AN APPLICATION OF NONPARAMETRIC STATISTICAL TECHNIQUES IN DETERMINING THE MOST PREFERED NETWORK PROVIDERS IN NIGERIA

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Abstract

Over the years, the improvement made by the different network providers in Nigeria has not satisfactorily met the customers' communication needs as there is a barrage of complaints of poor service in different network providers. As a result, the need to evaluate the quality of GSM received signal strength of the different mobile network providers, this study aimed at assessing the most essential and preferred network provider in the country. The data used were collected via student's opinions at the case study, Kaduna Polytechnic. The Mann – Whitney U test, Kruskal Wallis test, Chi-Square tests of independence, and Correlation analysis were applied for the analysis. The result from Mann – Whitney U test shows that there is no significant difference in the average number of usages of bandwidth types. Thus, from the rank's column, it was observed that Gigabytes has the highest average rank as an indication to the majority of the population subscribed to Gigabytes than megabytes, the Kruskal Wallis U Test result, indicates that there is a significant difference in populations' preference of network provider for the bandwidth's subscription. Similarly, the average rank column of the Kruskal Wallis U Test shows the MTN with the highest mean rank, placed as the most preferred network by the population of the study. Correlation and chi-square test resulted in a positive significant relationship among the network providers at the national level.

Keywords: Nonparametric Statistics, Sample Survey, MTN, AIRTEL, GLO, ETISALAT.

1.   INTRODUCTION

Nigeria is believed to be one of the largest telecommunication markets in the world, having estimated subscribers of about 149.2 million [1]. The subscribers base is in continuous increased and the sector has delivered a strong return on investments year on year. The telecommunication sector in Nigeria is a major contributor to the country's Gross Domestic Products (GDP) accounting for about 9.1% of the Nigerian Gross Domestic Product (GDP) [2].

Before 2013, telecommunication network subscribers were required to give up their mobile numbers for new ones when switching among the few network providers in Nigeria. This approach was not convenient for subscribers because of the attendant costs attached, thus, customers had to make do with the service that providers were offering, even if they were unsatisfied with it. With the increase in the number of providers, several service packages and strategies aimed at attracting new customers became common and leading to competition in the sector, and with the hands-off of government from regulation of the telecommunication sector, competition has become stiffer by the day, as expected of privatization, and subscribers now have a wider choice to justify their pays.

Hence, the different network providers strive for a larger market share, making the mobile telecommunication market to be more competitive and dynamic as the need to acquire new customers and retain the existing ones becomes a major issue for all competing firms. This service, according to Nigerian Communications Commission (NCC), would empower consumers, stimulate competition between the major service providers and enhance the delivery of their services in the country.

The year-on-year statistics show a steady increase in the number of porting requests, the average daily ports completed in 2013, 2014, and 2015 were 225, 405, and 592 respectively [3]. In this study, we considered four network providers (MTN, GLO, AIRTEL, and ETISALAT).

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MTN network provider is a member of the MTN Group, an acknowledged GSM Market leader and Africa's leading cellular telecommunications company. It becomes the first GSM network to make a call in Nigeria following the globally lauded Nigerian GSM auction conducted by the Nigerian Communication Commission earlier in the year.

Globacom network provider stands out as the first single company to build an $800 million high capacity fiber optics cable known as GLO. Airtel network provider is formerly known as Zain which was previously Celtel Nigeria. Etisalat network provider is the latest entrant into the GSM scene in Nigeria. Since the launch of GSM, mobile telephony has rapidly become the most popular method of voice communication in Nigeria. Growth in this sector has been so rapid that Nigeria has been rightly described in various media as one of the fastest-growing GSM markets in the world.

Available statistics for February 2015 to January 2016 revealed that subscribers who ported out of MTN Nigeria and Airtel were higher, given the data as 8,430 (January 2016), 10,737 (December 2015), 10,073 (November 2015), 11,414 (October 2015) and 3,409 (may 2013) as against Airtel Nigeria 4,396 (January), 3,188 (December), 3086 (November), 3056 (October) and 1,190 (May 2013) respectively (NCC, 2016), although subscribers who ported out of Globacom and Etisalat Nigeria were not many going by NCC's statistics. Etisalat recorded 976 (January), 1739 (December 2015), 1431 (November), 1241 (October), and 768 (May), while Globacom also recorded 1,065 (January), 2,092 (December), 2,377 (November), 1,703 (October) and 1,646 (May 2015) respectively. The good thing about MNP is that it has resulted new dimension to the competition in the industry forcing all network providers to work harder to earn the loyalty of subscribers because they now have choice and many factors drives their decisions[4].

