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THE APPLICATION OF THREE-STAGE NESTED DESIGN IN THE ANALYSIS OF 2023 NATIONAL ASSEMBLY ELECTIONS IN PLATEAU STATE, NIGERIA

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ABSTRACT

This research applies a three-stage nested design to analyze the 2023 National Assembly elections in Plateau State, Nigeria, focusing on the Plateau Central Senatorial district. The design allows investigation of factors at different hierarchical levels, namely Local Government Areas (LGAs), Wards, and Polling Units. Data were retrieved from the Independent National Electoral Commission's (INEC) Result Viewing Portal (IReV). The study aims to compute expected mean squares, estimate effect sizes, and determine the significance of variation between factors. The significance lies in the novel application of nested design in political analysis, offering a comprehensive understanding of electoral dynamics. The research utilizes Minitab for statistical computations, emphasizing the importance of this method in electoral studies. The result indicates significant effects at the Local Government Area (LGA) and Ward levels, emphasizing distinct electoral patterns and the influence of local dynamics. However, no significant differences were observed at the Polling Unit level at 5% significance level, indicating uniform voter behavior within analyzed LGAs and Wards. Variance component analysis reveals substantial contributions of LGAs and Wards to the total variance. Effect size computations show varying impacts of random factors at different nesting levels. Graphical analyses support the validity of statistical assumptions. These findings provide valuable insights for policymakers and electoral researchers, highlighting the importance of localized strategies and data quality improvement efforts for more accurate electoral analyses and informed decision-making. Recommendations include prioritizing localized strategies and continuous efforts to enhance public awareness of electoral processes at the local level.

Key words: Three-Stage Nested Design, 2023 National Assembly Elections, Electoral Analysis.

I. INTRODUCTION

Background of the Study

The method employed for analyzing the 2023 National Assembly elections in Plateau State, Nigeria. Specifically, we will focus on the application of three-stage nested design of experiment. This design allows for the investigation of multiple factors that may influence the election outcomes and provides a robust framework for analyzing the data collected.

A three-stage nested design is a type of experimental or research design that involves multiple levels of nesting or hierarchy. It is commonly used in various fields, including education, political science, medicine, psychology, and agriculture, to study the effects of multiple factors simultaneously. (Douglas C. Montgomery Design and Analysis of experiment 8th Edition).

Elections are a fundamental pillar of democratic societies, serving as a mechanism through which citizens exercise their right to choose their representatives. In 2023, the Plateau Central Senatorial elections in Plateau State, Nigeria, took place against a backdrop of heightened political interest and socio-economic dynamics. This election was marked by a significant level of importance, not only for the people of Plateau Central but also for the broader Nigerian political landscape.

Analyzing the Plateau Central Senatorial elections in 2023 requires a sophisticated and comprehensive approach that goes beyond traditional methods. In this context, the application of a three-stage nested design offers a promising framework to delve into the intricacies of this electoral process. This thesis aims to introduce and employ the three-stage nested design as a novel approach to electoral analysis, particularly focusing on its application in understanding the dynamics of the 2023 Plateau Central Senatorial elections.

The Plateau Central Senatorial district in Plateau State has long been a region of political interest, owing to its diverse demographic, cultural, and economic characteristics. The 2023 elections, held in the aftermath of a series of political realignments and socio-economic challenges, posed significant questions about the preferences and expectations of the electorate. In such a context, traditional election analysis methods might not provide a comprehensive understanding of the factors at play; hence a three-stage nested design analysis was employed.

The Independent National Electoral Commission (INEC) has, in the past decade, been working assiduously to raise the bar of service delivery, in the Nigerian electoral process. Within the period, efforts have been geared towards reviving up the confidence of Nigerians in national elections, by making the processes and procedures more transparent. The organization and conduct of elections, in a challenging environment (such as Nigeria), therefore, require election officials with some depth of professionalism and skills, to meet the expectations of the numerous election stakeholders.

Over the years, there has been a tremendous innovation in the electoral system. The Commission keeps re-tooling, refining and fine-tuning its election processes and procedures, with a view to using modern technology to enhance free, fair, credible and inclusive polls in Nigeria. It has also been a top priority of the Commission to make the Nigerian electoral process knowledge-based, by ensuring training and re-training of its permanent and ad-hoc staff. Thus, regular review of the Manual for Election Officials has been part of the continuous efforts of INEC to keep its staff abreast of the changing face of the electoral process, globally. INEC Regulations and Guidelines for Conduct of Elections 2022 in line with international best practice. Thus, over voting has been redefined in terms of Accredited Voters, and use of Technological Devices in accreditation, voting and management of results have been given legal backing. Recall that in 2019, the Commission reviewed the Voting Procedure to allow for Continuous Accreditation and Voting, to help voters cast their votes with minimal delay and in a less cumbersome manner. This was informed by the desire to make participation in elections more appealing and reduce voting apathy of eligible Nigerians; hence the introduction of the INEC Voter Enrolment Device (IVED) and Bimodal Voter Accreditation System (BVAS) to make the processes seamless. Moreover, Persons with Disability and the vulnerable in the society are also being better accommodated in the electoral process according to their priority status, and introduction of technological innovations in the new arrangement. It is for these reasons and more, that the training and re-training of election personnel has become more compelling to ensure voters exercise their franchise with minimal discomfort. These will enable officials to imbibe the right knowledge, skills and attitude needed for the discharge of credible electoral services, based on the Electoral Law and the Commission's Guidelines.

One of the prominent pillars, supporting and determining the quality of a democracy is the electoral process. That is why Idowu, Anikwe and Asekhamhe (2020) averred that in many nations across the globe, election is the accepted process through which individuals are chosen to represent a people or community in various organs of government.

Egwemi (2014) opines that election as a process under democracy through which people or the electorate exercise their freedom and inalienable right to organize their life and to choose those whom they delegate their rights as representatives.

Similarly, Animashaun (2010) cited in Vande (2017) corroborates that election is a democratic process that provides citizens with the freedom to choose their rulers and to decide on public policy. Under any democratic system, citizens who are legally qualified to exercise franchise are provided with opportunity to choose political alternatives and to make decisions that express their preferences. It is no surprise that modern States regard periodic and regular elections as a core attribute of democracy.

