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NON-PARAMETRIC TECHNIQUES AND HYPOTHESIS TESTING : AN EMPIRICAL ANALYSIS OF DECISION MAKING IN THE PUBLIC SECTOR

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ABSTRACT

The study is an empirical analysis of decision making in the public sector using non-parametric techniques of hypothesis testing. The study was based on the survey conducted among civil servants that cut across eight departments and ministries in Lagos State.

As observed in the paper, for a manager to arrive at a decision, there is need for him to formulate hypothesis based on the variables under consideration and to test it accordingly. We noted that different non-parametric tools of hypothesis testing could be applied, depending on what the manager wants to achieve and that non-parametric technique become most effective where nominal and ordinal levels of measurement are used, and that they do not require any assumption about the parent population.

A detailed literature review on each of the relevant variables of the research and each of the tests was carried out. The review includes the uses, assumptions made in the application of each test, and the use of each test in terms of their reliability in decision-making. Data generated from the field survey conducted were analyzed, using some selected non-parametric techniques and the results of our computations show that relatively unknown non-parametric tests can be as effective as other popular tests.

Finally, we noted that the probability accompanying the non-parametric tests are exact, the calculations are rapid and easy to use, the procedures are widely acceptable, and data can be analyzed on a "weak" measuring scale, that is the ordinal scale.

INTRODUCTION

The vital position of statistics in research studies over the years has been acknowledged and accepted. Statistics did not only help the researcher in analyzing generated data, but also guides him in making a right decision on how to solve a given problem of study.

Scholars have come to accept scientific research as the most prudent method of acquiring new knowledge. This acceptance rests not only on its ability to systematically and critically explain details on research findings/ results objectively. The objectivity of finding/results could be cumbersome even elusive, if appropriate statistical tools are not used. This therefore, means that researchers must appreciate the various divisions of statistical technique in order to know which, when, and how each of them should be used in their various statistical analyses.

In fact, over the years, controversies in academic, in particular, on the most suitable statistical technique a researcher should adopt in statistical analysis have filled the air. The fact remains that; they cannot do without each other and whichever one is adopted in research depend on what the researcher intends to accomplish, bearing in mind constraints of the approach.

A statistical method is all about making decisions and drawing conclusions based on information available that a public administrator requires helping him in decision making consists of a large set of data about which he has only partial knowledge based on a small portion of the data. This partial knowledge means that there is uncertainty in many life situations.

In the development of modern statistical method, the first techniques of inference, which appeared, were those that make a good many assumptions about the nature of the population from which the scores were drawn-since population values are "Parameters" these statistical techniques are called parametric.

More recently, we have seen the development of a large number of techniques of inference, which do not make numerous or stringent assumptions about parameter. The newer distribution-free or non-parametric technique" result in conclusion, which require fewer qualifications. (Sydney Siegel, 1956; Ferguson 1981; Aczel; 1999)

Every statistical test concludes with two types of decisions viz: a statistical decision and a practical decision. The statistical decision consists of accepting and rejecting the null hypothesis based on the sample of the decision and the decision rule considered which are designed to look at an individual parameter from a sample and compare it with a known or supposed value from the population. Such tests are extremely important in the development of statistical theory and for testing of many sample results. Apart from the statistical decisions that emanates from such process, there is also practical decision that follows a decision to act upon the results of the statistical test. (Ferguson, 1981)

Therefore, in order to make scientific full proof decision, it is important to know the kind of non-parametric techniques of hypothesis testing to use. Because, using the wrong one will not only lead to waste of resources, time, money, etc. but could equally prove costly when the time comes for decision-making. Not only will it not be effective but also misleading and of no importance in practice. The choice of the right techniques, on the other hand, will not only make the process effective, efficient and result oriented, but also in the field of research, contributes to knowledge and equally reinforce the statistical association as development of a proposition of a link between variables.

It is in the light of this that this study is embarked upon, with a view to determining the effectiveness of non-parametric techniques of hypothesis testing and decision making in the public sector, using Lagos State civil service as a case study. It is recognized that for an administrator working in the public service, statistics are in many ways, his stock of trade. The work of most ministries and departments according to Lerche (1983 :4) is evaluated in terms of figures which show the resources put at the disposal of the ministry, and what was achieved . To be effective in this kind of work, a bureaucrat must keep very careful track of how work under his supervision is progressing, and this is best achieved by constant collection and compilation of quantitative information. In government, the goal of administration is to provide protection, economic development and social amenities to the people of the country. It is therefore necessary for each section of government administration to have very accurate information about the areas of its responsibility; government need accurate statistics to fulfill its responsibilities to its citizens.

Statistical information is extremely valuable for officials who have to formulate objectives for policy in these areas. They can use such statistical analyses to decide what policy to be followed. Thus, in the course of this study, attempt was made to compare non-parametric technique of hypothesis testing (i.e. Chi-Square test) with some other non-parametric techniques such as Kruskal Wallis Test, Gamma, Lampda coefficient, the run test e.t.c let alone being used to determine the extent of their effectiveness in hypothesis testing and decision making in the public sector.

Data for the study was gathered from some selected ministries and departments in the Lagos State Civil Service. These include Ministries of Finance, Education, Works and Housing, Health, Environment and Economic Development, Women Affairs and Budget Office.

STATEMENT OF THE PROBLEM

Nowadays, most researchers are faced with the problem of how to choose an appropriate statistical technique to solve a particular problem. In fact, some researchers especially neophyte ones only know about the existence of the different categories of research statistical tools and their compartmentalization into sub-categories. They do not know which of these tools are most appropriate for various research situations. They are also vaguely familiar with the required procedures and make valid research decisions.

Decision-making is usually a major task of the society and for the management of any organization and public sector in particular. The quality of decisions made by the management from time to time determines the growth or otherwise of any public sector organizations. Not only that, social scientists before solving a problem or making a decisions embark on the rigorous and sophisticated processes of gathering, analyzing and interpreting data, to enable them make the right decision. The process is not only research-based but highly scientific, because all scientific methodology is applied. Thus, making social science, a science and researcher in social phenomena, a scientist.

The crossroad over parametric and non-parametric has risen out of the question of measuring social phenomena in an attempt to verify and generalize them. The question however, is: has parametric approach been able to measure and compare social science phenomena adequately? The simple answer is no. Thus, giving way to the use of non-parametric approach.

