1.40	0.387	1000
70	9.40	1.40	0.268	1000
95	11.00	1.60	0.193	1000
120	12.30	1.60	0.0754	1000
150	14.00	1.80	0.0991	1000

When assessing the quality of the cable samples, the statistic method employed was the t-distribution. This method is appropriate when the sample size is small and or the population standard deviation is not well known. To achieve the stated objectives, the t-test was carried out at 90% and 95% confidence interval to test the null hypotheses for rejecting the sample means from the hypothetical population mean of the NIS standards. The use of t-distribution sample calculations is illustrated for each cable size. These calculations include the steps for determining the t-statistic, degrees of freedom, and the corresponding p-values for the given confidence levels. By comparing the calculated t-values with the critical t-values from the t-distribution table, we can conclude whether the cable samples meet the required quality standards set by NIS. The results of the t-test indicate whether the null hypothesis (that the sample mean is equal to the population mean) can be rejected or not.

If the null hypothesis is rejected at the given confidence levels, it suggests that the sample quality significantly deviates from the expected standard, warranting further investigation or corrective measures. Table 3 presents a summary of the results, including the deviation of each sample's conductor resistance from the NIS standard. The deviations are calculated by comparing the measured conductor resistance values of the cable samples to the standard values specified by the NIS. This comparison provides a clear indication of how closely the samples adhere to the expected quality benchmarks. Table 3 also itemizes the population mean and standard deviation for the measured conductor resistance values. These statistical metrics provide a broader view of the overall quality and consistency of the cable samples produced in Lagos metropolis.

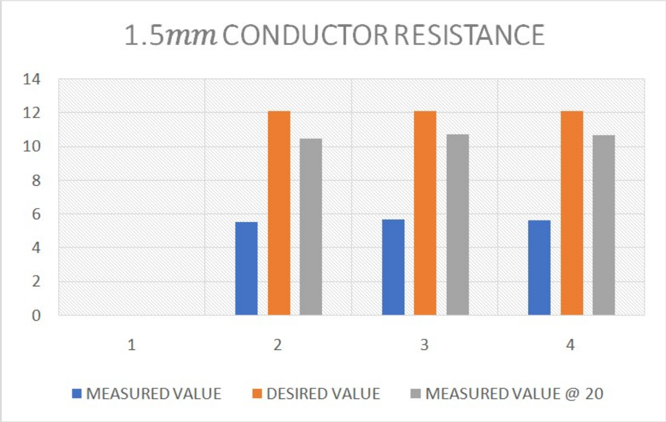

Figure 4. Comparison of the standard and measured conductor resistance for the 1.5mm^2 cable

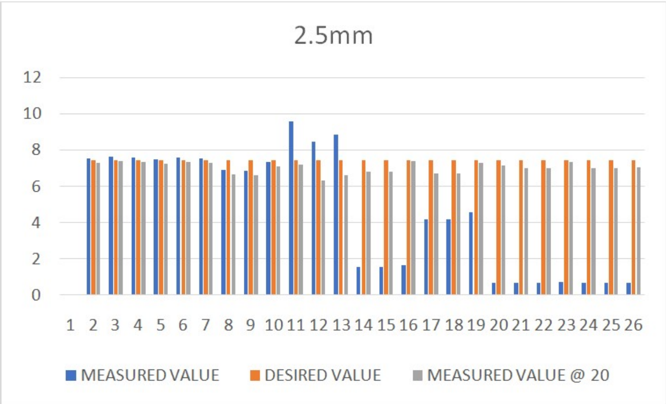

Figure 5. Comparison of the standard and measured conductor resistance for the 2.5mm^2 cable