As submitted by Baidoo, Dankwa and Eshun (2018), elections seem to have become a major factor in the stabilization and democratization of emerging democracies. They also maintain that election forms an important pillar that places the power to govern with the people and is a litmus test for democratic institutions. Vande (2017) submit that the sanctity of choice embedded in the modern democratic idea presupposes that the electorate has the latitude to choose those who would govern them in a regular, free, fair and credible electoral process. He further stated that for a legitimate government to rule, the people must have the luxury of choosing their leaders through the processes that meet international good practices. This implies that fraudulent elections fall below the accepted democratic norms, anywhere in the world. Vande (2017) submit that the sanctity of choice embedded in the modern democratic idea presupposes that the electorate has the latitude to choose those who would govern them in a regular, free, fair and credible electoral process. Similarly, Egbo and Uche (2012) in Idowu, Anikwe and Asekhamhe (2020) posit that vote racketeering is any form of financial, material or promissory inducement or reward by a candidate, political party, agent or supporter to influence a voter to cast his or her vote in favour of a given candidate or even abstain from doing so in order to enhance the chances of a particular contestant to win an election. The Independent National Electoral Commission (INEC) has scheduled the election to hold on the 25th, February 2023 across the 36 states of the nation including the Federal Capital Territory (FCT) Abuja.

II. STATEMENT OF THE PROBLEM

Many data in real life, such as medicine, enrolments, agriculture, elections etc have special structure that conform either to nested balance or unbalance nested designs. Ogoke etal (2021) were able to apply a three-stage balanced nested design in the field of medical science and used the ANOVA table results to test significance of factors and also test the variance components. Variance component for each factor gives an estimate of the amount of variation caused by that factor to the overall variance (variability) of the data set. The variance components are expressed in simple percentage in other to show their contribution (to the variability) more apparently. This work was not able to estimate the amount of effect size contributed by each factor to the data structure. In this work we intend to apply a three-stage nested design in political field, estimate the amount of effect size contributed by each factor to the data structure. This will further be tested using the total number accredited voters and the total number of votes cast during the 2023 National Assembly elections in Plateau State, Nigeria.

III. AIM AND OBJECTIVES OF THE STUDY

The main aim of this research is to apply a three-stage nested design in the analysis of 2023 Plateau Central Senatorial elections. Towards achieving this aim the following three objectives were obtained:

1. Application of three-stage nested design in political field and compute expected mean squares.
2. To estimate the amount of effect size contributed by each factor to the outcome of the election.
3. To determine the significance or insignificance of variation between factors: A, B(A) and C(B)

IV. SIGNIFICANCE OF THE STUDY

Although many data in real life situation in areas such as agriculture, medicine, and democratic set up etc. have data structure that conforms to the nested structure. Nested design has shown relevance in the society as far back as three decades ago. In 1990 Anderson discusses the misleading effect of using a one-way ANOVA in medical science instead of nested ANOVA when nested ANOVA is more appropriate in his classical compilation of methodological errors in Ogoke Uchenna Petronilla (2021). Kroodma et al (2001) advocated the use of nested anova to avoid problem of pseudo replication in analyzing of playback experiments. In 2008 German et al. applied the nested design to conquer the prevalent issue of pseudo replication leading to wrong degree of freedom in the measuring of Electromyographic (EMG) signal. However, the importance of nested design cannot be overemphasized, hence the researchers saw the need to apply the three-stage nested design of experiment in the analysis of 2023 National Assembly elections in the Central Senatorial District of Plateau State, Nigeria.

V. SCOPE AND LIMITATION

The generalizability of the findings will be limited to Plateau State and may not be applicable to other States or regions in Nigeria. Additionally, the study relied on data from the INEC Result Viewing Portal (IReV) which is a platform created by the Independent National Electoral Commission (INEC) in Nigeria to provide real-time transmission of election results from polling units to the central collation centre, which may be subject to response bias or misrepresentation. This research will be conducted using the Senatorial election results in Plateau Central Senatorial District of Plateau State Nigeria, on the application of three-stage nested design of experiment in the 2023 National Assembly elections. However, there are many statistical packages for data analysis, but for the sake of this research the researchers adopted Minitab Statistical package for computations.

VI. ASSUMPTIONS ASSOCIATED WITH A THREE-STAGE NESTED DESIGN

Independence: One of the fundamental assumptions in any experimental design is that observations within each level of nesting are independent of each other. This means that the outcome or response variable for one subject or unit does not depend on the outcome for another subject or unit within the same level of nesting.

Homogeneity of variance: Another important assumption is that the variances of the response variable are approximately equal across all levels of nesting. This assumption is known as homoscedasticity and ensures that the variability in the response variable is roughly constant.

Normality: It is assumed that the distribution of the response variable is approximately normal (follows a bell-shaped curve) within each level of nesting. Normality is important for statistical tests and inference, such as analysis of variance (ANOVA), which is commonly used in nested designs.

Random sampling: Researchers typically assume that the subjects or units at each level of nesting are selected through random sampling or that the sampling process is unbiased. This assumption helps to reduce the potential for bias in the estimates of treatment effects.

Independence of error terms: In a three-stage nested design, there are often multiple sources of variability, including variability between the highest level of nesting, intermediate levels, and within the lowest level (individual subjects or units). It is assumed that the error terms (residuals) associated with these sources of variability are independent of each other.

Linearity: It is assumed that the relationships between the independent variables (factors or treatments) and the response variable are approximately linear. This assumption is important when conducting regression analysis or ANOVA.

Absence of multicollinearity: If the design includes multiple independent variables or factors, it is assumed that these variables are not highly correlated with each other (i.e., there is minimal multicollinearity). High multicollinearity can make it difficult to interpret the individual effects of each factor.

Randomization: The allocation of treatments or factors to different levels of nesting is typically done through randomization to ensure that the results are not biased by systematic factors.

DEFINATION OF TERMS

Two-stage nested design of experiment: It is an experiment design framework that involves nesting one experimental design within another. In the context of election analysis, it refers to a research approach where multiple factors influencing election outcomes are examined in a hierarchical manner, taking into account various levels of variables.

Experiment: A careful design procedure conducted to collect data and test hypothesis. In election analysis, an experiment can involve manipulating or observing variables to understand their impact on election outcomes.

Analysis: The process of examining and interpreting data to draw meaningful conclusions.

2023 National Assembly elections: The upcoming elections scheduled for the year 2023 in Nigeria, where voters will elect Senators of the National Assembly.

Plateau State, Nigeria: A state in Nigeria, located in the central part of the country. Plateau State is known for its diverse ethnic and religious composition and has a significant political impact on the national level.

Factors: Variables or characteristics that have the potential to influence election outcomes. These factors can include voter demographics, political party affiliations, candidate profiles, campaign strategies, regional dynamics and other relevant variables.