Parametric statistical techniques tend to receive more attention than their non-parametric counterpart. Parametric techniques are more powerful and relatively robust to violation of assumption. (Jaccord and Becker, 1990; Aczel, 1999). Asika (1991) added that, "Parametric techniques are widely taught in schools and are considered the most effective inferential tools. Non-parametric techniques, on the other hand, are rarely mentioned, let alone used. In spite of their numerous advantages, the techniques are unempirical and are abandoned, even in a situation where it will make the testing of research hypotheses and making of decision tedious and lopsided.

The above perceptions have contributed to obvious less preference for non-parametric techniques and greatly dampened zeal for investigation into effectiveness of these twin tools of statistical analysis.

The question is: To what extent can managers rely on non-parametric techniques in arriving at useful and quality decisions? It is often considered useful to process the alternative being considered according to particular decision rule or decisions models. That is to say a manager should choose appropriately non-parametric tests for decisions being considered.

Experiences have shown over the years that some experiments, when carried out, their results cannot be quantified, but can only only be ranked. For example, taste between one food and another, beauty of two ladies, ability or intelligence of two teachers etc. From all these examples mentioned, we are going to get different responses from the participants.

Researchers are out to find dependable solutions to problems and as a result, they would not want to leave us in doubt of our results when any test is carried out, like the taste of food, when at the end of the day, we have different results, which one do we depend on. The above gave rise to the different types of tests being used in non-parametric techniques to arrive at valid and dependable solutions.

The problem of measurement is so important to a discussion of non-parametric statistics. Non-parametric techniques of hypotheses, though simple to calculate and apply, are often abused by researchers and students who do not bother to understand when each non-parametric statistics can be used. Thus, important information is wasted.

The use of parametric statistical techniques of hypotheses testing in decision making requires that assumption of normality of the population distribution, and that the data is analyzed and generalized using the interval and ratio scales of measurements. Those rigid assumptions limit the validity of parametric test to phenomena or real life problems where variables are normally distributed, for instance, intelligence test, age and height. Owing to this fact, other variables in the behavioural sciences that cannot be described quantitatively, and are measured on the nominal or ordinal scales (e.g. taste, brand, pre-ference, grades) cannot be effectively tested using parametric techniques. The problem therefore, defines the need for non-parametric statistical techniques. These problems are valid under general statistical assumptions and thus will be used in situations that parametric techniques may not be used.

The research will help researchers, including students and decision makers, to choose the right technique when developing a statistical theory and testing sample result which are used for decision-making. It is expected that the various uses, applications, recommendations and effectiveness of non-parametric techniques discussed herein will add to the body of knowledge already existing in the field, and improve researcher knowledge on the subject matter.

STATISTICAL TECHNIQUES OF HYPOTHESIS TESTING: AN HISTORICAL EVOLUTION

The American Encyclopedia (1964:531) revealed that statistics is a field of study, which developed most rapidly in the 20th century; especially after the first two decades. Ronald A. Fisher (1890) a geneticist and statistician contributed immensely towards the growth of inferential statistical methods. He developed exact methods the statistical designs of experiment and for making statistical inferences (i.e. both estimators and testing hypothesis). J. Neyman (1894) and E.S. Pearson (1985) extended Fisher's work on the theory of test of hypothesis to include the important idea of the power of a test. The development of statistical techniques to solve research problems could be traced to the works of Karl Pearson. As a part-time lecturer in Applied Mathematics at Geometry Gresham College between 1893 and 1901, he accomplished the following feats in statistical world:

1. Prepared a paper that brought the introduction of chi-square goodness of fit in 1800
2. Designed population standard deviation and normal curve in 1894
3. Proved that 'r' is the best estimate of the population correlation in 1895
4. Development single linear correlation curve linear regression and correlation contingency coefficient, kurtosis, standard deviation and mode in 1900.

   Besides, Karl Pearson, were Charles E. Spearman's rank correlation in 1945, Frank Wilcoxon who introduced signed-rank test, Herry B. Mann and D.R. Whitney who came up with Wilcoxon rank sum test and Mann Whitney U test in 1945 and 1947 respectively. Also worthy of mentioning is William H, Kruskal and W. Allen Wallis who in 1952 developed what is today known as Kruskal Wallis test.

Conover (1971:3) has traced the origin of non-parametric statistics to the late 1930's when different approaches to the problem of finding probabilities began to gather momentum. The approach involved making few changes in a model and using simple and unsophi-sticated methods to find the desired probabilities or at least a good appro-xima-tion to those probabilities. Approximate solutions to problems were found as opposed to the exact solution to the approximate problems fur-nished by parametric statistics.

Savage (1953) designated 1936 as the beginning of the subject, for in this year Hotelling and Pabst published their paper on rank correlation; Savage did point out, however, that papers relating to non-parametric statistics appeared as early as the nineteenth century. By 1962, the fertility of the subject was such that Savage (1962) extended his earlier (1953) bibliography of non-parametric statistics that contained more than 3,000 citations relating to non-parametric statistics.

Thus, parametric and non-parametric techniques are two statistical techniques of hypotheses testing and decision-marking developed by Fishers, J. Neyman and Abraham Wald. However, for the purpose of this study we shall focus on non-parametric techniques of hypothesis testing.

FORMULATION OF HYPOTHESIS

In evaluating and choosing among alternative solutions, the manager formulates hypothesis, which could be considered as a tentative generalization concerning two or more variables of interest in the solution of problem under consideration. (Winn and Johnson, 1978; Asika, 1991; Nwadinigwe, 2000).

An hypothesis is a probabilistic statement about the relationship or association between two or more variables. The statement of a hypo-thesis takes two forms-null (H_0) and research (H_1) hypothesis. The null indicates that no relationship exist between variables, while the research hypothesis indicates that there is a relationship between the variables which means that the null hypothesis is a converse of the research hypothesis.

Consequently, in testing these two opposing hypotheses, a confirmation or an acceptance of one means the rejection of the other. A quick rule of the thumb according to Ogbeide (1997) for identifying which variable is dependent or independent in the process of testing hypothesis is the concept of casual order. Time priority states that under normal condition, the independent variable must either occur first or change prior to the dependent variable.

It is appropriate to state at this juncture that the null hypothesis assumes the statusquo as the old theory; method or standard is still true. It is the complement of the alternative hypothesis, which is that the researcher is usually interested in proving.

