ON ASSESSMENT OF GSM QUALITY OF SERVICE BASED ON NETWORK TYPES AND PHONE BRAND FOR EFFICIENT KNOWLEDGE FRAMEWORK

ISSN: 2141 – 3290
www.wojast.com

*** RAHEEM[1] M. A. AND BASSEY[2] P. C.**
[1]*Department of Mathematics and Statistics, University of Uyo, Uyo, Nigeria*
[2]*Department of Computer Science, University of Uyo, Uyo, Nigeria*
[1]*rahemarsac@yahoo.com* , [2]*imecb@yahoo.com*

ABSTRACT

The need for the network operators to provide unprecedented quality of service (QoS) in other to attract, maintain and move subscribers to high value services necessitate this study. The quality of services provided by the popular GSM operators in Uyo metropolis was examined. Questionnaires were administered to collect relevant information relating to problems of no connectivity and terminated calls (also known as 'down time') experienced by the subscribers between 9am–12noon and 12noon-4pm for working days (Mondays- Fridays); and 8am–6pm for weekends (Saturdays and Sundays). The phone brands and time (weeks) were separately cross-classified with network types. Chi-square (χ^2) test of independence (test of no association) and the quality control chart for attribute (U–Chart) were adopted in analyzing the data. The results show that the network types and the time (weeks) are not significantly independent with respect to both problems. Also, the network type is independent (not associated with) of phone brand from 9am-12noon, but are significantly not independent from 12noon-4pm with respect to the two problems. On the average, based on the proportions of out of control points with respect to these problems, the providers can be ranked as the 1st : B (13%, 3%), 2nd : D (15%, 10%), 3rd : C (30%, 13%) and 4th :A (45%, 33%) respectively in their quality of service.

INTRODUCTION

GSM is an acronyms standing for Global System for Mobile communication. The GSM revolution in Nigeria started in August 2001 during the administration of President Olusegun Obasanjo. The first GSM call was made and has brought a great change in the face of information and communication technology (ITC) in Nigeria. The event heralded the beginning of a new era (era of GSM technology) which is completely aimed at reshaping the face of business transaction since it was launched. Consequently mobile telephone has rapidly become the most popular method of voice communication in Nigeria. Growth in this sector is so rapid that Nigeria has been rightly described in various media as "one of the fastest growing GSM market in the world." (Adegoke *et.al.,* 2008).

The telecommunication industry has changed a lot within ten years that the first GSM call was made, with fierce competition for subscribers among the service operators. One thing that Nigerians are worried about is the quality of service being provided by the operators. The euphoria of owning a phone is gradually giving way to complaint of terminated (dropped) calls and no connectivity. Most operators have a lot of work to do as regards quality of service (QoS) especially in the area of congestion so as to be able to cope with increasing number of subscribers on their respective networks. Competition is getting fierce by the day as the increasing numbers of operators have to compete desperately for the same potential subscribers (Ajala, 2005). Due to this competition, focus is gradually shifting from providing coverage to providing quality service. This explosive growth has brought huge revenue to both the operators and the government through tax and license fees. This establishes the fact that performance of network has direct impact on revenue. The Nigerian communication commission (NCC), a regulatory body empowered by the federal government to check the activities of those providers has continued to mount pressure on the operators towards stepping up the quality of service offered to Nigerians and had even gone a step further to award contract to private companies to conduct comparative analysis of the quality of service offered by each of the operators as well as sanctioning those that are not doing well.

Oyatoye and Okafor (2011) carried out research on an evaluation of the service delivery of telecommunication companies in Nigeria. The population of study consists of the three major network providers namely MTN, CELTEL, and GLOBACOM with keen interest on base station in Nigeria.

Suitable data that address traffic in GSM calls were collected in respect of the sample base station. Data collected included the number of attempted calls, successful calls and failed calls for a 24-hour period in each of the selected based stations of the considered telecommunication companies. The data obtained from the base stations were analyzed by a sequential simulation to find out if GSM calls of the selected network provider operate at optimal level. Descriptive statistics were used to describe the characteristic of these base stations. Analysis of variance was applied at 95% confidence interval to check if there is significant difference between the three network providers. Regression and correlation analysis were used to further explore the relationships between attempted calls, success calls and failed calls. Globacom had the highest mean value of successful calls (122.2) as against CELTEL (118.04) and MTN (52.38). This implies that GLOBACOM was the most functional in terms of optimizing GSM calls. It was also observed that the problems of no connectivity, account balance checking, suspended calls and poor SMS access are traceable to both location and network types (Bassey and Raheem; 2011). Although some of these problems are being addressed, efforts are still required to be intensified so that the subscribers would enjoy and have value for what they pay for.