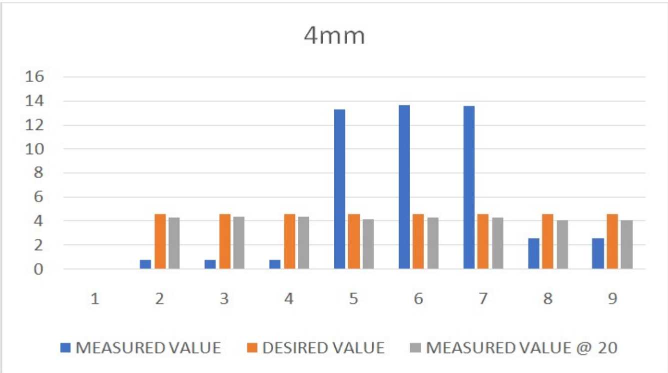

Figure 6. Comparison of the standard and measured conductor resistance for the 4mm^2 cable

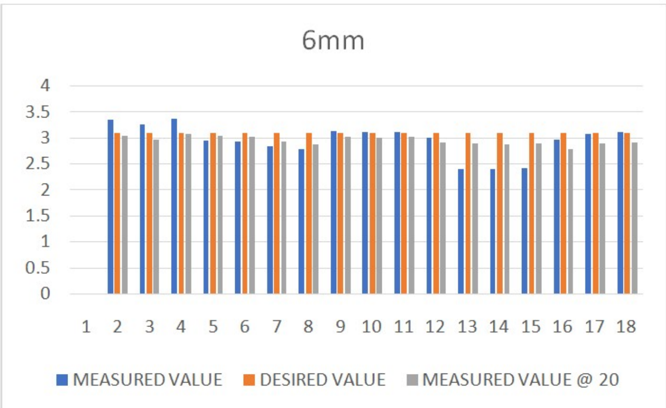

Figure 7. Comparison of the standard and measured conductor resistance for the 6mm^2 cable

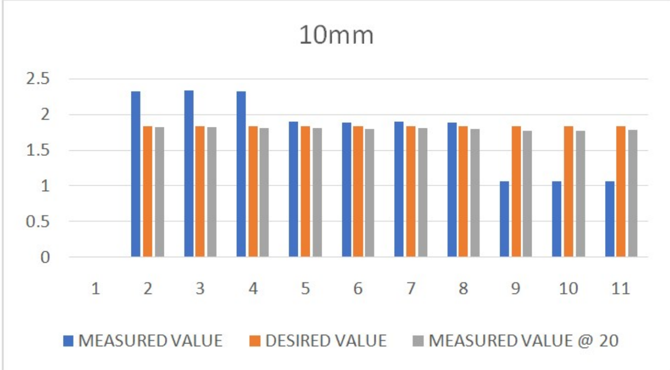

Figure 8. Comparison of the standard and measured conductor resistance for the 10mm^2 cable

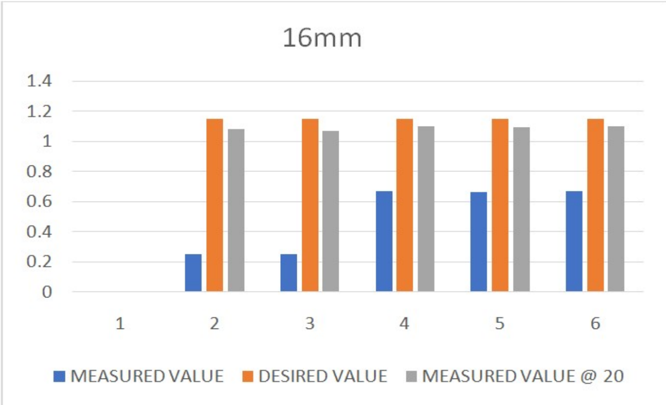

Figure 9. Comparison of the standard and measured conductor resistance for the 16mm^2 cable