A good rule to follow is to view the alternative as the hypothesis upon which the burden or proofs falls. This is the hypothesis the researcher is most interested in demonstrating to be true. After establishing the null and alternative hypotheses, the researcher can set up decision rules to determine whether the null hypothesis is going to be rejected or not (Frank and Steven, 1994)

In addition, Ogbeide (1997) observed that in testing hypotheses, it would be nice if we could always make a correct decision. However, this is statistically impossible. Since we will be making our decision on the basis of sample information, the best we can hope for is to control the risk, or prob-ability, with which an error occurs. The most frequently used probability values are 0.01 and 0.05. The probability assigned to each error will depend on the seriousness of the error. The more serious the error, the less confidence we have over the result of our hypothesis testing.

Conversely, the smaller the error the more confidence we have over the result of our analysis. The goal therefore, is to strive towards an error with a smaller probability. Nwadiningwe (2000) noted that managers need to formulate hypothesis because it among others:

1. Provides a link between the word of reality and the world of theory and explanation.
2. Transforms the researcher's ideas into testable forms.
3. Helps to specify what variables are to be measured or collected by the researcher in order that he may have the expected result discovery.
4. Guides the researcher in his research design, which helps in the generation of the requisite data.
5. Shows the direction of data analysis
6. Helps the researcher organize his reports
7. Helps the researcher to focus his attention and effort in the right direction.

PARAMETRIC AND NON ARAMETRIC TECHNIQUES

Parametric tests can be described as tatistical tests of inference that make use of normal probability model. The test has more power than non-parametric test because it makes maximum use of all the data when the populations are normally distributed.

Parametric techniques are used to analyze or test the relationship between variables that are measured with interval or ratio scale with the assumption of normal distribution (William Mender Hall, 1968:74; Ogbeide 1997:184; Hanber & Richard P. Flynn, 1998:297.

A variety of non-parametric statistics are available for use with nominal or ordinal data. Some require at least ordinal level data, but others can be specifically targeted for use with nominal level of data (Black, 1994). However, where the researchers are not sure whether or not the distribution is normal the safest thing to do is to resort to the appropriate non-parametric statistical method.

Non-parametric techniques can be applied successfully to situations of both normal and not so normal distribution. (Savage, 1953:844-906, Onwe, 1998)

Non-parametric statistics are distribution-free statistics and are not generally concerned with population parameter. The distribution of the variables is immaterial since the tests are not concerned with population parameter. (Denger and Ala, 1983, Asika 1991, Black 1994, Lucey 1996). Put differently, this kind of test is used when the type or nature of the population is not known or when the data collected are in ranked or discrete form, ranking also is done when values are ordered by assigning the first rank to the highest score, the next highest is assigned last place value. For example, an electorate may be asked in a pre-voting test to rank their preference for a number of political parties. Discrete data include all short, high, medium or low number in each category and so on.

According to Mendel Hall (1968), nonparametric statistical procedures apply not only to data that are difficult to quantify, but they are particularly useful in making inferences in situations where serious doubt exist about the assumption underlying standard methodology.

Sidney Siegel (1956) in his quest to understand the difference between parametric and nonparametric says "... some nonparametric techniques are often called ranking tests or order test" and these titles suggest one way in which nonparametric tests differs from parametric tests. In the computation of parametric tests, we add, divide and multiply the score, which are not truly numerical; they naturally introduce distortions in those data and thus throw in doubt any conclusion from the test. Many nonparametric tests, on the other hand, focus on the order or ranking of the scores, not on their "numerical" values and other nonparametric techniques are useful with data for which even ordering is impossible (i.e. with classificatory data).

Depending on the level of measurement that is used, statistical tools-parametric can be applied to help manager arrive at an optimal decision. However, where nominal and ordinal levels of measurement are adopted, it is more convenient to use the nonparametric statistical technique, which basically does not require any basic assumption regarding the population under study.

Having considered the views of various scholars on nonparametric tests, it is clear that there is a general and unifying agreement among the authors as regards the conditions under which the nonparametric techniques may be adopted in data analysis.

It is therefore, appropriate for us to summarize our discussion here by stating the condition under which nonparametric technique can be adopted. This includes:

1) When the hypothesis to be tested does not involve population parameters such as ì and ä.
2) When there are no assumptions of normality about the distribution of the variables.
3) When the data are generated from such weak measuring scales and ranking frequency counts and same subjective measuring scales.
4) When results are needed fast and no statistical sophistication is required. (Aczel, 1999:670).

Finally, it is important to stress that the strength of nonparametric statistics lies in their general applicability. Few restrictive assumptions are required and they may be used for observations that can be ranked but not exactly measured.

DECISION-MAKING IN STATISTICAL ANALYSIS

A decision is making a choice between alternative courses of action. It can be defined as making a judgment regarding what we ought to do in a certain situation after having deliberated on some alternative courses of action. It is a framework that guides those choices that determine the nature and direction of any organization. (Bartol and Martin, 1994:231)

Daft and Steers (1986) revealed that the decisions that managers make have a profound impact on the success of the organization. Hence, mana-gerial approaches to decision-making have been the subject of considerable curiosity and research. The rational model of managerial decision-making suggests that managers engage in completely rational decision pro-cesses, ultimately made optimal decision and possess and understand all information relevant to their decisions at time they make them.

Nwadinigwe (2000:20) observed that effective managerial decision is the process of efficiently arriving at the best solution to a given problem. According to him, if only one solution is possible, then no decision problem exists. When alternative courses of action are available the decision that produces the result most consistent with managerial objective is the optimal decision. Alternative decision must be weighed that is appraised quantitatively and qualitatively, so that appropriate decision could be made to formulate hypothesis which is defined as "fingers of knowledge" that guides the whole research, which determines all the things the researcher has to do while carrying out the research.

APPLICATION OF NONPARAMETRIC TECHNIQUES OF HYPOTHESIS TESTING.

In order to ascertain the authenticity of the research or alternative hypothesis, it has to be tested. Hypothesis testing as a fundamental activity in decision-making process lends credence to overall managerial decision-making. It is through the process that statements about the real world are empirically verified. Essentially we are talking about comparing the two statements (H_0 and H_1) statistically in order to arrive at a realistic managerial decision. In doing this, statistical tools are usually applied-that is, the parametric and nonparametric techniques.