However, this research work seeks to evaluate and access the level of performance of some popular GSM network providers operating in Uyo, in terms of problem of no connectivity and that of terminated (dropped) calls. The need for the network operators to provide unprecedented quality of service in other to attract, maintain and move subscribers to high value services necessitate this research study on the subject. Meanwhile, this work is aimed at assessing and comparing the quality of services provided by the network operators within Uyo metropolis. In line with the above, the following objectives come to play:

To determine if the problem of no connectivity is independent of network types and phone brands

To determine if the problem of terminated calls is associated with network types and phone brands

To see if the network types and time (weeks) are associated with respect to the problem of no connectivity and terminated calls

To see if the problems of no connectivity and terminated calls are statistically in control with respect to network providers

DESIGN AND METHODS

An average of thirty questionnaires were administered on daily basis to the subscribers of one or more of the four popular networks in Uyo metropolis right from the third week of October 2011 to the second week of November 2011, thus making the data a primary one. Meanwhile, the actual names of the GSM were used during survey but for privacy they are replaced with A, B, C, D, especially during report. The data obtained were pooled with respect to the observed problems encountered majority by subscribers of the various GSM networks considered in this work. The observation based on the problems of no connectivity and terminated calls experienced within the busy periods; which are periods ranging from 9:00am to 4:00pm on week days, and 8:00am to 6:00pm weekend, were cross-classified according to time (weeks) and network types, as well as the phone brand (or types) and network types. These were done to suit into the thought out methodologies. Meanwhile, the week day periods were also divided into early busy periods (from 9:00am – 12:00noon) and later busy periods (from 12noon – 4:00pm) for the purpose of this research. The two problems (no connectivity and terminated calls) are however viewed as defects. Chi-squared χ^2 tests of independence and control chart for attributes are the basic tools in the analysis of the data.

METHODOLOGIES

This section is meant to discuss the various methodologies adopted in this research to realize the set objectives.

Chi-Squared (χ^2) Test for Independence

A chi-square (χ^2) test is a measure of discrepancy between the actual and the expected frequencies. The larger the value of χ^2 , the greater the discrepancy between the actual and expected frequencies. If $\chi^2 = 0$, then the actual and the expected frequencies are not significantly different, otherwise $\chi^2 > 0$. In testing for independence two variables are involved, the number of rows r and the number of columns c would depend on the number of groups into which the two variables are categorized. This table is called r x c contingency table.

Assumptions and Conditions for the use of χ^2 Test

i) The observed data set satisfy the properties of a multinomial experiment. That is, the data for variable must be independent. Meaning each subject is observed only once.

ii) Data are treated as nominal variable, even if ordered.

iii) For chi-square χ^2, if the expected frequencies are less than 5, the tests of significance are liberal. At least 80% of the expected frequencies should be greater than or equal to 5. All should be at least 5 for a 2 x 2 chi-square.

The Test Statistic

$$\chi^2_{cal} = \sum\left[\frac{(n_{ij}-e_{ij})^2}{e_{ij}}\right] \sim \chi^2_{(r-1)(c-1);\alpha}$$

$$e_{ij} = \frac{R_i \text{ x } C_j}{G}$$

Where n_{ij} is the observed frequency in the *ith* row and *jth* column.

e_{ij} is the expected frequency in the *ith* row and *jth* column.

G is the grand total of observed frequency.

R_i is the *ith* row marginal total

C_j is the *jth* column marginal total

The Decision Rule

The test reject H_0 if $\chi^2_{cal} > \chi^2_{\alpha,(r-1)(c-1)}$ OR $p-value < \alpha$

Where (r-1)(c-1) is the degree of freedom and α is the level of significance

Hypothesis Testing in Ch-square Test of Independence

H_0: i^{th} problem with respect to k^{th} network type is independent of phone type/time

H_1: i^{th} problem with respect to k^{th} network type is not independent of phone type/time.

Control Chart for Attributes

Control chart is a statistical device principally used for the study and control of repetitive processes. It is essentially a graphic device for presenting data so as to directly reveal the frequency and extent of variables from established standards. A control chart consists of three horizontal lines

i) A Central Line (CL) to indicate the desired standard or level or the process.

ii) Upper Control Limit (UCL)

iii) Lower Control Limit (LCL)

The basis of control chart is the setting up of upper and lower control limits. These limits are used as a basis of judging the significance of the quality variation from sample to sample, lots to lots or from time to time. The moment a point falls outside these limits, it is taken to be a danger signal.

