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Comparative Analysis of GSM and CDMA, Strength and Weakness, Future Challenges and Practical Solutions (A Case Study of MTN and NITEL Nigeria

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Abstract

Considering the strength, weakness, future challenges and practical solutions of GSM and CDMAA, this paper comprehensively compares GSM and CDMA by making use of telecommunication service operators in Nigeria as a case study. The paper starts with the review of telecommunication system in Nigeria by looking at the history of telecommunication in Nigeria, the evolution of cellular communication architecture, GSM and CDMA technology and presentation of a comparative analysis between GSM and CDMA. The services of GSM telecommunication operators in Nigeria were compared with the CDMA operators. Finally emphasis is laid on the duo of MTN and NITEL. Two Urban Cities were chosen in South west of Nigeria (namely: Lagos and Ibadan). Chi-square test statistic is implored to investigate the subscribers' response on the type of services they enjoyed on their mobile phone. The discussion of result is presented based on the analysis of data extracted from the responses from the respondents and recommendations are made for further studies.

Keywords: NITEL, CDMA, GSM, Cell, Cellular, EDGE, 1G, 2G, 3G, telecom

Introduction

The ability to communicate over cellular networks distinguishes cell phones from other types of handheld devices. As the name implies, cellular networks provide coverage based on dividing a large geographical service area into smaller areas of coverage called cells. Cells play an important role in reuse of radio frequencies in the limited radio spectrum available to allow more calls to occur than otherwise would be possible. As a mobile phone moves from one cell to another, a cellular arrangement requires active connections to be monitored and effectively passed along between cells to maintain the connection.

Within Nigeria, different types of digital cellular networks abound that follow distinct, incongruous sets of standards. The two most dominant types of digital cellular networks in Nigeria are known as Code Division Multiple Access (CDMA) and Global System for Mobile Communications (GSM) networks. Other common cellular networks include Time Division Multiple Access (TDMA) and Integrated Digital Enhanced Network (iDEN). iDEN networks use a proprietary protocol designed by Motorola, while the others follow standardized open protocols. A digital version of the original analog standard for cellular telephone phone service, called Digital Advanced Mobile Phone Service (D-AMPS). Analog cellular networks are no longer supported by the major cellular carriers and perhaps only a few small carriers in rural areas continue to support them [Law08]. Second generation or 2G designates the original fully digital networks mentioned above that offered greater efficiency, performance, and services than 1G analog technology. Third generation or 3G network standards exist, which offer even higher data rates. Sometimes fractional designations such as 2.5G are used to designate incremental improvements between two generations. Different generational digital cellular networks can be found across the U.S. as cellular carriers update equipment to support newer digital technologies.

CDMA is a technology designed by Qualcomm in the U.S. It employs spread spectrum communications for the radio link. Unlike many other network interfaces that share a channel, CDMA spreads the digitized data over the entire bandwidth available, distinguishing multiple cells through a uniquely assigned sequence code. Successive versions of the IS-95 standard from the Telecommunications Industry Association (TIA) define CDMA conventions in the U.S. which is the reason why the term CDMA is often used to refer to IS-95 compliant cellular networks. IS-95 CDMA systems are sometimes referred to as CDMA One. The next evolutionary step for CDMA towards 3G services is CDMA2000, TIA/EIA/IS-2000 Series, Release A, based on the ITU IMT-2000 standard. Radio interfaces for CDMA2000 include One times Radio Transmission Technology (1xRTT) and Evolution-Data Optimized (EV-DO), each offering increasing levels of performance over CDMA One. Both Verizon and Sprint operate nationwide CDMA networks in the U.S.((Wayne Jansen & Rick Ayers 2008).