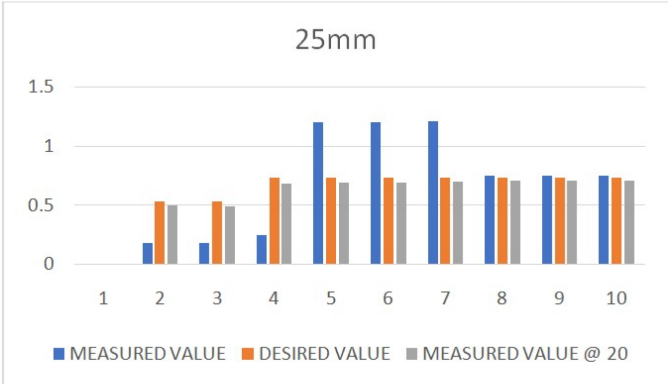

Figure 10. Comparison of the standard and measured conductor resistance for the 25mm^2 cable

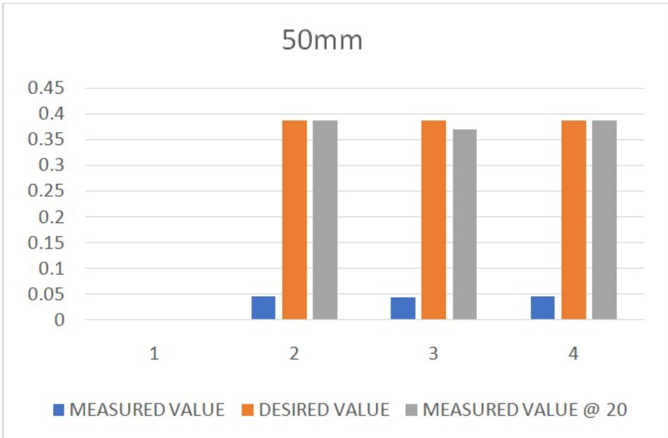

Figure 11. Comparison of the standard and measured conductor resistance for the 50mm^2 cable

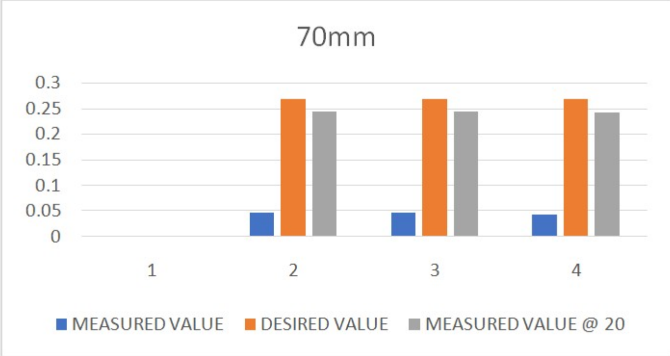

Figure 12. Comparison of the standard and measured conductor resistance for the 70mm^2 cable

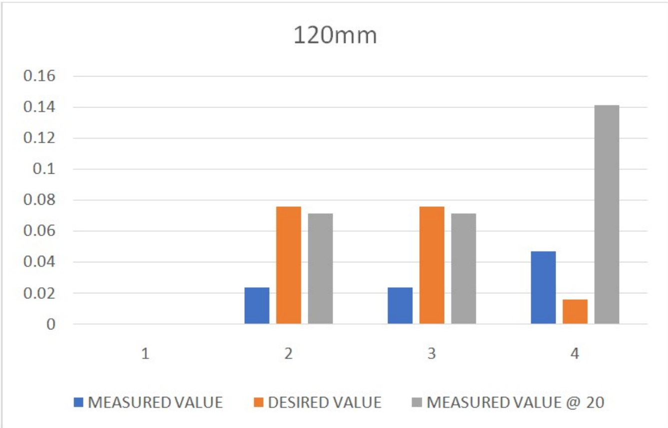

Figure 13. Comparison of the standard and measured conductor resistance for the 95mm^2 cable