Nested design: A design where one experimental design is nested within another.

VII. LITERATURE REVIEW

Many data in real life, such as medicine, enrolments, agriculture, elections etc have special structure that conform either to nested balance or unbalance nested designs. Ogoke etal (2021) were able to apply a three-stage balanced nested design in the field of medical science and used the ANOVA table results to test significance of factors and also test the variance components. Variance component for each factor gives an estimate of the amount of variation caused by that factor to the overall variance (variability) of the data set. The variance components are expressed in simple percentage in other to show their contribution (to the variability) more apparently. This work was not able to estimate the amount of effect size contributed by each factor to the data structure, and unable to carry out test on residual analysis.

The 2023 National Assembly Elections in Plateau State, Nigeria, stand as a critical event within the country's political landscape, with implications that extend far beyond the regional boundaries. As a dynamic and culturally diverse state in Nigeria, Plateau State has historically been a focal point of political discourse, often characterized by complex and multifaceted electoral dynamics. In light of this context, the application of the three-stage nested design offers a unique and comprehensive framework for analyzing the intricacies of the electoral process, providing an in-depth understanding of the various factors influencing voter behavior and election outcomes.

The literature surrounding the application of the three-stage nested design in the context of political analysis has grown significantly in recent years, with scholars and researchers recognizing its efficacy in dissecting the interplay of individual, local, and regional factors shaping electoral results. This methodology allows for a nuanced exploration of the micro-level interactions between voters and candidates, the meso-level dynamics within specific constituencies, and the macro-level influences that extend to the broader political landscape.

Prior studies employing the three-stage nested design in electoral analysis have underscored its capacity to uncover the complex relationships between socioeconomic factors, political affiliations, and voting patterns, providing valuable insights into the underlying mechanisms that determine electoral outcomes. By examining the application of this design in various political contexts, scholars have highlighted its adaptability and versatility, emphasizing its potential to reveal nuanced patterns that might otherwise remain concealed by conventional analytical approaches.

Moreover, the literature has emphasized the significance of incorporating qualitative and quantitative research methodologies within the framework of the three-stage nested design, enabling a comprehensive investigation that accounts for both the subjective experiences of voters and the objective data pertaining to electoral processes. This interdisciplinary approach has proven instrumental in capturing the intricacies of political behavior, offering a holistic perspective that goes beyond mere statistical analysis to encompass the broader social, cultural, and historical dimensions that shape the electoral landscape.

By delving into the existing literature on the application of the three-stage nested design in political analysis, this study aims to contribute to the growing body of knowledge concerning the 2023 National Assembly Elections in Plateau State, Nigeria. Through an exploration of the various scholarly perspectives and empirical findings, this research endeavors to provide a comprehensive understanding of the complexities inherent in the electoral process, shedding light on the underlying factors that informed voter choices and ultimately influenced the outcome of the elections in this critical Nigerian state.

U. Ogoke (May, 2021), a new statistical trend in medical research-nested design. This research is unlike many others in that the concept of the nested design is applied in the medical science as against the trend in the agricultural and social sciences. In this research, we consider a three-stage (2 × 5 × 2) nested design with the factors being Hospital Centre, Days of the week and Ailments such that the days of the week are nested within the centers and the ailments are nested within the days. The replications represent the weight of twelve (12) patients selected randomly for each day in each centre which brings the total number of replications to 240. This work being largely an illustration uses simulated data. Analyses of variance (ANOVA) for the sum of squares across all factors and within replicates were investigated for significance. Results obtained reveal that the days and ailments are significant factors in the experiment at 5% significant level.

W. Xue et al (September, 2022), exact settling performance design for CMOS three-stage nested miller-compensated amplifier. A method of the exact settling performance-driven design of three-stage nested-miller-compensated CMOS is proposed. With the user-specified settling time at a certain accuracy level, this method finds the optimal solution by a two stage strategy, where the parameters of the compensation network are first solved from the equations formulated based on the minimal settling condition, and then the trasconductance of the last stage is adjusted automatically according to the targeted settling time.. the accuracy of the method is guaranteed by the use of the SPICE simulation of the settling waveform in the entire procedure.

M.T. Obinna et al (March, 2022), Automation of Balanced Nested Design; NeDPy was aimed at developing a user friendly statistical package (NeDPy) that can be used to analyse experiment that has nested factor(s). NeDPy was coined from "Nested Design Python" and was developed using python programming language. Python modules like NumPy, Scipy, Matplotlib, Tkinter etc. was used to develop a user-friendly app with GUI (graphical user interface) that can analyze a two-stage and three-stage nested design to produce all relevant information. These include, indicating significant factor(s), creating ANOVA table, giving estimate for model and variance component, descriptive analysis, generating the residuals of the data set, drawing diagnostic plots like normal probability plot, box plot etc. NeDPy was used to solve problems from some cited sources where the problem has been solved both manually and using some trusted software. Some important results were compared and found to be identical. This validates NeDPy and makes it a recommendable statistical package for analyzing nested design.

Parvaneh Mehdizadeh (2021) A two-stage approach for joint modeling of longitudinal measurements and competing risks data. Proposed a two-stage method for joint modeling of longitudinal measurements and competing risks (JMLC) data based on the full likelihood approach via the conditional EM (CEM) algorithm. In the first stage, a linear mixed effect model is used to estimate the parameters of the longidudinal sub-model. In the second stage, we consider a cause-specific sub-model to construct competing risk data and describe an approximation for the joint log-likelihood that uses the estimated parameters of the first stage. We express the result of a simulation study and perform this method the "standard and new anti-epileptic drugs" trial to check the effect of drug assaying on the treatment effects of lamotrigine and carbamazephine through treatment failure.

M. Hardy et al (November 2022) worked on two-stage nested simulation of tail risk measurement a likelihood ratio approach. They used nested simulation method to incorporate complex models, though computationally highly burdensome. They proposed and analyze a two-stage simulation procedure that efficiently estimates the conditional tail expectation of cost of a dynamic hedging program for a variable Annuity Guaranteed Minimum Withdrawal Benefit (GMWB), under a multi-period nested simulation. In each of the two stages, the method re-uses the same set of inner level simulation paths for each outer scenario at each time point, using a likelihood ratio method to re-weight the probabilities of each individual path for the different outer scenarios. Their numerical study shows that, two-stage and likelihood ratio weighted procedure can offer a very significant improvement in efficiency, of the order of 95% as measured by the RMSE, compared with a standard nested simulation with the same computational cost.