Despite the tight competition and strategic means put in place by the various operators, Nigeria telecommunication subscribers have being influenced by several factors in their decision to leave or stay in a particular network.

Many researchers have worked on several aspects of the mobile networks especially the quality of service and received signal strength. Some of such works included. Some authors like Fajewonyomi [5], carried out a comparative study of the network performance of GLO and MTN. The researchers adopted an interview method to embark on the study thus interviewing most professionals and the public. Questionnaires were also deployed and visual observations made. Similarly, the authors Omorogiuwa and Edeko [6] using the GLO network and the net monitor software installed on a Nokia 3310 mobile carried out an investigation and modeling of power received at 1800MHZ in mountainous Terrain. The authors Olasunkanmi, Segun, Abolade, and Oluwole [7] carried out their evaluation of the GSM signal strength in terms of the network service bars. They employed the use of Nokia L600 GSM dual band (signal strength detector) supported by General Packet Radio Service (GPRS).

2.   METHOD

The study adopted a survey method to obtain the data. The population of the study consists of all subscribers that used any of the four popular network providers in Nigeria. Four hundred and twenty-seven (427) validly completed copies of the questionnaire were obtained from network subscribers in the study area.

2.1   Mann-Whitney U test

The Mann-Whitney U test is the alternative test to the independent sample t-test. It is a nonparametric test that is used to compare two population means that come from the same population, it is also used to test whether two population means are equal or not. It is used for equal sample sizes and is used to test the median of two populations. Usually, the Mann-Whitney U test is used when the data is ordinal. Wilcoxon rank-sum, Kendall's and Mann-Whitney U test are similar tests and in the case of ties, it is equivalent to the chi-square test.

Mann-Whitney U test is used for every field but is frequently used in psychology, medical/nursing, and business. In medicine, it is used to know the effect of two treatments and whether they are equal or not. It is also used to know whether or not a particular drug cures the ailment or not. In business, it can be used to know the preferences of different people and it can be used to see if that changes depending on location administration analysis and reporting.

$$U_i = n_i n_i + \frac{n_i(n_i+1)}{2} - R_i \qquad\qquad (1)$$

Where:

U = Mann-Whitney U test

n_i = sample sizes

R_i = Rank of the sample size used

2.2   Kruskal-Wallis Test

The Kruskal-Wallis Test was developed by Kruskal and Wallis [8] jointly and is named after them. The Kruskal-Wallis test is a nonparametric (distribution-free) test and is used when the assumptions of ANOVA are not met. They both assess for significant differences on a continuous dependent variable by grouping independent variables (with three or more groups).

In the ANOVA, we assume that the distribution of each group is normally distributed and there is approximately equal variance on the scores for each group. However, in the Kruskal-Wallis Test, we do not have any of these assumptions. Like all non-parametric tests, the Kruskal-Wallis Test is not as powerful as the ANOVA.

$$H = \frac{12}{N(N+1)} \sum \frac{R_i^2}{n_i} - 3(N+1) \tag{2}$$

Where,

H = Kruskal-Wallis Test statistic

n_i = total number of observations in all samples

R_i = Sum of the ranks assigned

The Kruskal-Wallis test statistic is approximately a Chi-square distribution, with k-1 degrees of Freedom where n_i should be greater than 5. If the calculated value of the Kruskal-Wallis test is less than the critical chi-square value, then the null hypothesis cannot be rejected. If the calculated value of the Kruskal-Wallis test is greater than the critical chi-square value, then we can reject the null hypothesis and say that the sample comes from a different population.

2.3   Chi-square (χ^2) test

A Chi-square (χ^2) test is a nonparametric statistical test used to determine if the two or more classifications of the samples are independent or not.

$$\chi^2 = \sum_{i=1}^{r} \sum_{j=1}^{c} \frac{(O_{ij} - e_{ij})^2}{e_{ij}} \tag{3}$$

Where,

e_{ij} = the expected value in the contingency table,

O_{ij} = the observed value in the contingency table

Degree of freedom df = (r-1) (c − 1)

2.4   Correlation analysis

Correlation analysis is the measure of the degree of relationship between two variables, one is dependent and the other is independently incurred. Correlation is a statistical method to investigate two or more quantitative variables. Correlation coefficients are range from -1 to 1 when the value of the correlation coefficient is close to positive or negative 1 then we says the two variables are highly correlated. As the coefficient approached 0, we say the relationship between the two variables is said to be weaker.