Control charts for attribute are used to study those product characteristics which are not amenable to measurement such characteristics can only be identified by their presence or absence from the product.

Hypothesis Testing in Control Charts

H_0: i^{th} problem through k^{th} network provider experienced daily is statistically within control

H_1: i^{th} problem through k^{th} network provider experienced daily is not statistically within control

U – Chart: Control chart for C is used in situation wherein in the inspection consist of determining the number of defects C in a sample. U – Chart is an alternative chart for C – Chart, it is used with data collected in sub-groups of varying sizes.

The central line of the control chart for U is U and the 3 – sigma control limit are:

$$\text{UCL} = \bar{u} + 3\sqrt{\frac{\bar{u}}{n}} = \bar{u} + 3\sigma_u \quad (3.1)$$

$$\text{LCL} = u - 3\sqrt{u} = \bar{u} - 3\sigma_u \quad (3.2)$$

$$\text{CL} = \bar{u} = \frac{\sum c}{\sum n} \quad (3.3)$$

Where: 'c' is the number of defective, 'n' is the sample size in each sub-groups

ANALYSIS

A chi-square (x^2) test of independence and control chart for Attribute (U-chart) earlier discussed in section three were applied in analyzing the data. The data collected for each of the four selected network types, having been cross-classified (see Tables 1-8) were analyzed using SPSS; the following were the interpretations of the results obtained:

(i) The H_0^1 was rejected implies that the problem of No connectivity calls between 9am-12noon is influenced by or are associated with the phone types and network types.

(ii) The H_0^2 was not rejected which means that problem of no connectivity calls between 12noon – 4pm is independent indicating that phone types and Network types has no significant association with or influence on the problem.

(iii) The H_0^3 was rejected implies that the problem of terminated calls between 9am – 12noon is significant i.e. there is association between the phone types and Network type.

(iv) The H_0^4 was not rejected indicates that problem of terminated calls are not influence by the phone types and Network types between 12noon-4pm.

(v) The H_0^5 was rejected implies that the problem of No connectivity calls are traceable to time (weeks) and Network types 9am – 12noon.

(vi) The H_0^6 was rejected implies that the problem of No connectivity calls between 12noon – 4pm are associated with time (weeks) and Network types.

(vii) The H_0^7 was rejected for the problem of terminated calls between 9am-12noon implies that the problem of terminated calls are associated with the time (weeks) and Network types

(viii) The H_0^8 was rejected meaning the Network types and time (weeks) are not independent with respect to problem of terminated calls from 12noon-4pm.

(ix) The H_0^9 was rejected, indicating the daily problem of no connectivity due to k^{th} provider is statistically out of control.

(x) The H_0^{10} was rejected, meaning the daily problem of terminated calls due to k^{th} provider is statistically out of control

Table 1: Phone type and Network type for Problem of No connectivity between 9a.m-12noon

Network types			MTN	GLO	AIRTEL	ETISALAT	Total
Phone Types	1	Count	70	60	70	84	284
		Expected Count	60.6	75.5	69.7	78.2	284.0
	2	Count	40	72	38	44	194
		Expected Count	41.4	51.6	47.6	53.4	194.0
	3	Count	50	76	79	60	265
		Expected Count	56.6	70.4	65.0	73.0	265.0
	4	Count	40	41	43	70	194
		Expected Count	41.4	51.6	47.6	53.4	194.0
Total		Count	200	249	230	258	937
		Expected Count	200.0	249.0	230.0	258.0	937.0

Table2: Phone types * Network type on Problem of No connectivity from 12noon to 4:00pm

Network types			MTN	GLO	AIRTEL	ETISALAT	Total
Phone Types	1	Count	76	33	42	44	195
		Expected Count	64.0	43.2	47.9	39.9	195.0
	2	Count	23	33	40	33	129
		Expected Count	42.4	28.6	31.7	26.4	129.0
	3	Count	71	38	40	38	187
		Expected Count	61.4	41.4	45.9	38.3	187.0
	4	Count	48	43	41	21	153
		Expected Count	50.2	33.9	37.6	31.3	153.0
Total		Count	218	147	163	136	664
		Expected Count	218.0	147.0	163.0	136.0	664.0

Table 3: Phone types * Network type on Problem of terminated calls between 9:00am – 12noon