S.W Cheng et al (March, 2022), a two-stage design for experiments with sliding levels. Design of experiments with related factors can be implemented by using the technique of sliding levels. In a sliding-level experiment, the desirable experimental region is irregular. Taguchi (1987) proposed an analysis strategy by re-centering and re-scaling the slid factor. Hamada and Wu (1995) showed by counter example that in many cases the interactions cannot be completely eliminated by Taguchi's strategy. They proposed an alternative method in which the slid factor is modeled by nested effects. These works implicitly assume that the irregular shape of the experimental region is known before hand. In practice, we often encounter sliding-level experiments whose desirable regions are unknown. We propose a two-stage design for such experiments.

S. Yasiu et al (January 2018), D-Optimal three stage unbalanced nested designs for the determination of measurement precision. They used variance component to measure the precision of results of random effect models. The measurement results were statistically modeled by nested designs. Although balanced nested designs are widely used staggered nested designs, which are one type of unbalanced nested designs, have the statistical advantage that the degree of freedom in all stages except for the top stage are equal. Thus, balanced nested designs do not necessarily have a better performance from the statistical point of view. In this study, D-Optimal designs are identified in general nested designs that include both balance and unbalanced designs and consider the practical feasibility of collaborative assessment experiments as well.

E.S. Lieberman (August 2002), Nested Analysis as a Mixed-Method Strategy for Comparative Research. This paper details a unified approach which joins intensive case-study analysis with statistical analysis. Not only are the advantages of each approach combined, but also there is a synergistic value to the nested research design: for example, statistical analyses can guide case selection for in-depth research, provide direction for more focused case studies and comparisons, and be used to provide additional tests of hypotheses generated from small-N research. Small-N analyses can be used to assess the plausibility of observed statistical relationships between variables, to generate theoretical insights from outlier and other cases, and to develop better measurement strategies. This integrated strategy improves the prospects of making valid causal inferences in cross-national and other forms of comparative research by drawing on the distinct strengths of two important approaches.

Martin Krzywinski (October, 2014), Many studies are affected by random-noise sources that naturally fall into a hierarchy, such as the biological variation among animals, tissues and cells, or technical variation such as measurement error. With a nested approach, the variation introduced at each hierarchy layer is assessed relative to the layer below it. We can use the relative noise contribution of each layer to optimally allocate experimental resources using nested analysis of variance (ANOVA), which generally addresses replication and blocking. Recall that factors are independent variables whose values we control and wish to study3 and which have systematic effects on the response. Noise limits our ability to detect effects, but known noise sources (e.g., cell culture) can be mitigated if used as blocking factors. We can model the contribution of each blocking factor to the overall variability, isolate it and increase power. Statisticians distinguish between fixed factors, typically treatments, and random factors, such as blocks.

D. Oyewola et al (March, 2023), Optimizing sentiment analysis of Nigerian 2023 Presidential election using two-stage residual long short term memory. Sentiment analysis is the process of recognizing positive or negative attitudes in text. This technique makes use of computational linguistics, text analysis, and natural language processing. The 2023 presidential election in Nigeria is a significant event for the country, as it will determine the leader of the nation for the next four years. As such, it is important to understand the sentiment of the public towards the different candidates. In this research, we aimed to understand the sentiment of the public towards the three main candidates in the 2023 presidential election in Nigeria, Atiku, Tinubu, and Obi, by conducting a sentiment analysis on tweets related to the candidates. We used the long short-term memory (LSTM), peephole long short term memory (PLSTM), and two-stage residual long short-term memory (TSRLSTM) models to classify tweets as positive, neutral, or negative. Our dataset consisted of a large number of tweets that were preprocessed to remove noise and irrelevant information. Results showed that TSRLSTM performed excellently well in classifying the tweets and in identifying the sentiment towards each candidate individually. Our findings provide valuable insights into the public's opinion on the candidates and their campaign strategies, which can be useful for researchers, political analysts, and decision-makers. Our study highlights the importance of sentiment analysis in understanding public opinion and its potential applications in the field of political science.

A.K Wagner (October, 2006), Modeling voter choice to predict the final outcome of two-stage elections. Most election forecasting research to date has been conducted in the context of single-round elections. However, more than 40 countries in the world employ a two-stage process, where actual voting data are available between the first and the second rounds to help politicians understand their position in relation to each other and to voter preferences and to help them predict the final outcome of the election. In this study we take advantage of the theoretical foundation on voter behavior from the political science literature and the recent methodological advances in choice modeling to develop a Nested Logit Factor Model of voter choice which we use to predict the final outcome of two stage elections and gain insights about the underlying political landscape. We apply the proposed model to data from the first stage and predict the final outcome of two stage elections based on the inferences made from the first stage results. We demonstrate how our proposed model can help politicians understand their competitive position immediately after the first round of actual voting and test its predictive accuracy in the run-off election across 11 different state governorship elections.

P. Goose et al (2019) Optimal Experimental Design in the Presence of Nested Factors. The investigator compared two machines but also wants to understand the effect of flipping the switch. The main effect of the switch is conditional on the machine. This article describes several example situations involving branching factors and nested factors. We provide a model that is sensible for each situation, present a general method for constructing appropriate models, and show how to generate optimal designs given these models

VIII. METHODOLOGY

The Three-Stage Nested Design research study involves three factors: A, B, and C.

Nested design is a type of experimental design used to analyse data set with nested factor(s). An experiment is said to have a nested factor if the levels of one factor (nested factor) occurs uniquely with only one level of the other factor. In modern science, nested designs have numerous real life applications "Douglas C Montgomery 12th Edition". In the analysis of the 2023 Plateau Central Senatorial Elections in Plateau State, Nigeria, a secondary method of data collection was employed. Data retrieval was conducted through the IReV portal, facilitating efficient and systematic extraction of election-related information. A sample size of 1000 responses was utilized, enhancing the statistical reliability and generalizability of the findings. This dual approach, leveraging on electronic portal and strengthened the robustness of the research methodology for a comprehensive analysis of the election.

Factor A: Local Government (5 Levels)

Factor A represents the first stage of nesting, with five different levels corresponding to different local governments in the central senatorial district of Plateau State, Nigeria. These local governments are treated as independent groups or categories.

Factor B: Wards (10 Levels in each Local Government)

Factor B is nested within Factor A, i.e. each local government (Factor A level), there are ten different levels corresponding to different wards. This implies that the wards are specific to each local government and do not overlap across local governments.

Factor C: Polling Units (10 Levels in Each Ward)

Factor C is further nested within Factor B. Within each ward (Factor B level), there are ten different levels representing different polling units. This nesting structure indicates that polling units are specific to each ward and do not overlap across wards within the same local government.