$$r = \frac{n\sum_{i=1}^{n} x_i y_i - \sum_{i=1}^{n} x_i \sum_{i=1}^{n} y_i}{\sqrt{\left(n\sum_{i=1}^{n} x_i^2 - \left(\sum_{i=1}^{n} x_i\right)^2\right)\cdot\left(n\sum_{i=1}^{n} y_i^2 - \left(\sum_{i=1}^{n} y_i\right)^2\right)}} \tag{4}$$

Where,

n = number of observation

x_i = dependent variables

y_i = independent variables

2.5   Research Hypothesis

H_O: $\mu_1 = \mu_2 = \mu_3$ (there is no significant difference among the network providers, at least one is not significant)

H_1: $\mu_1 \neq \mu_2 \neq \mu_3$ (there is a significant difference among the network providers, at least one is significant).

3.   DISCUSSION OF RESULT

Table 3.1 Respondents opinion on network providers of the type of Bandwidth

Type of Bandwidth	ND1	ND2	HND1	HND2	Total	%
Mega Bytes	45	47	27	29	166	39
Giga Bytes	94	104	48	15	261	61
Total	139	151	77	60	427	100

Source: Department of Mathematics and Statistics Kaduna Polytechnic, 2021

The result in table 3.1 depicts that about 61% of the study population, their subscription were Gigabytes, thus, a higher number of those who subscribed to Gigabytes are ND2 students.

Table 3.2 Respondents choice of Bandwidth Network Providers

	ND1	ND2	HND1	HND2	Total	%
Network provider						
MTN	93	85	56	44	278	65.1
GLO	9	16	5	6	36	8.4
Airtel	33	38	13	6	90	21.1
Etisalat	5	9	4	5	23	5.4

Source: Department of Mathematics and Statistics Kaduna Polytechnic, 2021

The result from table 3.2 represents respondent's opinions on bandwidth network providers, thus, more than half 65.1% of the students subscribed to MTN network for bandwidth, while 21.1% subscribed to Airtel. Furthermore, a high number of those who subscribed to MTN and Airtel network for the provision of bandwidth were ND1 and ND2 students respectively.

Table 3.3 Respondents opinion on Subscription Time

	ND1	ND2	HND1	HND2	Total	%
Subscription Time						
Morning	8	25	8	8	49	11.5
Afternoon	106	109	58	43	316	74.0
Evening	24	15	14	9	62	14.5

Source: Department of Mathematics and Statistics Kaduna Polytechnic, 2021

The result in Table 3.3 represents the respondent's opinion on subscription time. It depicts about 74% of the students in the afternoon section subscribed most. The finding also divulged that majority of those who subscribed in the afternoon period were ND1 and ND2 students respectively.

Table 3.4 Mann-Whitney U test

Type of Subscription	Mean Rank	Mann-Whitney U	p-value
Mega bytes	3.50	4.00	.343
Gigabytes	5.50		

Source SPSS 2020 version

The result in Table 3.4 shows the Mann-Whitney U test for the difference in the average number of network providers. By indication from the p-value, there exists no difference for the two variables in respect to the Mann-Whitney U - the value of 4.00 and the p-value of 0.343 at 0.05 alpha levels. Since the p-value is greater than 0.05, we fail to reject the null hypothesis. The findings show that there is no significant difference in the average number of usages of bandwidth between Megabytes and Gigabytes. Thus, from the mean rank column, it was observed that Gigabytes with the highest mean rank (5.50), reflect that majority of the students subscribed in Gigabytes. This analysis indicates that the average number of students that subscribed to a bandwidth of Megabytes and Gigabytes does not differ significantly.

Table 3.5 Kruska-wallis test

Network Provider	Mean Rank	Kruskal-Wallis H	Df	p-value
MTN	14.50	11.588	3	.009
Glo	6.63			
Airtel	9.38			
Etisalat	3.50			

Source: Researcher's work

The result in Table 3.5 represents the Kruska-Wallis test for the difference in student's preference of Network Provider. By the calculated Kruska-Wallis values

($\chi^2 = 11.588$) and the p-value of 0.009 at 0.05 alpha levels, there is sufficient statistical evidence for the rejection of the null

hypothesis. However, the result shows that there is a significant difference in students' preference of network provider for

the subscription of bandwidth, the need of post hock test arrived. Again, from the mean rank column, it is observed that

MTN with the highest mean rank (14.50), reflects that the network is the most preferred network by students for bandwidth

subscriptions.