GSM is a cellular system used worldwide that was designed in Europe, primarily by Ericsson and Nokia. Cingular and T-Mobile operate nationwide networks in the U.S. while GSM uses a TDMA air interface. TDMA refers to a digital link technology whereby multiple phones share a single-carrier radio-frequency channel by

taking turns—using the channel exclusively for an allocated time slice, then releasing it and waiting briefly while other phones use it. A packet switching protocol enhancement to GSM wireless networks called the General Packet Radio Service (GPRS) was standardized to improve the transmission of data. Enhanced Data rates for GSM Evolution (EDGE) is a later augmentation to GPRS that provides higher levels of performance. The 3G evolutionary step for GSM is known as Universal Mobile Telecommunications System (UMTS) and involves enhancing GSM networks with a Wideband CDMA (W-CDMA) air interface.

TDMA is also used to refer specifically to the standard covered by IS-136, which defines a specific type of cellular network. The term TDMA can refer to a general technique or a specific type of cellular network which can be a source of confusion. For example, although GSM uses a TDMA air interface (i.e., the general technique), as does iDEN, neither of those systems is compatible with so-called TDMA cellular networks that follow IS-136. (Rick Ayers & Wayne Jansen, 2008).
This paper presents comparison between GSM and CDMA by sampling the opinions of the subscribers on their experiences in the usage of the services rendered by the service providers in the most two popular cities of south west in Nigeria.

Evolution of Telecommunication in Nigeria

Today, people enjoy the beauty of telecommunications without considering how telecommunications has progressed through various stages of development right from its inception a little over a century ago. Nigeria's telecommunications system has progressed through various stages of development from the primitive communications equipment in its colonial days to the enormous variety of technologies available today.

The development of telecommunications in Nigeria began in 1886 when a cable connection was established between Lagos and the colonial office in London. By 1893, government offices in Lagos were provided with telephone service, which was later extended to Ilorin and Jebba in the hinterland. A slow but steady process of development in the years that followed led to the gradual formation of the nucleus of a national telecommunications network (Ajayi et al, 1998)

In 1923, the first commercial trunk telephone service between Itu and Calabar was established. Between 1946 and 1952, a three-channel line carrier system was commissioned between Lagos and Ibadan and was later extended to Oshogbo, Kaduna, Kano, Benin, and Enugu; thus connecting the colonial office in London with Lagos and the commercial centers in the country with local authority offices.

By the time of independence, automatic exchanges were established at the main centers and a subscriber trunk dialing system (STD) was introduced in Lagos and Ibadan. With the attainment of independence in 1960, Nigeria embarked on a periodic national development plan.

The existing services offered by NITEL are telephony, telex and telex delivery services, telegraphy and registered telegraphic addresses, pay phones and public coin telephones, transmission and reception of real-time television for network services, private leased telephone and telex service, private wire, leased telephone and telegraph services, alternate voice data (AVD) circuits, voice cast and press reception, international public counter services, NIFAX service (facsimile), a data switching system, electronic mail (national service only) and cellular.

Cellular telephony was first introduced in 1992 with the formation of Mobile Telecommunications Service (MTS). MTS is a joint-venture between NITEL and Digital telecommunications of Atlanta; in 1994, MTS had a nation-wide monopoly over cellular service. MTS began with a capacity of 10,000 lines; and due to the high level of unmet telecommunications demand, the system was filled to capacity within one year. Subsequently, in February 1994, MTS added an additional 20,000 lines and had plans to add an additional 25, 000 lines. Even with this additional capacity, it is common to receive a fast busy signal during peak hours due to network congestion.

Nigeria's cellular market is expected to grow at a rate of 25% annually through 1997. The major markets are in Lagos (among the young urban elite), the oil-based communities of Portharcourt and Warri; and the cities of Kano and Abuja. In 1992, the market for cellular equipment was US $5 million. In 1993, over half of the cellular equipment was supplied by U.S. companies; and over half of the equipment purchased was produced by

Motorola. As of early 1995, NITEL maintained a monopoly over the following services: the provision and operation of public switches and trunks and their associated infrastructure; and the provision and operation of international network links. To participate in Nigeria's telecommunications sector, a company must be either owned by a Nigerian citizen or be registered in Nigeria; the NCC hopes that this requirement will encourage joint ventures between foreign companies and Nigerian companies. (Ajayi et al, 1998)

Mobile cellular services made their debut on the Nigerian market in 1993 with a "national" service operated by NITEL and a smaller Lagos service operated by Mobile Telecommunications Services (MTS). The two companies, with a joint subscriber base of 12 500, offered voice services over an analogue E-TACS network, as well as basic value-added services such as voicemail and paging, from three switches (in Lagos, Enugu, and Abuja). In 1995, MTS closed its operations due to failure to pay interconnection charges to NITEL. M-Tel subsequently emerged as NITEL's mobile service provider (American Embassy, 1994).