This nested design allows for examining the effects of factors A, B, and C on the outcome of interest while accounting for the hierarchical structure of the data. However we will perform statistical analyses, such as analysis of variance (ANOVA) or mixed-effects models, to assess the impact of each factor on the research outcome. This design can help to understand how factors at different levels (e.g., local governments, wards, and polling units) influence your dependent variable (response).

However, the researchers intend to work on the application of three-stage nested design in the analysis of 2023 Presidential and National Assembly elections in Plateau Central Senatorial District of Plateau State, using Minitab statistical package for data analysis.

The thee-stage nested design is depicted as shown below.

IX. STATISTICAL ANALYSIS

The linear statistical model for the three-stage nested design is

$$y_{ijkl} = \mu + \tau_i + \beta_{j(i)} + \gamma_{k(ij)} + \varepsilon_{ijk(l)} \qquad \begin{cases} i = 1,2,\dots,a \\ j = 1,2,\dots,b \\ k = 1,2,\dots,c \\ l = 1,2,\dots,n \end{cases} \qquad \dots\dots (3.1)$$

Where τ_i is the effect of the i^{th} (L.G.A.), $\beta_{j(i)}$ is the effect of the j^{th} (Wards) within the i^{th} (L.G.A.), $\gamma_{k(ij)}$ is the effect of the k^{th} (Polling Units) within the j^{th} Wards and i^{th} (L.G.A.), and $\mathrm{E}_{(ijk)l}$ is the usual NID (o, σ^2) error term.

Figure .1: The three-stage nested design data structure.

$$y_{ijkl} = \mu + \tau_i + \beta_{j(i)} + \gamma_{k(ij)} + \varepsilon_{l(ijk)} \longrightarrow \quad (3.2)$$

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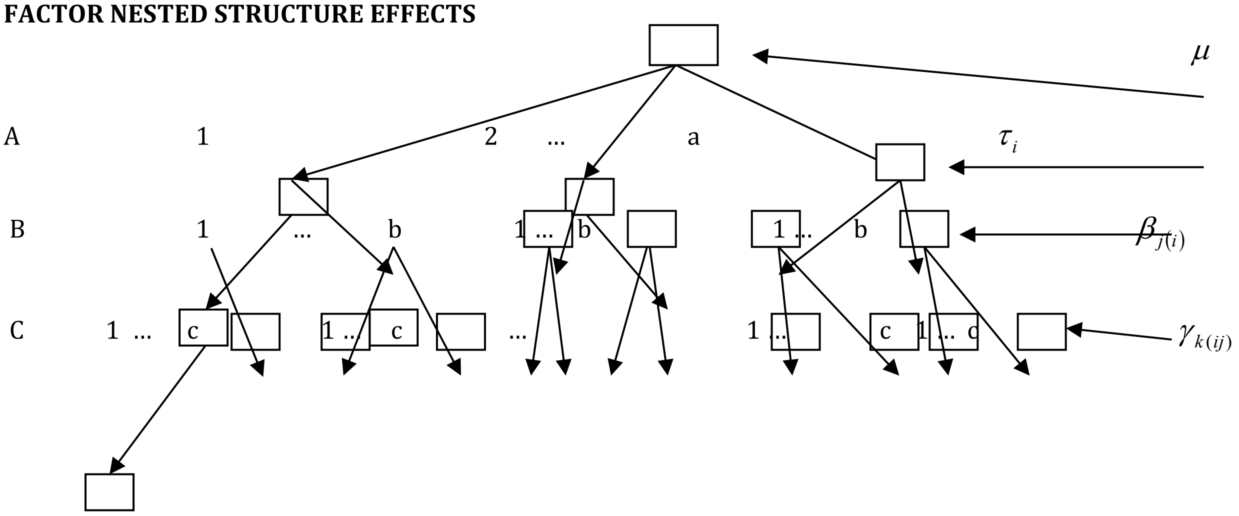
FACTOR NESTED STRUCTURE EFFECTS



Observation

$$\left\{\begin{array}{ll} y_{1111}\ y_{1121}\ y_{1211}\ y_{1221},\ldots, y_{11(n)1} & y_{2111}\ y_{2121}\ y_{2211}\ y_{2311},\ldots, y_{21(k)1} \\ y_{1112}\ y_{1122}\ y_{1212}\ y_{1222},\ldots, y_{12(n)2} & y_{2112}\ y_{2122}\ y_{2221}\ y_{2222},\ldots, y_{22(k)2} \\ y_{1113}\ y_{1123}\ y_{1213}\ y_{1223},\ldots, y_{13(n)3} & y_{2113}\ y_{2133}\ y_{2321}\ y_{2233},\ldots, y_{23(16)3} \end{array}\right.$$

The Computing formulas for the sums of squares may be obtained by the quantities below:

$$SS_T = \sum_{i=1}^{a}\sum_{j=1}^{b}\sum_{k=1}^{c}\sum_{l=1}^{n} y_{ijkl}^{\ 2} - \frac{y_{....}^{\ 2}}{abcn} \qquad (3.3)$$

$$SS_A = \frac{1}{bcn}\sum_{i=1}^{a} y_{i...}^{\ 2} - \frac{y_{....}^{\ 2}}{abcn} \qquad (3.4)$$

$$SS_{B(A)} = \frac{1}{cn}\sum_{i=1}^{a}\sum_{j=1}^{b} y_{ij..}^{\ 2} - \frac{1}{bcn}\sum_{i=1}^{a} y_{i...}^{2} \qquad (3.5)$$

$$SS_{C(B)} = \frac{1}{n}\sum_{i=1}^{a}\sum_{j=1}^{b}\sum_{k=1}^{c} y_{ij..}^{\ 2} - \frac{1}{cn}\sum_{i=1}^{a}\sum_{j=1}^{b} y_{ij..}^{\ 2} \qquad (3.6)$$

$$SS_E = \sum_{i=1}^{a}\sum_{j=1}^{b}\sum_{k=1}^{c}\sum_{l=1}^{n}\left(y_{ijkl} - \bar{y}_{....}\right)^2 \qquad (3.7)$$