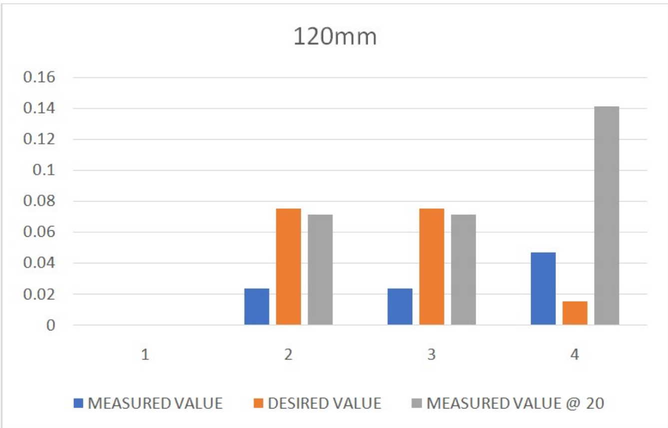

Figure 14. Comparison of the standard and measured conductor resistance for the 120mm^2 cable

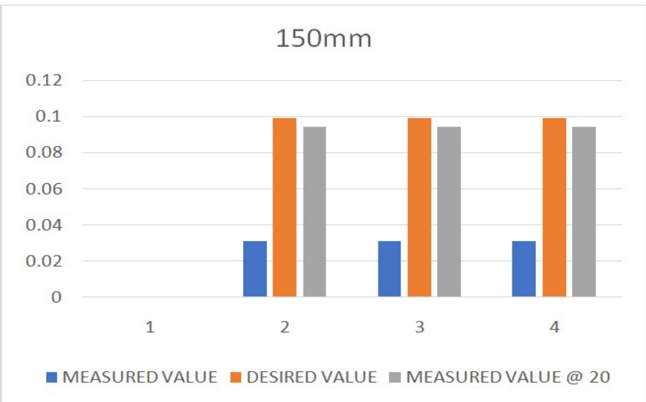

Figure 15. Comparison of the standard and measured conductor resistance for the 150mm^2 cable

Due to the limited samples of some cable size, the t-distribution statistical approach was used in testing for the quality of the cable samples at 90% and 95% confidence levels. Since quality of a product is a measure of its population mean, thus t-distribution is used to predict the population mean from sample mean.

For 1.5mm^2 cable size

$$\sum X = 31.85 \quad (1a)$$

$$\sum /X - \bar{X}/ = 0.33334 \quad (2a)$$

$$\bar{X} = \frac{\sum X}{n} = 10.61667 \quad (3a)$$

$$S = \sqrt{\frac{\sum /X - \bar{X}/^2}{n-1}} = 0.12229 \quad (4a)$$

At 95% confidence level $1 - \alpha = 1 - 0.95 = 0.05$, and $\frac{\alpha}{2} = 0.025$, where: t0.05 = 0.7965. Population mean is 10.46 ≤ μ ≤ 10.63Ω. Similarly for 90% confidence, population mean 10.48Ω ≤ μ ≤ 10.61Ω.

For 2.5mm^2 cable size

$$\sum X = 264.8 \quad (1b)$$

$$\sum /X - \bar{X}/ = 8.48 \quad (2b)$$

$$\bar{X} = \frac{\sum X}{n} = 6.9684 \quad (3b)$$

$$S = \sqrt{\frac{\sum /X - \bar{X}/^2}{n-1}} = 0.2596 \quad (4b)$$

At 95% confidence level $1 - \alpha = 1 - 0.95 = 0.05$, and $\frac{\alpha}{2} = 0.025$, where: t0.05 = 2.015. Population mean is 6.38 ≤ μ ≤ 7.25Ω. Similarly for 90% confidence, population mean 6.40Ω ≤ μ ≤ 7.30Ω.

For 4mm^2 cable size

$$\sum X = 33.93 \quad (1c)$$

$$\sum /X - \bar{X}/ = 0.73 \quad (2c)$$

$$\bar{X} = \frac{\sum X}{n} = 4.24 \quad (3c)$$

$$S = \sqrt{\frac{\sum /X - \bar{X}/^2}{n-1}} = 0.1012 \quad (4c)$$

At 95% confidence level $1 - \alpha = 1 - 0.95 = 0.05$, and $\frac{\alpha}{2} = 0.025$, where: t0.05 = 2.015. Population mean is 4.72.000 ≤ μ ≤ 4.23Ω. Similarly for 90% confidence, population mean 4.86Ω ≤ μ ≤ 4.34Ω.