The GSM licensing process was cancelled early in 2000 and the government of Nigeria reopened the process of auctioning four mobile cellular licenses in December of that year, after soliciting credible bidders. The four winners who emerged out of this process agreed to pay a US$285 million license fee each. License fees were settled within the mandatory 14-day period by Econet Wireless Nigeria, Mobile Telephone Networks (MTN) Communications Nigeria. Communications Investments Nigeria Limited (CIL) failed to make the deposit into NCC's bank account, forfeiting its license and forbidden from participating in NCC-organised auctions for a period of five years. CIL contested the NCC's verdict, but it is now effectively out of the game, its spectrum having been allocated to the forthcoming Second Network Operator.

Prior to the awarding of new licenses, a host of licenses granted to companies by previous regimes were revoked. One of those licenses belonged to Motophone, the only other mobile cellular operator in the country at the time and more successful than M-Tel. While Motophone is involved in a court case with the government and the NCC over the cancelled operational rights, its network infrastructure lied fallow, the price demanded by the owner was too high for other network operators to consider purchasing pieces of it.

The new GSM licenses have been awarded for a period of five years (renewable) and all operators can operate in the 900Mhz and 1800Mhz spectrum bands. Whereas, they do provide for a potential upgrading of future networks to GPRS (general packet radio switching), they do not encompass third generation (3G) networks, which will probably be auctioned off sometime in the future. Existent GSM operators will, however, obtain preferential access to the bidding process. The operators do not foresee a 3G mobile network being developed in Nigeria until the later half of the current decade. All licenses permit operation of an international gateway while definite targets have been set for the GSM operators in terms of network rollout (minimum of 100 000 subscribers each in first year of operations, 1.5 million subscribers in 5 years, and minimum 5% geographical coverage in each of the country's geopolitical states). The NCC has indicated that its primary interest lies in securing as comprehensive and efficient a mobile network as possible, even if that may mean slightly revised schedules. The operators are confident that the estimated pent up demand for mobile services will drive subscription rates much faster than the stipulated requirements dictate. Vigorous advertising of soon-to-come services and actual network rollout began soon after awarding of the licenses.

Studies conducted in the Nigerian market indicate that simultaneous launching of three players in this market will create growth akin to the rapid growth normally witnessed in as many individual markets. Furthermore, this level of competition should see the expansion of packages offered at a greater rate and the introduction of value-added services to attract and retain clients. Cellular services market penetration is forecast to reach a level greater than 5 per 100 people by the year 2010 – an equivalent of some 9 million subscribers, with roughly a 60% / 40% split between rural and urban areas.

Regulatory Surroundings

The process of liberating the telecommunications trade in Nigeria began in 1992 with institution of the Nigerian Communications Commission by Decree 75 of 1992. The objectives of the regulators are to establish a platform which might facilitate the provision of telecommunications services and facilities, permitting personal entrepreneurs to enter the market whereas promoting truthful competition and enhancing the amount of service for all involved.

The most recent project on the cards for the regulator has been the licensing of the second national operator that follow the unsuccessful arrangement to sell the government stake in NITEL has been delayed till a vendor is found for the state run telecommunications operator.

In addition, the regulator recently came out against the business use of the doctrine (Industrial, Scientific, Medical) bands of 2.4GHz to 5.8GHz. The NCC cited the tendency for users during this band to disregard rules guiding the employment of those bands with no protection against interference.