Social researchers are eager to reject the null hypothesis when it is false. As a result, many of them would ideally prefer to employ parametric tests of significance. As previously noted, however, it is often not possible to satisfy the requirements of parametric tests. In the first place, much of the data of social research is at the ordinal or nominal level of measurement. Secondly, it may be difficult to know whether the characteristics under study are in fact distributed normally in the population.

If these elements are not there, then the data cannot be analyzed parametrically i.e. using parametric tests such a correlation; z-test, student-t, analysis of variable (ANOVA), regression analysis, etc. Therefore, when the requirements have been violated, the results of a parametric test, whose requirements have gone unsatisfied, lack any meaningful interpretation. Under such conditions, many social researchers wisely turn to non-parametric techniques or tests to arrive at the alternative decision. Nonparametric techniques do not depend on any assumptions about the parameter of the parent population distribution and other associated elements. They can be used as a short-cut replacement for more complicated tests.

The most popular of these include Chi-square (χ^2), Yule's (Q) and Pearson's contingency Co-efficient (C). Other nonparametric test, which are rarely mentioned, by scholars and students in the discussion of nonparametric test are Phi-coefficient (ô), Cramer's V (V), Gamma (ã), Lambda (ë), the Kruskal Wallis H-test, the run test (Wall Wolforwitz), the Kolmogorov-Smirnov test, Wilcoxon signed-rank test, etc.

For the purpose of this paper therefore, attempt will be made to compare a commonly used nonparametric techniques with some other nonparametric tests that are rarely mentioned, let alone being used to determine the extent of their effectiveness in hypothesis testing and decision making in social science research.

CHI-SQUARE TEST

Probably the most widely used of all non-parametric test is the chi-square (Pronounced " Ki-Square" and Written χ^2). Chi-square was developed by Fisher(1890) and is used to assess the significance of the difference between the observed frequencies and the expected frequencies from the hypothetical universe. MC Clave (1988) observed that the expected frequencies can be thought of as values expected to fall in each category, based on some theoretical probability distribution. The observed frequencies can be thought of as values from probability distribution categorized into two ways e.g. Yes, No When the data is non -metric i.e. when they are expressed in frequencies (Asika, 1991; Lucey, 1996).

Chi-square's major weakness is that its value is influenced by the sample size; the larger the sample, the larger the value of χ^2 . Consequently, the Chi-square may easily exceed 1.00. Hence, so it is not an appropriate measure of assessing the degree or strength of association between variables. Chi-Square is frequently used to test goodness-of-fit and independence of classification.

TEST OF GOODNESS OF FIT

The goodness of fit is performed by establishing a null hypothesis (such as the data representing a inform distribution of interest). Then the expected frequencies (E) are determined, based on the probability distribution stated in the null hypothesis. These calculated expected (E) are compared with the observed frequencies (O). If the expected and observed frequencies appear to agree, then the null hypothesis is accepted. If the observed and the expected frequencies do not seem to agree the null hypothesis is rejected (Cangelosi, et. al; 1983:279).

The critical value of Chi-square is expressed as.

$$\chi^2_c = \sum_{1}^{n} \frac{(0_i - E_i)^2}{Ei}$$

Where
0i=Observed frequency of the variable (sample)
Ei=Expected frequency (based on the hypothesized population distribution)

ILLUSTRATION

A survey conducted to determine whether or not majority of employees in Lagos State Civil Service would vote to support the implementation of open Performance Appraisal method as a new method of appraising employees in the public sector. The members were given papers to indicate Yes or No. Out of 60 staff members, 55 indicate yes. Test the relevant hypothesis.

Ho: Majority of the employees do not believe they will vote in support of the implementation of a new appraisal method.

Hi: Majority of the employees believes that they will vote in support of the implementation of a new appraisal method.

Using the Equation

Expectation	Observed Frequency	Expected Frequency	(0i-Ei)	$(0i-Ei)^2$	$\frac{(0i-Ei)^2}{Ei}$
Yes	55	30	-25	625	20.833
No	5	30	25	625	20.833
Total	60				**41.666**

Using the Equation $= \sum \frac{(0i-Ei)^2}{Ei}$ $\chi^2 = 41.67$

DECISION RULE/ CRITERION

We reject the null hypothesis at 0.05 (5%) if the computed value of the test statistic X^2 exceeds the critical tabulated value of χ^2 α 0.95 (r-1) degree of freedom.

Before we take our decision, we must compute (r-1) degree of freedom where r = no of rows.

D. f = r -1 = 2-1 = 1 d. f.

Before we take our decision we must compute (r-1) degree of freedom where r = no of rows.

$\therefore$ d.f. = r-1 = 2-1 = 1 d. f.

At I d. f. and assumed 0.05 level of significance, χ^2_t = 3.841.

RESEARCH RESULT

$\chi^2_c > \chi^2_t$ @ $\alpha = 0.05$.

Therefore, data are statistically significant @ 5% sampling error. An association exists between the variables. We can conclude that majority of the employees believe that they will vote to support the implementation of a new appraisal system in the Civil Service.

TEST OF INDEPENDENCE

At times, data obtained from random sample may be classified by two or more attributes. When we have two more attributes so that we can cross classify the data, the resulting presentation is called a contingency table. Such cross-classification is usually done in order to investigate the relationships between the row attributes and the column attributes. An investigation of this relationship is a statistical test of independence.

In order to compare the observed and the expected frequencies, it is necessary to calculate the expected frequencies (Eij). Expressed as a word equation:

$$Eij = \frac{\text{(row total (i)) (column total (j))}}{\text{Overall total (n)}}$$

These expected frequencies (Eij) are then used in equation to perform a test of statistical independence.

$$\chi^2 \text{ test} = \sum \frac{(0i\text{-}Eji)^2}{Eji}$$

FIELD REPORT ON LEADERSHIP STYLES

A survey was conducted in October 2005 (see the attached questionnaire) on the impact of political orientation on leadership styles among Lagos State Civil servants. A total number of 120 questionnaires were distributed to official on grade level 06 and above in 7 ministries and departments which include; Public Service Office, Ministry of Women Affairs, Ministries of Education, Economic Planning and

Budget, Ministry of Science and Technology, Board of Internal Revenue. 88, representing 73% of the respondents, returned the administered questionnaire.