Table .1 Analysis of variance for the three-stage nested design

Sum of Variation	Sum of Squares	Degrees of freedom	Mean Square	Fratio
A	$bcn\sum_{i=1}^{a}\left(y_{i...} - \bar{y}_{....}\right)^2$	a-1	MS_A	$\frac{MSA}{MSE}$
B(within A)	$cn\sum_{i=1}^{a}\sum_{j=1}^{b}\left(y_{ij..} - \bar{y}_{....}\right)^2$	a(b-1)	$MS_{B(A)}$	$\frac{MSB(A)}{MSE}$
C(within **B**)	$n\sum_{i=1}^{a}\sum_{j=1}^{b}\sum_{k=1}^{c}\left(y_{ijk..}^{\ 2} - \bar{y}_{....}\right)^2$	ab(c-1)	$MS_{C(B)}$	$\frac{MSC(B)}{MSE}$

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Error	$\sum_{i=1}^{a}\sum_{j=1}^{b}\sum_{k=1}^{c}\sum_{l=1}^{n}\left(y_{ijkl}-\bar{y}_{ijk.}\right)^2$	abc(n-1)	MS_E	
Total	$\sum_{i=1}^{a}\sum_{j=1}^{b}\sum_{k=1}^{c}\sum_{l=1}^{n}\left(y_{ijkl}-\bar{y}_{....}\right)^2$	abcn-1		

Where a = 2, b = 5, c = 2, n = 10, N = abcn = 1000

Design and Analysis of Experiments, Douglas C. Montgomery, 7th and 8th Edition.

COMPUTATION OF EFFECT SIZE

This methods were constructed following Cohen's' 1988 guideline and follow its benchmark.

f = 0.10 is a small effect; **f** = 0.25 is a medium effect; **f** = 0.40 is a large effect.

Random factors

Let f denote the effect size parameter

For a random factor at first level (factor A)

$f = \sqrt{\frac{\hat{\sigma}^2{}_\alpha}{\sigma_A{}^2}}$

For a random factor at second level (factor B); $f = \sqrt{\frac{\hat{\sigma}^2{}_\alpha}{\sigma_A{}^2}}$

Fixed factors

For a fixed factor at first level (factor A); $f = \sqrt{\frac{\sum_i^a \alpha_i{}^2}{\sigma_A{}^2 bn}}$

And for a fixed factor at second level (factor B); $f = \sqrt{\frac{\sum_i^a \beta_j{}^2}{\sigma_B{}^2 n}}$

Where,

$\hat{\sigma}^2{}_\alpha$ = variance component of factor A

$\hat{\sigma}^2{}_\beta$ = variance component of factor B

$\hat{\sigma}^2{}_\gamma$ = variance component of factor C

$\alpha_i =$ Least square estimate of model parameters for factor A

$\beta_j =$ Least square estimate of model parameters for factor B

$\gamma_k =$ Least square estimate of model parameters for factor C

The least square estimates of the model parameters are:

$\hat{\mu} = \hat{Y}$

$\hat{\alpha}_i = \bar{Y}_{i..} - \bar{Y}_{...}$ i = 1,2,…,a

$\hat{\beta}_{j(i)} = \bar{Y}_{ij.} - \bar{Y}_{i..}$ i = 1,2,…,a and j = 1,2,…,b

Variance Components: $\hat{\sigma}^2 = MS_E$, $\hat{\sigma}^2{}_\alpha = \frac{MS_A - MS_{B(A)}}{bcn}$, $\hat{\sigma}^2{}_\beta = \frac{MS_{B(A)} - MS_{C(B)}}{cn}$

$\hat{\sigma}^2{}_\gamma = \frac{MS_{C(B)} - MS_E}{n}$

X. COMPUTATION AND RESULT

Computations were done by Minitab Statistical package. There are several computations done by Minitab Statistical package they include; clearly indicating the significant factor(s) in an experiment. Production of an ANOVA table, Estimation of variance component and use of graphs for diagnostic check etc.

CONCLUSION

Reject the null hypothesis if the calculated F is greater than the tabulated F and conclude base on the researchers claim, but if otherwise do not reject the null hypothesis at a giving level of significance.

DATA PRESENTATION AND ANALYSIS

Data Structure presentation

Here's the link to the file: Data for Accreditation and votes cast https://eu.docworkspace.com/d/sINiYkpS5AYKkoKoG?sa=03&st=0t

Results and Discussion

Table .2 Analysis of Variance for total accredited voters and total votes cast

Source of Variation	DF	SS	MS	F-Value	P-Value
LGA	4	699937	174984	3.07	0.026
WARD(LGA)	45	2568573	57079	57.99	0.000
POLLING UNIT(LGA, WARD)	50	49216	984	0.08	1.000
Error	900	11113947	12349		
Total	999	14431674			

Table.3 Expected Mean Squares, using Adjusted SS for total accredited voters and total votes cast

Source	Expected Mean Square for Each Term
LGA	(4) + 10.0000 (3) + 20.0000 (2) + Q[1]
WARD(LGA)	(4) + 10.0000 (3) + 20.0000 (2)
POLLING UNIT(LGA, WARD)	(4) + 10.0000 (3)
Error	(4)

Table 4. Variance Components, using Adjusted SS for total accredited voters and total votes cast

Source	Variance	% of Total	StDev	% of Total
LGA	589.525	3.89%	5.305	4.31%
WARD(LGA	2804.75	18.51%	52.960	43.02%
POLLING UNIT(LGA, WARD)	-1136.45*	0.00%	0.000	0.00%
Error	12348.8	81.49%	111.125	90.27%
Total	15153.6		123.100	

COMPUTATION OF EFFECT SIZE FOR TOTAL ACCREDITED VOTERS AND TOTAL VOTES CAST

Random factors

Let f denote the effect size parameter

For a random factor at first level (factor A); $f = \sqrt{\frac{\hat{\sigma}^2{}_\alpha}{\sigma_A{}^2}} = \sqrt{\frac{589.525}{174984}} = 0.058043279$

For a random factor at second level (factor B); $f = \sqrt{\frac{\hat{\sigma}^2{}_\beta}{\sigma_\beta{}^2}} = \sqrt{\frac{2804.75}{57079}} = 0.22167101$

For a random factor at third level (factor C); $f = \sqrt{\frac{\hat{\sigma}_\gamma{}^2}{\sigma^2{}_\gamma}} = \sqrt{\frac{0}{984}} = 0.0000$

DECISION

Local Government Area (LGA) exhibited a statistically, suggesting distinct electoral patterns across regions. Ward-level analysis demonstrated a highly significant impact, emphasizing the importance of local dynamics in influencing voting outcomes. However, at the Polling Unit level, no significant differences were observed, indicating uniformity in voter behavior within the LGAs and Wards analyzed, testing at 5% level of significance.