For 6mm^2 cable size

$$\sum X = 50.06 \quad (1d)$$

$$\sum /X - \bar{X}/ = 1.1647 \quad (2d)$$

$$\bar{X} = \frac{\sum X}{n} = 2.9447 \quad (3d)$$

$$S = \sqrt{\frac{\sum /X - \bar{X}/^2}{n-1}} = 0.07716 \quad (4d)$$

At 95% confidence level $1 - \alpha = 1 - 0.95 = 0.05$, and $\frac{\alpha}{2} = 0.025$, where: t0.05 = 2.015. Population mean is 2.78 ≤ μ ≤ 3.26Ω. Similarly for 90% confidence, population mean 2.84Ω ≤ μ ≤ 3.49Ω.

For 10mm^2 cable size

$$\sum X = 17.98 \tag{1e}$$

$$\sum /X - \bar{X}/ = 0.068 \tag{2e}$$

$$\bar{X} = \frac{\sum X}{n} = 1.798 \tag{3e}$$

$$S = \sqrt{\frac{\sum /X - \bar{X}/^2}{n-1}} = 0.017748 \tag{4e}$$

At 95% confidence level $1 - \alpha = 1 - 0.95 = 0.05$, and $\frac{\alpha}{2} = 0.025$, where: t0.05 = 2.015. Population mean is 1.75 ≤ μ ≤ 1.80Ω. Similarly for 90% confidence, population mean 1.77Ω ≤ μ ≤ 1.81Ω.

For 16mm^2 cable size

$$\sum X = 5.44 \tag{1f}$$

$$\sum /X - \bar{X}/ = 0.052 \tag{2f}$$

$$\bar{X} = \frac{\sum X}{n} = 1.088 \tag{3f}$$

$$S = \sqrt{\frac{\sum /X - \bar{X}/^2}{n-1}} = 0.011662 \tag{4f}$$

At 95% confidence level $1 - \alpha = 1 - 0.95 = 0.05$, and $\frac{\alpha}{2} = 0.025$, where: t0.05 = 2.015. Population mean is 0.967 ≤ μ ≤ 1.05Ω. Similarly, for 90% confidence, population mean 0.985Ω ≤ μ ≤ 1.098Ω.

For 25mm^2 cable size

$$\sum X = 5.838 \tag{1g}$$

$$\sum /X - \bar{X}/ = 1.0305 \tag{2g}$$

$$\bar{X} = \frac{\sum X}{n} = 0.6487 \tag{3g}$$

$$S = \sqrt{\frac{\sum /X - \bar{X}/^2}{n-1}} = 0.17337 \tag{4g}$$

At 95% confidence level $1 - \alpha = 1 - 0.95 = 0.05$, and $\frac{\alpha}{2} = 0.025$, where: t0.05 = 2.015. Population mean is 0.637 ≤ μ ≤ 0.690Ω. Similarly, for 90% confidence, population mean 0.640Ω ≤ μ ≤ 0.6950Ω.

For 50mm^2 cable size

$$\sum X = 1.51 \tag{1h}$$

$$\sum /X - \bar{X}/ = 0.159 \tag{2h}$$

$$\bar{X} = \frac{\sum X}{n} = 0.3775 \tag{3h}$$

$$S = \sqrt{\frac{\sum /X - \bar{X}/^2}{n-1}} = 0.0406 \tag{4h}$$

At 95% confidence level $1 - \alpha = 1 - 0.95 = 0.05$, and $\frac{\alpha}{2} = 0.025$, where: t0.05 = 2.015. Population mean is 0.368 ≤ μ ≤ 0.380Ω. Similarly, for 90% confidence, population mean 0.37Ω ≤ μ ≤ 0.385Ω.