Network types			MTN	GLO	AIRTEL	ETISALAT	Total
Phone Types	Nokia	Count	91	77	76	75	319
		Expected Count	85.9	75.9	82.2	75.1	319.0
	Samsung	Count	59	61	67	53	240
		Expected Count	64.6	57.1	61.8	56.5	240.0
	China	Count	94	77	89	99	359
		Expected Count	96.6	85.4	92.5	84.5	359.0
	Others	Count	82	73	80	58	293
		Expected Count	78.9	69.7	75.5	69.0	293.0
Total		Count	326	288	312	285	1211
		Expected Count	326.0	288.0	312.0	285.0	1211.0

Table4: Phone types * Network type on Problem of terminated calls between 12noon-4:00pm

Network types			MTN	GLO	AIRTEL	ETISALAT	Total
Phone Types	1	Count	60	56	47	68	231
		Expected Count	59.4	54.3	61.0	56.4	231.0
	2	Count	60	38	52	34	184
		Expected Count	47.3	43.2	48.6	44.9	184.0
	3	Count	50	58	60	52	220
		Expected Count	56.5	51.7	58.1	53.7	220.0
	4	Count	52	51	69	57	229
		Expected Count	58.8	53.8	60.4	55.9	229.0
Total		Count	222	203	228	211	864
		Expected Count	222.0	203.0	228.0	211.0	864.0

Table5: Time * Network type for Problem of No connectivity from 9:00am- 12noon

Network types			MTN	GLO	AIRTEL	ETISALAT	Total
Weeks	1	Count	174	31	133	54	392
		Expected Count	189.2	37.2	115.8	49.8	392.0
	2	Count	120	3	59	27	209
		Expected Count	100.9	19.8	61.8	26.5	209.0
	3	Count	57	27	14	4	102
		Expected Count	49.2	9.7	30.1	13.0	102.0
	4	Count	10	10	15	10	45
		Expected Count	21.7	4.3	13.3	5.7	45.0
Total		Count	361	71	221	95	748
		Expected Count	361.0	71.0	221.0	95.0	748.0

Table 6: Time * Network type for Problem of No connectivity from 12noon-4:00pm

Network type				GLO	AIRTEL	ETISALAT	Total
Weeks	1	Count	193	33	102	56	384
		Expected Count	205.2	35.3	96.4	47.1	384.0
	2	Count	115	8	42	17	182
		Expected Count	97.2	16.7	45.7	22.3	182.0
	3	Count	46	17	9	7	79
		Expected Count	42.2	7.3	19.8	9.7	79.0
	4	Count	12	5	19	4	40
		Expected Count	21.4	3.7	10.0	4.9	40.0
Total		Count	366	63	172	84	685
		Expected Count	366.0	63.0	172.0	84.0	685.0

Table 8: Time * Network type for Problem of Terminated calls from 12noon-4:00pm

Network types			MTN	GLO	AIRTEL	ETISALAT	Total
Weeks	1	Count	117	12	64	34	227
		Expected Count	110.0	17.5	63.3	36.1	227.0
	2	Count	62	6	29	25	122
		Expected Count	59.1	9.4	34.0	19.4	122.0
	3	Count	26	10	9	4	49
		Expected Count	23.8	3.8	13.7	7.8	49.0
	4	Count	2	5	17	5	29
		Expected Count	14.1	2.2	8.1	4.6	29.0
Total		Count	207	33	119	68	427
		Expected Count	207.0	33.0	119.0	68.0	427.0

RESULTS AND DISCUSSION

The result for this research work shows that from 9am-12noon and from 12noon-4pm, the network types and time (weeks) are statistically not independent(associated) with respect to both problems, implying

that the problems are traceable to various network types and time (weeks). From 9am-12noon for the problem of no connectivity and from 12noon-4pm for the problem of terminated calls, the null hypotheses were not rejected with respect to phone brand and network type (Table 9).

Table 9: Results on Tests of Independence

Hypothesis	Chi-sq. calculated value	Chi-sq. tabulated value	p-value (p)	Decision Rule	Decision
1	31.12	16.92	0.000	P< 0.05	Reject H_0
2	16.422	16.92	0.059	p>0.05	Do not reject H_0
3	27.962	16.92	0.001	P<0.05	Reject H_0
4	8.002	16.92	0.534	p>0.05	Do not reject H_0
5	87.683	16.92	0.000	P<0.05	Reject H_0
6	45.05	16.92	0.000	P<0.05	Reject H_0
7	50.585	16.92	0.000	P<0.05	Reject H_0
8	43.504	16.92	0.000	P<0.05	Reject H_0

The following results as summarized in the tables 10-15 were obtained from the control charts for both problem of no connectivity and terminated call.