Table 3.6 ANOVA A Post Hock test

NETWORK PROVIDERS		Sum of Squares	Df	Mean Square	F	P-value
MTN	Between Groups	424.500	2	212.250	.177	.860
	Within Groups	1200.500	1	1200.500		
	Total	1625.000	3			
GLO	Between Groups	69.500	2	34.750	7.722	.247
	Within Groups	4.500	1	4.500		
	Total	74.000	3			
AIRTEL	Between Groups	348.500	2	174.250	.478	.715
	Within Groups	364.500	1	364.500		
	Total	713.000	3			

Source: Researcher's work

The result in Table 3.5 represents a post hock test; this indicates that the p – values of both network providers are greater than the alpha value, we, therefore, uphold the null hypothesis. Thus the result shows that there is no significant difference in students' preference of network providers for the subscription of bandwidth.

Table 3.7 Chi-Square Analysis

			Classes				
			ND1	ND2	HND1	HND2	Total
Time	Morning	Count	8	25	8	8	49
		Expected Count	15.8	17.1	9.2	6.9	49.0
	Afternoon	Count	106	109	58	43	316
		Expected Count	102.1	110.3	59.2	44.4	316.0
	Evening	Count	24	15	14	9	62
		Expected Count	20.0	21.6	11.6	8.7	62.0
Total		Count	138	149	80	60	427
		Expected Count	138.0	149.0	80.0	60.0	427.0

Source: Researcher's work

The result in Table 3.5, revealed the Chi-square analysis on time of subscription and various levels of students, this finding sought to indicate if the time of bandwidths' subscription of students depends on their level. Thus, the estimated = 11.409, DF= 6, p-value = 0.077, which indicates that the null hypothesis fails to be rejected. In summation, the subscribing time of network providers depends on the level of students. It further implies that there is no significant relationship between subscribing time of bandwidth and level of students in the case study.

Table 3.8 Correlation Analysis

		MTN	GLO	AIRTEL	ETISALAT
MTN	Pearson Correlation	1	.969	.999*	.992
	Sig. (2-tailed)		.159	.027	.081
	Sum of Squares and Cross-products	5528.000	5260.000	2868.000	2078.000
	Covariance	2764.000	2630.000	1434.000	1039.000
	N	4	4	4	4
GLO	Pearson Correlation	.969	1	.979	.993
	Sig. (2-tailed)	.159		.132	.078
	Sum of Squares and Cross-products	5260.000	5330.667	2758.667	2042.000
	Covariance	2630.000	2665.333	1379.333	1021.000
	N	4	4	4	4
AIRTEL	Pearson Correlation	.999*	.979	1	.996
	Sig. (2-tailed)	.027	.132		.054
	Sum of Squares and Cross-products	2868.000	2758.667	1490.667	1084.000
	Covariance	1434.000	1379.333	745.333	542.000
	N	4	4	4	4
ETISALAT	Pearson Correlation	.992	.993	.996	1
	Sig. (2-tailed)	.081	.078	.054	
	Sum of Squares and Cross-products	2078.000	2042.000	1084.000	794.000
	Covariance	1039.000	1021.000	542.000	397.000
	N	4	4	4	4

Source: Researcher's work

From Table 3.8, the correlation is significant at the 0.05 level (2-tailed). However, the test of the relationship between the network providers shows that MTN to itself exists a perfect relationship. The correlation coefficient among the network providers was found between Airtel is strong positive relation (0.999), Etisalat with (0.992), Glo with (0.979), and MTN with (0.969) respectively. Therefore, any increase or decrease in-network providers is equally causing to others among them.

CONCLUSION
Global System for mobile Communication (GSM) is a telecommunication network that is used globally for communication services such as voice communication, data connection for fax, short message service (SMS) and full dial-up connection to the internet for e-mail and web browsing. The effectiveness of the GSM network depends largely on the quality of its received signal strength; therefore, knowing the network with the best received signal strength (RSS) in an area helps the subscribers in their communication-voice and data. In this paper, we considered four networks providers (MTN, GLO, AIRTEL and ETISALAT) which was carried out in Kaduna Polytechnic.
The study was able to identify the most preferred network providers. Thus from the mean rank table, it was observed that MTN with the highest rank (14.50) reflects that MTN network is the most preferred network by students in Kaduna Polytechnic.
Indication to the majority of the population subscribed to Gigabytes than megabytes, the Kruskal Wallis U Test result, indicates that there is a significant difference in populations' preference of network provider for the bandwidth's subscription.
Similarly, the average rank column of the Kruskal Wallis U Test shows the MTN with the highest mean rank, placed as the most preferred network by the population of the study. Correlation and chi-square test resulted in a positive significant relationship among the network providers at the national level.

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