For 70mm^2 cable size

$$\sum X = 0.728 \tag{1i}$$

$$\sum /X - \bar{X}/ = 0.00043 \tag{2i}$$

$$\bar{X} = \frac{\sum X}{n} = 0.2427 \tag{3i}$$

$$S = \sqrt{\frac{\sum /X - \bar{X}/^2}{n-1}} = 0.000473 \tag{4i}$$

At 95% confidence level $1 - \alpha = 1 - 0.95 = 0.05$, and $\frac{\alpha}{2} = 0.025$, where: t0.05 = 2.015. Population mean is 0.222 ≤ μ ≤ 0.24Ω. Similarly, for 90% confidence, population mean 0.228Ω ≤ μ ≤ 0.239Ω.

For 95mm^2 cable size

$$\sum X = 0.556 \tag{1j}$$

$$\sum /X - \bar{X}/ = 0.0433 \tag{2j}$$

$$\bar{X} = \frac{\sum X}{n} = 0.185 \tag{3j}$$

$$S = \sqrt{\frac{\sum /X - \bar{X}/^2}{n-1}} = 0.021 \tag{4j}$$

At 95% confidence level $1 - \alpha = 1 - 0.95 = 0.05$, and $\frac{\alpha}{2} = 0.025$, where: t0.05 = 2.015. Population mean is 0.183 ≤ μ ≤ 0.1859Ω. Similarly, for 90% confidence, population mean 0.182Ω ≤ μ ≤ 0.187Ω.

For 120mm^2 cable size

$$\sum X = 0.2436 \tag{1k}$$

$$\sum /X - \bar{X}/ = 0.0929 \tag{2k}$$

$$\bar{X} = \frac{\sum X}{n} = 0.0945 \tag{3k}$$

$$S = \sqrt{\frac{\sum /X - \bar{X}/^2}{n-1}} = 0.03286 \tag{4k}$$

At 95% confidence level$1 - \alpha = 1 - 0.95 = 0.05$, and $\frac{\alpha}{2} = 0.025$, where: t0.05 = 2.015. Population mean is 0.069 ≤ μ ≤ 0.142Ω. Similarly, for 90% confidence, population mean 0.702 ≤ μ ≤ 0.143Ω.