GSM, or the worldwide System for Mobile Communication was introduced to Nigeria in 2001. This launch liberated Nigerians from the telecommunication monopoly of NITEL. Through the history of African country, NITEL humiliated and abused Nigerians for several years with their service. GSM has boosted the economic activities in African country and improved the standard of life for the Nigerians. They are now ready to enjoy services like mobile television, affordable Internet service, cheaper international calls, and even Internet banking (Pandya,2003)

Historical Perspective

GSM versus CDMA

GSM is an acronym for Global System for Mobile communications; it was originated from Groupe Spécial Mobile while CDMA is an acronym for Code Division Multiple Access. GSM is a specification of an entire wireless network infrastructure, while CDMA relates only to the air interface — the radio portion of the technology.

Code Division Multiple Access (CDMA) describes a communication channel access principle that employs spread-spectrum technology and a special coding scheme (where each transmitter is assigned a code). CDMA also refers to digital cellular telephony systems that use this multiple access scheme, as pioneered by QUALCOMM, and W-CDMA by the International Telecommunication Union (ITU), which is used in GSM's UMTS

In the world of wireless technologies today, GSM and CDMA are seriously competing. Some people believe GSM is leading the market with about 84% market share globally and that the remaining16% market share is for CDMA while some believe it is just about 75% market share globally for GSM and 25% market share for CDMA. Some people believe there is no much difference or that the CDMA is even better. Take for example in the USA, CDMA is the more dominant standard. Below is the Comparison table.

Stands for	Code Division Multiple Access	Global System for Mobile communication
Storage Type	Internal Memory	SIM (subscriber identity module) Card
Global market share	25%	75%
Dominance	Dominant standard in the U.S.	Dominant standard worldwide except the U.S.
Data transfer	EVDO/3G/4G/LTE	GPRS/E/3G/4G/LTE
Network	There is one physical channel and a special code for every device in the coverage network. Using this code, the signal of the device is multiplexed, and the same physical channel is used to send the signal.	Every cell has a corresponding network tower, which serves the mobile phones in that cellular area.
International roaming	Less Accessible	Most Accessible
Frequency band	Single (850 MHz)	Multiple (850/900/1800/1900 MHz)
Network service	Handset specific	SIM specific. User has option to select handset of his choice.

Interim Standard-136: North American Time Division Multiple Access

North American TDMA, often referred as TDMA, was developed in response to the need to increase cellular capacity. Unlike Europe and Japan where additional spectrum was made available for second generation digital systems, US operators were constrained to re-use the same spectrum used for Advance Mobile Phone System (AMPS). As a result, the TDMA standard was developed to be compatible with the analogue AMPS system. Again, the pressure on capacity forced the Telecommunications Industry Association (TIA) to consider a rapid development of a digital standard. As a result two TDMA standards were developed. Interim Standard – 54 (IS-54) often referred to as Digital-AMPS (D-AMPS), was the first of these. It shares the same 21 analogue call set-up channels with AMPS so that the call processing is the same between the two systems and handsets which can support dual AMPS/ D-AMPS. The second phase standard is IS-136 which implements digital call set-up channels to enable stand-alone TDMA handsets. IS-136 has effectively replaced IS-54 (Prabhakar, 2013).

The Statement of the Research Problem

Scholarly works in Telecommunications have focussed on various perspectives and aspects of the industry. Some of these works include Attah (1998), Biature (1989), Ajayi et al (1998), Salawu (1991) and Okafor (1993). Despite these, it has been observed that existing studies have not explored a comparative analysis of GSM and CDMA Nigeria. Hence, the paper considers this aspect for the purpose of bridging the existing gap by conducting a research on GSM and CDMA services in Nigeria through a comparative analysis approach.

Objectives of the study

The aim of this paper is to perform comparison analysis on GSM and CDMA and also sample the opinions of subscribers to know what they feel about the services of mobile operators under the category of GSM and CDMA in mobile and cellular communications. Towards this end, the objectives of this paper shall be to:

i) carry out comparative analysis on GSM and CDMA of mobile telecommunications;
ii) sample opinion of subscribers on mobile telecommunication operators in Nigeria; and
iii) analyse the opinion of subscribers on mobile telecommunication operators in Nigeria.