PERSONAL CHARACTERISTICS OF RESPONDENTS

1. TABLE I: RESPONSDENTS SEX

CLASSIFI-CATION	FREQ.	%
MALE	48	54.5
FEMALE	40	45.5
TOTAL	48	100

As shown in the table 1 above, majority of the respondents were men. The data showed that men constituted 54.5%, while the remaining 45.5% were female.

2. TABLE II: RESPONDENTS AGE

CLASSIFI-CATION	FREQ.	%
20-29	20	22.7
30-30	41	46.6
40-49	19	21.6
50 AND ABOVE	08	9.1
TOTAL	48	100

TABLE (II) reflected the age distribution of the respondents. Respondents cut across all age brackets. The highest number of respondents came from age grade 30 – 39 and this constituted 46.6% of the sampled population.

3. TABLE III: MARITAL STATUS OF RESPONDENTS

CLASSIFI-CATION	FREQ.	%
MARRIED	53	60.2
SINGLE	29	32.9
DIVORCED	02	2.3
SEPARATED	03	3.4
WIDOWED	01	1.1
TOTAL	88	100

Table (III) revealed that majority of the respondents which constituted 60.2% were married, 32.9% were single, while 2.3%, 3.4% and 1.1% were divorced, separated and widowed respectively.

4. TABLE IV: EDUCATIONAL QUALIFI-CATION OF RESPONDENTS

CLASSIFI-CATION	FREQ.	%
First School Leaving Certificate	06	6.8
WASSC/GCE/ NECO/TC II	11	12.5
ND/NCE	10	11.4
HND/B.A/B.Sc	46	52.3
Postgraduate	13	14.8
Others	02	2.2
TOTAL	48	100

Table (IV) reflected the educational attainment of respondents. Respondents were generally educated in most ministries covered. About 67.1% of the respondents had university degrees and post graduate qualifications. Thus, most of the respartments in the 7 mini-stries and departments covered were educated. This is attested to by the fact that a large number of them had minimum of university degrees.

RESPONDENTS VIEWPOINT ON LEADERSHIP STYLES AND POLITICAL ORIENTATION.

5. TABLE V: POLITICAL ORIENTATION OF RESPONDEDNTS

LEADERSHIP SYTLE	POLITICAL ORIENTATION			TOTAL
	CONSERVATION	LIBERAL	RADICALS	
AUTOCRATIC	07	09	08	24
DEMOCRATIC	13	29	09	51
LAISSEZ-FAIRE	03	06	04	13
TOTAL	23	44	21	88

The data on the table above indicates that 7 out of 23 conservative and 9 out of 44 liberals and 8 out of 21 radicals used autocratic style; 13 out of 23 conservatives, 29 out of 44 liberals and 9 out of 21 radicals used democratic style. While 3 out of 23 conservatives, 6 out of 44 liberals and 4 out of 21 radicals used Laissez-faire style of leadership.

Finally, it was discovered that out of the sampled population, 23 conservative, 44 liberals and 21 radicals could be categorized with respect to leadership styles.

HYPOTHESIS TESTING

The first step in hypothesis is to state the null and alternative hypotheses.

Ho: there is no relationship between political orientation and leadership styles.

Hi: there is a strong relationship between political orientation and leadership styles.

The observed table is presented on the next page.

OBSERVED/EXPECTED TABLE

LEADERSHIP STYLE	POLITICAL ORIENTATION			Total
	Conservative	Liberals	Radicals	
Autocratic	7 (6.3)	9 (12)	8 (5.7)	24
Democratic	13 (13.3)	29 (25.5)	9 (12.2)	51
Laissez-faire	3 (3.4)	6 (6.5)	4 (3.1)	13
Total	23	44	21	88

To calculate the expected frequencies from the table, we can adopt the formula.

$$Eij = \frac{n_i \times n_j}{N}$$

Where n_i = Row total n_j = column total and N = Grand total Using the equation above

$$E_a = \frac{R_1 c_1}{N} = \frac{24 \times 23}{88} = 6.3$$

$$E_b = \frac{R_1 c_2}{N} = \frac{24 \times 44}{88} = 12$$

$$E_c = \frac{R_1 c_3}{N} = \frac{24 \times 21}{88} = 5.7$$

$$E_d = \frac{R_2 C_1}{N} = \frac{51 \times 23}{88} = 13.3$$

$$E_e = \frac{R_2 C_2}{N} = \frac{51 \times 44}{88} = 25.5$$

$$E_f = \frac{R_2 C_3}{N} = \frac{51 \times 21}{88} = 12.2$$

$$E_g = \frac{R_3 C_1}{N} = \frac{13 \times 23}{88} = 3.4$$

$$E_h = \frac{R_3 C_2}{N} = \frac{13 \times 44}{88} = 6.5$$

$$E_i = \frac{R_3 C_3}{N} = \frac{13 \times 21}{88} = 3.1.$$

The Chi-square value can then be calculated using the formula.

$$\chi^2 = \sum_{i=1}^{n} \sum_{j=1}^{m} \frac{(Oij - Eij)^2}{Eij}$$

$$\chi^2 = \frac{(7-6.3)^2}{6.3} + \frac{(9-12)^2}{12} + \frac{(8-5.7)^2}{5.7} + \frac{(13-13.3)^2}{13.3} + \frac{(29-25.5)^2}{25.5} + \frac{(9-2.2)^2}{12.2} + \frac{(3-3.4)^2}{3.4} + \frac{(6-6.5)^2}{6.5} + \frac{(4-3.1)^2}{3.1} +$$

$$= 0.07 + 0.75 + 0.92 + 0.01 + 0.48 + 0.83 + 0.05 + 0.04 + 0.26$$

$$\chi^2 = 3.41$$

The degree of freedom is given as (r–1) (c – 1) (where r = no of rows and C = no of columns).
= (3 – 1) (3-1)
= 2 X 2 = 4 d. f.

At 5% (0.05) level of significance, the critical value for chi-square with 4 d.f, is 9.488. Thus, calculated χ^2 (χ^2 = 3.41) is smaller than critical χ^2 @ 4 d.f, the value is not statistically significant @ α = 0.05.

RESEARCH RESULT

Don't reject Ho = There is no relationship between political orientation and leadership style.

INTERPRETATION: There is no sufficient evidence to proof that autocratic democratic and laissez-faire leadership is dependent on whether one is conservative, liberal or radical.