Table 3. Result summary compared with standard and computed standard deviation

Cable Size (mm^2)	Conductor Resistance (Ω) at Room Temperature	NIS Standard for Conductor Resistance (Ω)	Conductor Resistance (Ω) at 20℃	$/X - \bar{X}/$	$/X - \bar{X}/^2$	Standard Deviation	Population Mean of Resistance (Ω) at 95% Confidence
1.5	5.531	12.1	10.45	0.16667	0.027778	0.12229	10.46 ≤ μ ≤ 10.63
	5.684	12.1	10.74	0.123333	0.015211		
	5.644	12.1	10.66	0.043333	0.001878		
			31.85	0.333337	0.044868		
2.5	7.593	7.41	7.35	0.341579	0.116676	0.2596	6.38 ≤ μ ≤ 7.25Ω
	7.550	7.41	7.31	0.411579	0.169397		
	7.622	7.41	7.38	0.371579	0.138071		
	7.581	7.41	7.34	0.271579	0.073755		
	7.477	7.41	7.24	0.351579	0.123608		
	7.564	7.41	7.32	0.321579	0.103413		
	7.532	7.41	7.29	0.298421	0.089055		
	6.879	7.41	6.67	0.338421	0.114529		
	6.844	7.41	6.63	0.141579	0.020045		
	7.342	7.41	7.11	0.201579	0.040634		
	9.559	7.41	7.17	0.638421	0.407581		
	8.443	7.41	6.33	0.338421	0.114529		
	8.832	7.41	6.63	0.158421	0.025097		
	1.534	7.41	6.81	0.148421	0.022029		
	1.536	7.41	6.82	0.421579	0.177729		
	1.664	7.41	7.39	0.258421	0.066781		
	4.197	7.41	6.71	0.248421	0.061713		
	4.200	7.41	6.72	0.311579	0.097081		
	4.552	7.41	7.28	0.151579	0.022976		
	0.697	7.41	7.12	0.011579	0.000134		
	0.683	7.41	6.98	0.011579	0.000134		
	0.683	7.41	6.98	0.391579	0.153334		
	0.720	7.41	7.36	0.031579	0.000997		
	0.685	7.41	7.00	0.051579	0.00266		
	0.687	7.41	7.02	0.061579	0.003792		
	0.688	7.41	7.03	0.101579	0.010318		
	2.875	7.41	7.07	0.118421	0.014024		
	2.784	7.41	6.85	0.118421	0.014024		
	2.787	7.41	6.85	0.281579	0.079287		
	2.950	7.41	7.25	0.118421	0.014024		
	2.787	7.41	6.85	0.098421	0.009687		
	2.794	7.41	6.87	0.098421	0.009687		
	2.795	7.41	6.87	0.218421	0.047708		
	3.474	7.41	6.75	0.208421	0.043439		
	3.477	7.41	6.76	0.208421	0.043439		
	3.477	7.41	6.76	0.208421	0.043439		
	3.464	7.41	6.76	0.208421	0.043439		
	3.465	7.41	6.76	0.208421	0.043439		
	3.466	7.41	6.76	0.341579	0.116676		
			264.8	8.48	2.561705		
4.0	0.786	4.61	4.30	0.05	0.0025	0.1012	4.72 ≤ μ ≤ 4.23Ω
	0.784	4.61	4.29	0.11	0.0121		
	0.796	4.61	4.35	0.13	0.0169		
	0.800	4.61	4.37	0.07	0.0049		
	13.276	4.61	4.17	0.05	0.0025		
	13.665	4.61	4.29	0.03	0.0009		
	13.594	4.61	4.27	0.14	0.0196		
	2.575	4.61	4.10	0.15	0.0225		
	2.570	4.61	4.09	0.05	0.0025		
			33.93	0.73	0.0819		
6.0	3.360	3.08	3.06	0.0953	0.009082	0.07716	2.78 ≤ μ ≤ 3.26Ω
	3.334	3.08	3.04	0.0153	0.000234		
	3.249	3.08	2.96	0.1153	0.013294		
	3.360	3.08	3.06	0.0853	0.007276		
	2.936	3.08	3.03	0.0653	0.004264		
	2.922	3.08	3.01	0.0147	0.000216		
	2.839	3.08	2.93	0.0847	0.007174		
	2.775	3.08	2.86	0.0753	0.00567		
	3.120	3.08	3.02	0.0553	0.003058		
	3.098	3.08	3.00	0.0753	0.00567		
	3.114	3.08	3.02	0.0347	0.001204		
	3.000	3.08	2.91	0.0647	0.004186		
	2.399	3.08	2.88	0.0747	0.00558		
	2.391	3.08	2.87	0.0547	0.002992		
	2.412	3.08	2.89	0.1647	0.027126		
	2.959	3.08	2.78	0.0547	0.002992		
	3.075	3.08	2.89	0.0347	0.001204		
	3.096	3.08	2.91	0.0953	0.009082		
			50.06	1.1647	0.101224		