Research Methodology

In this research paper, a comparative analysis approach was employed to the study of GSM and CDMA through the employment of random sampling method. Questionnaires were also distributed to elicit information and opinions of subscribers on mobile telecommunication in Nigeria. In the course of our data analysis, Chi-square test statistics was used to investigate the hypothesis formulated in the research and the opinions of the subscribers on mobile telecommunication in Nigeria. Two most populated urban cities were selected in south west geo-political zone in Nigeria. 100 questionnaires were distributed among the randomly selected subscribers of telephone in each of the cities, thereby making a total number of 200 questionnaires. Discussion and recommendations were based on the results of the analysis.

Data Presentation and Analysis

In each of the two urban cities under investigation, a total number of 100 questionnaires were distributed, and the entire questionnaires were returned for analysis making a total number of 200 questionnaires administered and analysed.

Data extracted are presented below:

Table1. Sex

Cities	Male	Female	Total
Lagos	67	33	100
Ibadan	60	40	100
Grand Total	127	73	200

Table2. Level of Education

Cities	Illiterate	Semi-Illiterate	Educated	Total
Lagos	4	10	86	100
Ibadan	10	20	70	100
Grand Total	14	30	156	200

Table3. Level of Awareness, First Mentioned, Regular Users, and Widest Network Coverage of Telephone Operators in Nigeria

Table3a. Lagos

S/N	Operators	Type	No of Awareness		First Mentioned		Regular Users		Widest Network Coverage	
			Response	Percentage	Response	Percentage	Response	Percentage	Response	Percentage
1	Airtel	GSM	100	100%	20	20%	24	24%	21	21%
2	MTN	GSM	100	100%	35	35%	32	32%	38	38%
3	GLO	GSM	100	100%	25	25%	24	25%	22	22%
4	Etisalat	GSM	100	100%	10	10%	15	15%	19	19%
5	Visafone	GSM	50	50%	0	0%	2	2%	0	0%
6	MTEL	GSM	28	28%	0	0%	0	0	0	0%
7	Others	GSM	0	0%	0	0%	0	0%	0	0%
8	Starcomms	CDMA	52	45%	0	0%	3	3%	0	0%
9	Multilinks	CDMA	30	30%	0	0%	0	0%	0	0%
10	Visafone	CDMA	45	45%	0	0%	0	0%	0	0%
11	Intercellular	CDMA	15	15%	0	0%	0	0%	0	0%
12	Odua-net	CDMA	2	2%	0	0%	0	0%	0	0%
13	21st Century	CDMA	14	14%	0	0%	0	0%	0	0%
14	Mobiletel	CDMA	1	1%	0	0%	0	0%	0	0%
15	Zoom Mobile	CDMA	2	2%	0	0%	0	0%	0	0%

16	Moribound NITEL	CDMA	80	80%	0	0%	0	0%	0	0%

Table3b. Ibadan

S/N	Operators	Type	No of Awareness		First Mentioned		Regular Users		Widest Network Coverage	
			Response	Percentage	Response	Percentage	Response	Percentage	Response	Percentage
1	Airtel	GSM	100	100%	15	20%	16	16%	19	19%
2	MTN	GSM	100	100%	45	35%	41	41%	47	47%
3	GLO	GSM	100	100%	30	25%	23	23%	20	20%
4	Etisalat	GSM	100	98%	10	10%	20	20%	16	16%
5	Visafone	GSM	20	20%	0	0%	0	0%	0	0%
6	MTEL	GSM	14	14%	0	0%	0	0%	0	0%
7	Others	GSM	0	0%	0	0%	0	0%	0	0%
8	Starcomms	CDMA	30	30%	0	0%	0	0%	0	0%
9	Multilinks	CDMA	20	20%	0	0%	0	0%	0	0%
10	Visafone	CDMA	19	19%	0	0%	0	0%	0	0%
11	Intercellular	CDMA	2	2%	0	0%	0	0%	0	0%
12	Odua-net	CDMA	20	20%	0	0%	0	0%	0	0%
13	21st Century	CDMA	0	14%	0	0%	0	0%	0	0%
14	Mobiletel	CDMA	0	1%	0	0%	0	0%	0	0%
15	Zoom Mobile	CDMA	0	2%	0	0%	0	0%	0	0%
16	Moribound NITEL	CDMA	87	80%	0	0%	0	0%	0	0%