GAMMA (÷)

Gamma is a measure of the degrees and direction of relationship between variables and it is similar to Yules Q. The major difference between Gamma and Yules Q is that where as Yules Q is restricted to 2 x 2 contingency tables, Gamma can be used for large data like 3 x 3 contingency tables.

Gamma is calculated on the basis of products of positive diagonal cells minus products of negative diagonal cells, divided by the sum of these cross products (Ogbeide, 1997:193). The formula for calculating Gamma is given as:

$$(\div)=\frac{P_D - N_D}{P_D + N_D}$$

Where P_D = Positive diagonal combinations (.i.e. to the right of the table).

N_D = Negative diagonal combinations (i.e. to the left of the table).

N = 88

LEADERSHIP SYTLE	POLITICAL ORIENTATION			TOTAL
	CONSER-VATIVES	LIBERAL	REDICALS	
AUTOCRATIC	07(a)	09(b)	08 (c)	24
DEMOCRATIC	13(d)	29(e)	09 (f)	51
LAISSEZ-FAIRE	03(g)	06 (h)	04 (i)	13
TOTAL	23	44	21	88

To compute the value of Gamma (÷), we must first of all determine the values of both the positive (P_D) and negative (N_D) diagonal combinations and products before plugging these values into the gamma formula. In a 3 x 3 table, the formula for calculating P_D and N_D are as follows:

(i) $P_D = a(e + f + h + i) + b(f + i) + d(h+i) + e(i)$

(ii) $N_D = c(d + e + g + h) + b(d+ g) + f(g + h) + e(g)$

The formulae can now be used to analyze the previous data in which the political orientation has been cross tabulated with leadership styles adopted.

$P_D = a(e + f + h + i) + b(f + i) + d(h + i) + e(i)$

$= 07(29 + 09 + 06 + 04) + 09(09 + 04) + 13(6+4)+29(4)$

$= 7(48) + 9(13) + 13(10) + 29(4)$

$= 336 + 117 + 130 + 116$

$= \underline{699}$

$N_D = c(d + e + g + h) + b(d + g) + f(g + h) + e(g)$

$= 8(13 + 29 + 3 + 6) + 9(13 + 13) + 9(3 + 6) + 29(3)$

$= 8(51) + 9(16) + 9(9) + 29(3)$

$= 408 + 144 + 81 + 87$

$N_D = \underline{720}$

$$(\div) = \frac{P_D - N_D}{P_D + N_D}$$

$$= \frac{699 - 720}{699 + 720}$$

$$= \frac{-21}{1419}$$

$= -\underline{0.0147}$

Research Result: There is a negligible association between the Political orientation and the leadership styles adopted by the sampled population.

Interpretation: Those respondents who are conservatives, liberals and radicals are less likely to adopt Autocratic, Democratic and Laissez-faire style of leadership.

LAMBDA COEFFICIENT (λ)

Lambda coefficient (λ) is another test that is used for tables larger than 2x2 in which variables are nominal. The computation of Lambda coefficient (λ) is not, based on chi-square (χ^2). The test is used as an index of reducing the error in predicting values of one variable from values of another. It measures only the degree or strength rather than the direction of association. Lambda coefficient is easy to compute.

The formula is given as:

$$(\lambda) = \frac{F_{iv} - M_{dv}}{N - M_{dv}}$$

(λ) = Lambda coefficient

F_{iv} = Sum of the largest cell frequencies within each category of the independent variable.

M_{dv} = The largest marginal total among categories of the dependent variable.

N = The total number of cases.

A Lambda coefficient value of Zero indicates that there is no association between two variables while a value of 1 shows that there is a perfect association between the variables.

$$(\lambda) = \frac{F_{iv} = M_{dv}}{N - M_{dv}}$$

RESPONDENTS LEADERSHIP STYLES BY POLITICAL ORIENTATION

LEADERSHIP SYTLE	POLITICAL ORIENTATION			TOTAL
	CONSER-VATIVES	LIBERAL	REDICALS	
AUTOCRATIC	07	09	08	24
DEMOCRATIC	13	29	09	51
LAISSEZ-FAIRE	03	06	04	13
TOTAL	23	44	21	88

$$(\lambda) = \frac{F_{iv} - M_{dv}}{N - M_{dv}}$$

$$= \frac{(13+ 29 + 09) - 51}{88 - 51}$$

$$= \frac{51 - 51}{37}$$

$$= 0$$

Result: There is no association between the political orientation and the leadership styles adopted. Interpretation: From the calculation above, one can conclude that those respondents who are conservatives, liberals and radicals are not likely to adopt any of the leadership styles, since there is no relationship between political orientation and leadership style.

The result of the chi-square analysis of data in our table is not statistically significant. (Calculated χ^2 = 3.41; d.f = 4; α = 0.05). This result led to the acceptance of the null hypothesis. In the same vein, the result of the Gamma test shows that two variables (i.e. political orientation and leadership styles) are not related. Hence, we have to accept the null hypothesis. Again, we have adopted the Lambda analysis and the result of our analysis, like other tests carried out, using both Chi-square and Gamma, indicates that the null hypothesis (Ho) should be upheld while the alternative hypothesis (Hi) is rejected. The result is a pointer to the fact that relatively unknown tests like Gamma and Lambda can be as effective as popular non-parametric tests like Chi-square in hypothesis testing.

KRUSKAL-WALLISTESTS: ANALYSIS OF VARIANCE BY RANKS

W.H. Kruskal and W.A. Wallis reported a non-parametric test of significance in 1952 requiring only ordinal level (ranked) data. No assumptions about the shape of the populations are required by the test (Manson and Lind, 1990: 656).

For the Kruskal-Wallis test to be applied, the sample selected from the populations must be independent.

For the Kruskal-Wallis test:

(i) All the samples are combined

(ii) The combined values are ordered from low to high, and

(iii) The ordered values are replaced by ranks, starting with 1 for the smallest value.

The data used under the chi-square test of independence can be applied, using Kruskal-Wallis test. The first step in testing is to state the null and alternative hypotheses (see hypotheses stated above under chi-square).