………………Continue

10.0	2.317	1.83	1.81	0.022	0.000484	0.017748	1.75 ≤ μ ≤ 1.80Ω
	2.323	1.83	1.82	0.022	0.000484		
	2.334	1.83	1.82	0.012	0.000144		
	2.316	1.83	1.81	0.012	0.000144		
			17.98	0.068	0.00126		
16.0	1.903	1.83	1.81	0.008	0.000064	0.011662	0.967 ≤ μ ≤ 1.05Ω
	1.889	1.83	1.80	0.018	0.000324		
	1.903	1.83	1.81	0.012	0.000144		
	1.885	1.83	1.79	0.002	0.000004		
	1.062	1.83	1.77	0.012	0.000144		
			5.44	0.052	0.00068		
25.0	0.173	0.524	0.487	0.3537	0.125104	0.17337	0.637 ≤ μ ≤ 0.690Ω
	0.176	0.524	0.495	0.3617	0.130827		
	0.173	0.524	0.487	0.0293	0.000858		
	0.241	0.727	0.678	0.0423	0.001789		
	1.201	0.727	0.691	0.0413	0.001706		
	1.199	0.727	0.690	0.0473	0.002237		
	1.209	0.727	0.696	0.0523	0.002735		
	0.746	0.727	0.701	0.0513	0.002632		
	0.745	0.727	0.700	0.0513	0.002632		
	0.745	0.727	0.700	0.3537	0.125104		
			5.838	1.0305	0.2705		
50.0	0.0442	0.387	0.377	0.04825	0.002328	0.04062	0.368 ≤ μ ≤ 0.380Ω
	0.0452	0.387	0.386	0.03125	0.000977		
	0.0432	0.387	0.369	0.04825	0.002328		
			1.51	0.159	0.0066		
70.0	0.0460	0.268	0.285	0.042	0.00176	0.021	0.222 ≤ μ ≤ 0.24Ω
	0.0474	0.268	0.243	0.0003	9E-08		
	0.0474	0.268	0.243	0.0003	9E-08		
	0.0423	0.268	0.242	0.0007	4.9E-07		
			0.728	0.0433	0.001765		
95.0	0.0043	0.193	0.188	0.001	0.000001	0.000725	0.183 ≤ μ ≤ 0.1859Ω
	0.0042	0.193	0.184	0.003	9E-06		
	0.0043	0.193	0.188	0.001	0.000001		
	0.0042	0.193	0.184	0.003	9E-06		
			0.556	0.008	0.0000021		
120.0	0.0236	0.0754	0.0713	0.0232	0.000538	0.03286	0.069 ≤ μ ≤ 0.142Ω
	0.0236	0.0754	0.0713	0.0232	0.000538		
	0.0236	0.0754	0.0713	0.0465	0.002162		
			0.2836	0.0929	0.00324		

CONCLUSION

This study applied t-distribution statistical analysis to evaluate the quality of electrical cables produced in Lagos, Nigeria, with a focus on the standard conductor resistance and sample resistance. The primary objective was to determine the conformity of the cables to established standards and identify areas for improvement in the production process. After having gathered data, the sample data were able to estimate the population mean and standard deviation. These metrics was employed in evaluating the level of compliance of the sample resistance values obtained against the NIS/IEC standard resistance of the cable sizes. Since the t-tests were conducted at two different confidence levels: 90% and 95%, the statistical analysis of the quality of the cables was sound. The findings from the outcome of the cable samples manufactured in Lagos metropolis indicated that the overall resistance values complied with the laid down industry requirements. This means that quality assurance and quality control policies implemented in the production of the company's products are adequate in guaranteeing quality, reliability and safety of the products. The t-tests confirmed adherence of the sample resistances to the population mean on which cable samples with considerable deviations were flagged. Regarding the conformity measurements, an average of 4 was obtained, which would mean that some deviation in the values of resistance was detected. Such variations indicate areas that might be improving to enhance the standardization and quality utilized in the manufacturing line. Cable manufacturing industries in Lagos have good compliance with the quality measures in their cable production as depicted in the standard procedures, however, the need to constantly assess and update the manufacturing processes in a bid to meet and improve on the required product quality is important. The strategies of improvement and adopting latest quality control methods can help these factories to firm up their position in the market and offer quality cables, which is the need of the hour for various sectors. Arising from the results presented in this work, the following recommendations are important to further enrich the body of knowledge;

1. Modern technology like artificial intelligence (AI) should be incorporated into cable manufacturing process for continuous monitoring.
2. Automated and artificial intelligence-based system should be incorporated into quality assurance testing.
3. Mechanisms to systematically gather and analyze customer feedback on cable performance and quality are necessary.

Conflict of Interest: No conflict of interest

Authors' Contributions

Author 1: Conceptualization; Author 2: Results interpretation; Author 3: Data analysis; Author 4: Editorial work and manuscript review; Author 5: Proofreading; Author 6: Data collection

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