The results highlight the hierarchical impact of Local Government Areas (LGA), Wards within LGAs, and Polling Units within LGAs and Wards on total accredited voters and votes cast. The adjusted Expected Mean Squares provide a robust framework for understanding the varying contributions of these nested levels to the overall election, testing.

Local Government Areas (LGA) contributed 3.89% to the total variance, indicating regional distinctions in voting patterns at. Wards within LGAs accounted for a substantial 18.51% of the variance, underscoring the importance of local dynamics in shaping electoral outcomes. However, the Polling Unit level exhibited negligible variance, suggesting homogeneity in voting behavior within the LGAs and Wards analyzed.

The effect size analysis indicates varying impacts of random factors. Factor A at the first level exhibits a small but notable effect size (f = 0.058043279), suggesting a modest influence on the variability observed in both total accredited voters and total votes cast. Factor B at the second level demonstrates a larger effect size (f = 0.22167101), indicating a moderate impact on the variability within this level of the nesting structure. However, factor C at the third level shows an effect size of 0.0000, suggesting negligible influence, possibly implying that this factor does not significantly contribute to the variability observed in the election data at the third level of nesting.

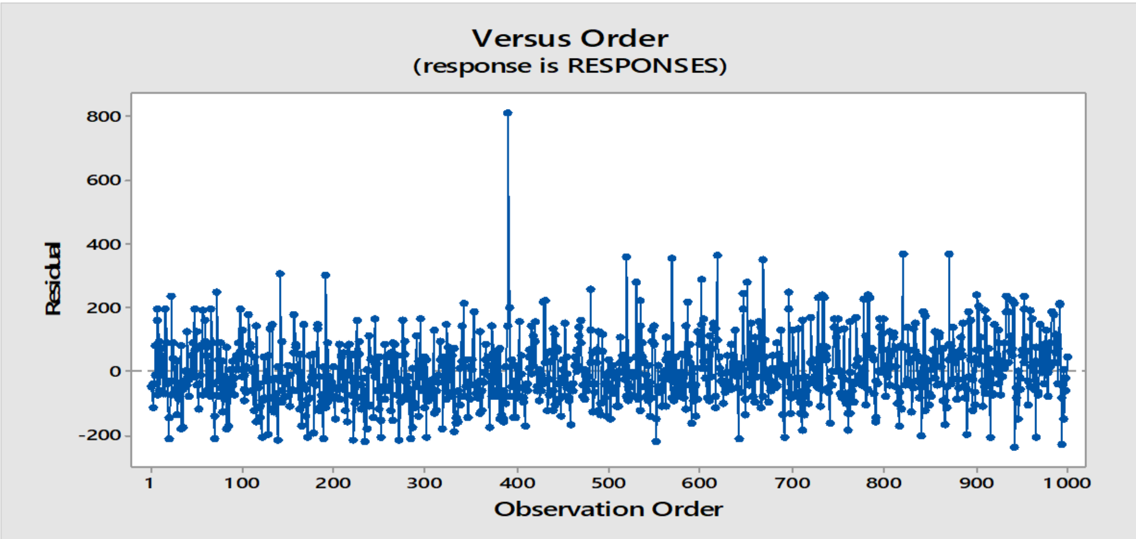

Figure .2 for total accredited voters and total votes cast

The graph was plotted on residual versus response variable and indicates that the residual values lie mostly between -200 and 200. The points on the graph randomly scattered around zero. Patterns or trends in the plot indicate issues like heteroscedasticity (unequal variance) or non-linearity in the model.

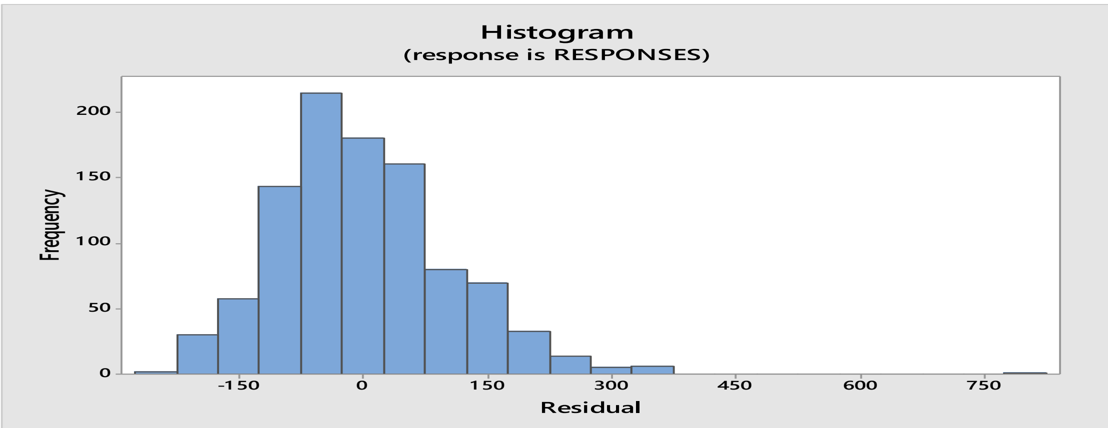

Figure 3 for total accredited voters and total votes cast

Based on the histogram's characteristics, it can be concluded that the dataset exhibits a distribution consistent with a normal distribution. This suggests that the normality assumption for this statistical analysis is reasonable and parametric tests that assume normality is appropriate for this dataset.