LEADERSHIP SYTLE	POLITICAL ORIENTATION					
	CONSER-VATIVE	RANKS	LIBERALS	RANKS	RADI-CALS	RANKS
AUTOCRATIC	07	4	09	6.5	08	5
DEMOCRATIC	13	8	29	9	09	6.5
LAISSEZ-FAIRE	03	1	06	3	04	2
TOTAL	$\Sigma R_1 =$	13	$\Sigma R_2 =$	185	$\Sigma R_3 =$	13.5

NB: $n_1 = 3$ $n_2=3$ and $n_3 = 3$

$N = n_i + n_2 + n_3 = 9$

Solving H.

$$H = \frac{12}{N(N+1)} \left[\frac{(\Sigma r_1)^2}{n_1} + \frac{(\Sigma r_2)^2}{n_2} + \frac{(\Sigma r_3)^2}{n_3} \right] - 3(N+1)$$

$$= \frac{12}{9(9+1)} \left[\frac{(13)^2}{3} + \frac{(18.5)^2}{3} \; \frac{(13.5)^2}{3} \right] - 3(9+1)$$

$$= \frac{12}{90}\left[\frac{169}{3} + \frac{342.25}{3} + \frac{182.25}{3}\right] - 3\ (10)$$

$$= 0.133\left[56.33 + 114.08 + 60.75\right] - 3\ (10)$$

$$= 0.133\left[231.16\right] - 30$$

$$= 30.74428 - 30$$

$$H = 0.74428$$

$$= 0.74$$

Since the computed value of H (0.74) is less than critical value of 5.991, the null hypothesis is accepted at the 0.05 levels. This shows that there is no relationship between the political orientation and leadership styles adopted.

Our result shows that null hypothesis (H0) should be accepted while we reject the alternative hypothesis (H1). This shows that Kruskal-Wallis test, Gamma test, Lambda coefficient which are not commonly used like non-parametric tests, can be as effective as chi-square test in the test of hypothesis, using the same data.

THE EFFECTIVENESS OF THE NON-PARAMETRIC TECHNIQUES OF HYPOTHESIS TESTING.

In this paper we have adopted a number of non-parametric tests such as chi-square, Kruskal-Wallis, Gamma test, and Lambda tests for the analysis of the same data. Our results indicate that each of these tests is effective in hypothesis testing. However, it is important to state that the chi-square test of hypothesis is effective in decision making when the following occurs:

I If the variables drawn from independent samples are measured on nominal scale.

II In the case of Goodness of fit, the observed values are categorized into a number on non-overlapping categories.

III An appropriate level of significance is chosen, in order to reject the null hypothesis when it is meant to be acceptable.

On the other hand, the Kruskal-Wallis H-test is effective in hypothesis testing and decision-making if the following hold:

I The H approximates the χ^2 distribution when each of the P sample size s exceeds 5.

II the samples are random and independent

III The probability distribution from which sample are drawn is continuous

IV The ties are properly treated.

The Gamma, as indicated above, is computed on the basis of products of positive diagonal cells, minus products of negative diagonal cells, divided by the sum of this cross products. From this, we can deduce that Gamma determines how far the data cluster along the diagonals or conversely, how widely dispersed they are across the entire cells. If the data is more concentrated along the diagonals and in the cell below the diagonal, then the Gamma will be larger. Gamma also determines whether the data lay more along the positive than the negative diagonal. If the values are greater along the negative diagonal, the Gamma will have a negative sign (Ogbeide, 1997:193).

The Lambda coefficient is used as an index of reducing error in predicting values of one variable from values of another and it is used for tables larger than 2x2 in which the variables are nominal. One fundamental weakness of the Lambda coefficient is that it may take on a numerical value of zero, particularly in a 2x2 table, in instances where all of the other measures will not be zero. The situation may occur merely because one of the marginal of the dependent variables (row marginal) is much larger than the rest.

Despite this drawback, the Lambda coefficient, also known as Guttman's coefficient of predictability, is still useful for analyzing contingency tables, particularly those larger than 2x2 as demonstrated by its application in this paper.

Generally, it was discovered that the results of our analysis in the application of Chi-square, Kruskal-Wallis test; Lambda and Gamma tests show that the decision as to whether to accept or reject a null hypothesis remained unchanged.

It was discovered that, irrespective of the test employed in the analysis of data, the researcher would still arrive at the same decision. It is important to note that the Chi-square test involves more complex calculations than Kruskal-Wallis test, Lambda coefficient or Gamma test. This shows that these three non-parametric tests, though relatively unknown or unpopular, are equally effective in hypothesis testing in public sector management research and can be calculated with less difficulty.

Since the decisions taken when the Chi-square tests were used are not different from our decisions when all of kruskal-Wallis test, Gamma and Lambda were adopted, one may agree with the view of Soni Harnett (1991) and Jaccord & Becker (1990) that other non-parametric tests can be as powerful as the Chi-square test. Besides, their computation can be less tedious than the chi-square, since they do not require the correlation of the expected frequencies.

CONCLUSION AND RECOMMENDATIONS

From the discussions and analysis presented in this paper, we have been able to discover that non-parametric procedure is a statistical procedure that has (certain) desirable properties that hold under relatively mild assumptions, regarding the underlying population(s) from which the data are obtained. The rapid development of non-parametric statistical procedure include the fact that the proce-dures forgo the traditional assumption that the underlying population are normal; techniques are often (although not always) easier to apply than their normal theory counterparts; proce-dures are often quite easy to under-stand and are applicable in situations where the normal theory cannot be used.

Generally, there is one major condition for the application of non-parametric techniques of hypothesis testing. The condition is that the data should be measured on nominal and ordinal scales. According to Hickey (1986:172) many social science research projects involve variables that are measured on nominal and ordinal scales. For instance, measures of attitudes are often measured on linkent scales where the response categories are "Strongly agree", "agree", disagree" and "Strongly disagree". In this situation, sample distribution may be compared to some hypothesized distribution.

Thus, if the assumption of normality are satisfied, then the parametric tests, t and f, are most suitable. If it can be shown that the assumptions are grossly not satisfied, then, a distribution-free alternative (non-parametric test) should be used. In summary, in non-parametric statistics of hypothesis testing, probability statements accompanying these tests are exact, then calculations are rapid and easy to use, the procedures are widely acceptable, data can be analyzed on a weak measuring scale-that is, the ordinal scale. In contrast, parametric procedures should be avoided in these cases.

Only a few non-parametric tests have been considered in this paper. Many of them can be used in place of certain parametric tests. The question is, then which test do we use, the parametric or non-parametric test? Further, when there is more than one non-parametric test, which one do we use? As we have seen in the preceding analysis, there are varieties of tests, many of which somewhat duplicate the job done by others. What we must keep in mind is that we should use the best test for our particular needs. The power of the test and the cost of sampling as related to size and availability of the desired response variable, will play important roles in determining the specific test to be used.