Table10: Problem of No connectivity from 9:00a.m-12noon for 20 Working Days

Network Types	A	B	C	D
No. of Out-of-Control points	9	2	9	2
Proportion of Out-of-Control points (%)	45	10	45	10

Table11: Problem of No connectivity from 12:00 noon-4:00p.m for 20 Working Days

Network types	A	B	C	D
No. of Out-of-Control points	9	3	3	4
Proportion of Out-of-Control points (%)	45	15	15	20

Table12: Problem of Terminated calls from 9:00a.m-12noon for 20 Working Days

Network types	A	B	C	D
No. of Out-of-Control points	5	0	3	2
Proportion of Out-of-Control points (%)	25	0	15	10

Table13: Problem of Terminated calls from12noon-4:00 p.m for 20 Working Days

Network types	A	B	C	D
No. of Out-of-Control points	8	1	2	2
Proportion of Out-of-Control points (%)	40	5	10	10

Table14: Problem of No connectivity from 8:00a.m-6:00p.m for 8 Weekend Days

Network types	A	B	C	D
No. of Out-of-Control points	2	2	4	1
Proportion of Out-of-Control points (%)	25	25	50	12.5

Table15: Problem of Terminated calls from 8:00a.m-6:00p.m for 8 Weekend Days

Network types	A	B	C	D
No. of Out-of-Control points	3	2	1	2
Proportion of Out-of-Control points (%)	37.5	25	12.5	25

Under control chart it is observed that virtually in all cases both problems are statistically out of control but with varying degrees. Thus the proportion of out of control points relative to each provider is

summarized as follows: for no connectivity problem- A(45%), B(13%), C(30%) and D(15%); for terminated calls problem- A(33%), B(3%), C(13%) and D(10%).

CONCLUSION

Based on the findings of this research, it was observed that the higher the number of subscribers to a particular provider the lower the QoS. For example provider A is being subscribed to most yet its QoS dropped considerably with respect to the two problems (No connectivity and terminated calls). Also it was found that time of calls significantly influenced the QoS with respect to the two problems experienced by most subscribers of the various network types. Meanwhile QoS has nothing to do with phone brand (or type) especially among the subscribers within Uyo metropolis. On the average, the operators' level of performance with regards to the quality of service may be ranked thus: 1st (B), 2nd (D), 3rd (C) and 4th (A). Thus, one could conclude that provider B is comparatively the most reliable in terms of the two problems, followed by provider D. With this findings it is expected that subscribers need to look inward when making the choice of which network satisfies their needs and reduces the burden of frustration, which may be traced to the two problems. However, it is to be noted that findings of this research is flexible in that there is bound to be improvement on the QoS given the fact that each of the providers identifies and deals with factor(s) causing these problems and step up their QoS.

ACKNOWLEDGEMENTS

The contributions of research students which include Offiong, Inem Patrick, George, Ekemini Udoudo, Esua, Blessing Edeke, Ukpong, Benjamin Edet, towards the success of this research are highly appreciated;

REFERENCES

Adegoke, A., Babalola, I. and Balogun, W. Performance Evaluation of GSM Mobile System in Nigeria. *The Pacific Journal of Science and Technology.* (9) 2.

Ahmad A. and Ahmad H. (2008). Mix Drivers of Clients Satisfaction in Technology–enabled Service: *Study of Nigerian GSM Subscribers, communications of the IBIMA*, (1).

Ajala I. (2005). GIS and GSM Network Quality Monitoring: A Nigerian Case Study. http://www.directionsmagcom/articles/gis-and-gsm-network quality-monitoring-a-nigerian-case-study/123278.

Bassey, P. C. and Raheem, M. A. (2011). "Dynamic Control Ontology for Efficient GSM Quality of Service", Information Technology for People Centered Development. Nigerian Computer Society (NCS) 10th International Conference.

Gupta, C. B. and Gupta, V. (2005). An Introduction to Statistical Methods, 23rd Revised Edition. *Vikas Publishing House.*

Oyatoye E. O. and Okafor A. A. (2011). "An Evaluation of the Service Delivery of Telecommunication Company", *International Journal of Academic Research.* (3) 2.

Palm, C. C. (1988). Intensity Variations in Telephone Traffic North Holland Studies in Telecommunication, *Publisher Elsevier,* and Hand Cover.

Shoewu, O. and Edeko, O. (2011), Outgoing Call Quality Evaluation of GSM Network Services, *American Journal of Scientific and Industrial Research*. 2(3), 409-417.