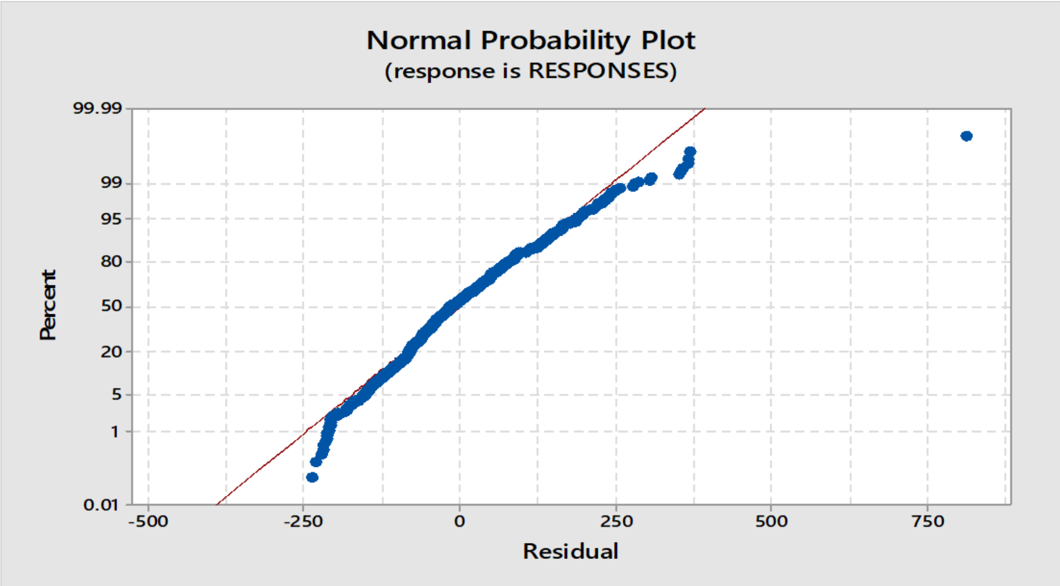

Figure 4. for total accredited voters and total votes cast

The straight-line pattern in the normal probability plot suggests that the registration and voting pattern are approximately normally distributed. This provides evidence supporting the normality assumption for statistical analyses. The closer the points are to the straight line, the stronger the evidence for normality. However, few points' shows deviation from the straight line.

XI. CONCLUSION

The analysis conducted on total accredited voters and total votes cast revealed significant insights into the hierarchical impact of administrative divisions on electoral outcomes. Local Government Areas (LGAs) and Wards within LGAs exhibited substantial effects on voting patterns, highlighting the influence of regional and local dynamics. However, no significant differences were observed at the Polling Unit level, indicating uniformity in voter behavior within analyzed LGAs and Wards. The effect size analysis further emphasized the varying impacts of random factors at different levels of nesting testing at 5% level of significance. Additionally, graphical analyses supported the validity of assumptions underlying the statistical tests conducted. These findings contribute to a nuanced understanding of electoral dynamics, providing valuable insights for future research and electoral policymaking.

RECOMMENDATION

Policymakers should prioritize localized strategies tailored to address specific dynamics at the Ward level, given the significant impact of Wards within LGAs on electoral outcomes. Further research should explore specific factors influencing voting behavior within Polling Units to better understand homogeneity in this context. Continual efforts to improve the quality and of electoral data collection are essential to ensure more accurate and comprehensive analyses in future elections. Continuous validation of statistical assumptions, as demonstrated through graphical analyses, should be integrated into electoral research methodologies to ensure the robustness and reliability of findings. Efforts to enhance public awareness and education on electoral processes, particularly at the local level, can empower voters and foster greater engagement in democratic processes.

XII. REFERENCES

[1] Christopher Awariefe and Monday O. Nana (April 2020) An application of ordinary least Square, International Journal of Advanced Academic Research | Sciences, Technology and Engineering| ISSN: 2488-9849 Vol. 6, Issue 4 (April 2020) https://www.researchgate.net/publication/368477087

[2] Marcel Tochukwu Obinna* , Uchenna Petronilla Ogoke, Ethelb ert Chinaka Nduka (2020) Automation of Balanced Nested Design; NeDPy. International Journal of Statistics and Applications 2020, 10(1): 17-23 DOI: 10.5923/j.statistics.20201001.03

[3] Montgomery DC. Design and analysis of experiment. 8th Ed. NewYork : John Wiley; 2013.

[4] Ou Dang, Mingbin Feeng, Mary Hardy (September 2022) Two-Stage Nested Simulation of Tail Risk Measurement A Likelihood Ratio Approach. Journal of Insurance Mathematics and Economics 108(2), DOI:10.1016/j.insmatheco.2022.10.002

[5] Parvaneh Mehdizadeh (2021) A two-stage approach for joint modeling of longitudinal measurements and competing risks data. Journal of Biopharmacutical Statistics 31(2):1-21.

[6] Peter Goos and Bradley Jones (January 2019) Optimal Experimental Design in the Presence of Nested Factors. Journal of Technometrics 61(4):1-25, DOI: 10.1080/00401706.2018.1562986

[7] Seiichi Yasui and Yoshikazu Ojima (June 2018) D-Optimal Three-Stage Unbalanced Nested Designs for the Determination of Measurement Precision. Frontiers in Statistical Quality Control 12 book series (FSQC).

[8] Uchenna Ogoke (May 2021) A New Statistical Trend in Medical Research-Nested Design. DOI:10.3155/glm2021.10.1.2

[9] Wagner A Kamakura, José Afonso Mazzon and Arnaud De Bruy (2006) Modeling voter choice to predict the final outcome of two-stage elections,. International Journal of Forecasting 22(4):689-706 DOI:10.1016/j.ijforecast.2006.04.002

[10] Wang Xue, Yushun Guo, Yuliang Zhang, Chang Shu (2022) Exact Settling Performance Design for CMOS Three-Stage Nested-Miller-Compensated Amplifiers. https://www.researchgate.net/publication/363612807

[11] Cohen, J. (1988). Statistical power analysis for the behavioural sciences (2nd ed.). New York: Academic Press.

[12] Idowu, Anikwe and Asekhamhe (2020) averred that in many nations across the globe, election is the accepted process through which individuals are chosen to represent a people or community in various organs of government.

[13] Egwemi (2014) opines that election as a process under democracy through which people or the electorate exercise their freedom and inalienable right to organize their life and to choose those whom they delegate their rights as representatives

[14] Animashaun (2010) cited in Vande (2017) corroborates that election is a democratic process that provides citizens with the freedom to choose their rulers and to decide on public policy. Under any democratic system

[15] Animashaun (2010) cited in Vande (2017) corroborates that election is a democratic process that provides citizens with the freedom to choose their rulers and to decide on public policy. Under any democratic system

[16] Baidoo, Dankwa and Eshun (2018), elections seem to have become a major factor in the stabilization and democratization of emerging democracies.

[17] Vande (2017) submit that the sanctity of choice embedded in the modern democratic idea presupposes that the electorate has the latitude to choose those who would govern them in a regular, free, fair and credible electoral process.

[18] Vande (2017) submit that the sanctity of choice embedded in the modern democratic idea presupposes that the electorate has the latitude to choose those who would govern them in a regular, free, fair and credible electoral process.

[19] Anikwe and Asekhamhe (2020) posit that vote racketeering is any form of financial, material or promissory inducement or reward by a candidate.

[20] INEC Regulations and Guidelines for Conduct of Elections 2022 in line with international best practice.

[21] Wilkinson, L., & APA Task Force on Statistical Inference. (1999). Statistical methods in psychology journals: Guidelines and explanations. American Psychologist, 54, 594–604.