More specifically, we have considered the chi-square test, which can be used to assess whether the distribution of cases across the categories of one classification scheme are different, depending on the category of another classification scheme. The Kruskal-Wallis test assesses the difference between K independent samples, while the Gamma is suited for analysing ordinal scale variable, although it can be applied to other categorical variables as well. It is a measure of the degree and direction of relationship between variables. The Lambda coefficient is used when the variables are nominal and it measures only the degree or strength rather than the direction of association. It is important to stress that a good manager must ascertain which statistical tools are most appropriate for his needs at any point in time.

It is appropriate to point out at this juncture that the non-parametric tech-niques are easy to compute. The tests typically are much more easier to learn and apply than the parametric tests. No sophistication in mathematics or statistics is required of any researcher or student using them. In addition, their interpretation often is more direct than the interpretation of parametric tests.

However, non-parametric statistics are often abused by researchers and students who do not bother to un-derstand when each non-para-metric statistics can be used, since it is easy to calculate and apply. Re-searchers and students often prefer non-para-metric statistics when it is obvious that parametric statistics are more appropriate. Thus, important date and time are wasted.

On the basis of the conclusion of this paper, the following recommendations are made.

First, in the use of non-parametric techniques of hypothesis testing, the sample size n should be made large enough, so that non-parametric test statistics would be power efficient, in order for it to yield a smaller value of â (Type II error) for the decision to be reliable. It is also safe to recommend that lecture on data analysis in research methodology should be packaged to accommodate a joint discussion of both parametric and non-parametric techniques with vivid explanation on their merits, and demerits.

Not only that, the use of non-parametric techniques should be taught more in research methodology so that student and other researchers will be more conversant with the technique. In addition, attention should be paid to other relatively unknown non-parametric tests such as Kruskal Wallis test, Wilcoxon test, Mann-Whitney test, Gamma test, Lambda coefficient, Pearson's contingency coefficient, Kolmogorov Smirnov test etc., since these tests are equally effective in hypothesis testing and they do not require much mathematical computation like the chi-square tests.

Also research supervisors in our tertiary institutions should be familiar with the application of these various non-parametric techniques of hypothesis testing in management research and advise their students on which of them should be used in a particular circumstance.

Finally, since many problems in business and public sector management require the use of non-parametric methods and the techniques so far discussed provide the managers with powerful tools for decision making, it is therefore recommended that further research be carried out on the effectiveness of these techniques of analysis in hypothesis testing and decision making. This will enable managers and administrators to be provided with framework that will guide them in organising information, investigating situations, arriving at choices and implementing decision.

BIBLIOGRAPHY

Aczel D. Amir (1999), Complete Business Statistics Boston: Mc Craw Hill PP. 669-739

Andrey Hanber and Flipin P. Richard (1980), Fundamentals of Behavioral Statistics, New York: Addis on Wesley Publishing Company P. 297.

Asika Nnamdi (1991) Research Methodology for Beharioural Science, Lagos: Longman Publishers.

Bartol M. Katheryn and David C. Martin, (1994) Management, New York: MC Graw Hill Inc, pp 231-233.

Black Ken (1994), Business Statistics: Contemporary Decision-Making, Minneapolis: West Publishing Company.

Cangelosi Vincent E. et.al. (1983) Basic Statistics: A Real World Approach, New York.

Conover W. J. (1971), Practical Non-Parametric Statistics, New York: John Willey & sow Inc.

Daft L. Richard and Richard M. Steers (1986) Organsiations: A Micro/Macro Approach Scott Foresman p.440

Denga Daniel and Anthony Ala (1983) Introduction to Research Methods & Statistics In Education & Social Sciences, Calabar: Rapid Education Publishers Ltd.

Encyclopaedia Americana (1964) The Encyclopaedia Americana vol. 25, Sulphuric Acid, USA: Encyclopedia Americana Incorporation pp 530-539.

Encyclopaedia of Professional Management, vol. I (1995) London: Fourth Grolier Printing pp 212-214.

Fagbohungbe O.B. (1993) Research Methods for Nigeria Tertiary institutions, Lagos: Kole Consults.

Fakuade (1977) "Mathematics as a service Subject" In Journal of the Science Teachers' Association of Nigeria Vol. 16, No1, December 1977, PP 82 & 89.

Fatula Grace (1996) Statistical Methods for Business and Technology, Akure: Time Vine Nigeria Ltd.

Ferguson George (1981), Statistical Analysis in Psychology and Education, New York: Hill Book company pp398-399

Hickey A. Anthony (1986) An Introduction to Statistical Techniques for Social Research, New York: Random House.

Jaccord and Becker (1990) Statistics for Beharioual Sciences, California: Wads Work Publishing Company.

Lerche C.O (1983) Social and Economic Statistics, London : Longman Group Ltd.

Levine M. David and Mark L. Berenson (1979), Basic Business Statistics, Englewood Cliffs, New Jersey: Prentice Hall Inc. P. 6.

Luce T (1996) Quantitative Techniques, London: Ashford Colour Press.

Manson and Lind (1990) Statistical Techniques in Business and Economics. Boston: Homewood pp 638-639, 656.

Manson et.al (1999) Statistical Techniques in Business and Economics, Boston: Mc Graw Hill pp 511-579.

Mc Clave J.T. and Benson P.G. (1988) Statistics for Business and Economics New York: Dellen Publishing.

Mendel Hall William (1968), Introduction to Probability and Statistics, California: Waldworth Publishing Company.

Nwadinigwe Ikechukwu (2000), Fundamentals of Research Methods and Statistics in Behavioural Sciences and Education, Lagos: Charado & Sons Publishing Co.

Ogbeide Uyi-Ekpen (1997) Statistical Techniques for Social and Management Sciences, Lagos: Amfit top Book Publishing Ltd, p. 184.

Onwe O.J. (1998) Elements of Project and Dissertation Writing, Lagos: Impressed Publishes

Osuala E. C. (2001) Introduction to Research Methodology, Onitsha: African-Fep Publishers Ltd.

Siegel Sidney (1956) Non-Parametric for Behavioural Sciences, New York: Mc Graw Hill Book Company.