Table 4a. Lagos

Voice and Data

S/N	Operators	Type	Only Voice		Only Data		Both Data & Voice	
		GSM	Response	Percentage	Response	Percentage	Response	Percentage
1	Airtel	GSM	12	12%	18	18%	10	10%
2	MTN	GSM	15	15%	10	0%	20	20%
3	GLO	GSM	10	10%	10	10%	12	12%
4	Etisalat	GSM	12	12%	17	17%	10	10%
5	Visafone	GSM	2	2%	1	0%	2	2%
6	MTEL	GSM	0	0%	0	0%	0	0%
7	others	GSM	0	0%	0	0%	0	0%
8	Starcomms	CDMA	2	2%	4	4%	1	0%
9	Multilinks	CDMA	0	0%	0	0%	1	0%
10	Visafone	CDMA	2	2%	3	3%	0	0%
11	Intercellular	CDMA	0	0%	0	0%	0	0%
12	Odua-net	CDMA	0	0%	0	0%	0	0%
13	21st Century	CDMA	1	1%	0	0%	0	0%
14	Mobiletel	CDMA	0	0%	0	0%	0	0%
15	Zoom Mobile	CDMA	0	0%	0	0%	0	0%
16	Moribound NITEL	CDMA	0	0%	0	0%	0	0%

Table 4a. Ibadan

Voice and Data

S/N	Operators	Type	Only Voice		Only Data		Both Data & Voice	
			Response	Percentage	Response	Percentage	Response	Percentage
1	Airtel	GSM	8	8%	10	14%	4	4%
2	MTN	GSM	20	20%	3	3%	14	14%
3	GLO	GSM	9	9%	10	10%	12	12%
4	Etisalat	GSM	8	8%	15	15%	10	10%
5	Visafone	GSM	0	0%	0	0%	0	0%
6	MTEL	GSM	0	0%	0	0%	0	0%
7	others	GSM	0	0%	0	0%	0	0%
8	Starcomms	CDMA	1	1%	5	5%	0	0%
9	Multilinks	CDMA	2	2%	3	3%	0	0%
10	Visafone	CDMA	0	0%	0	0%	0	0%
11	Intercellular	CDMA	0	0%	0	0%	0	0%
12	Odua-net	CDMA	0	0%	0	0%	0	0%
13	21st Century	CDMA	1	1%	0	0%	0	0%
14	Mobiletel	CDMA	0	0%	0	0%	0	0%
15	Zoom Mobile	CDMA	0	0%	0	0%	0	0%
16	Moribound NITEL	CDMA	0	0%	0	0%	0	0%

Analysis of Data

From the table 3a and 3b above, it is glaring that GSM service providers are more popular than CDMA in Nigeria. MTN is the most popular because of the highest response in awareness test, though about four GSM operators scored 100% each including MTN but MTN scored highest mark in First mentioned, Regular user and

widest network coverage. It was also observed that there are subscribers that use more than one GSM line for different services as shown in table 4a and 4b above. As a result of this, we would like to formulate null and alternate hypothesis to be verified using chi-square test to investigate the assumptions.

The chi-square test provides a method for testing the association between the row and column variables in a two-way table. The null hypothesis H_0 assumes that there is no association between the variables (in other words, one variable does not vary according to the other variable), while the alternative hypothesis H1 claims that some association does exist. The alternative hypothesis does not specify the type of association, so close attention to the data is required to interprete the information provided by the test.

Test of Hypothesis

Ho: There is no association in the type of services enjoyed by subscribers and the services offered by providers

H1: There is an association in the type of services enjoyed by subscribers and the services offered by providers

Level of Significance 5%, $\alpha = 0.05$

Decision Rule: Accept the null hypothesis if X^2 calculated is less than X^2 on the table, otherwise reject the null hypothesis **Ho** and accept the alternate hypothesis

LAGOS

Chi-square statistic

Observed Value (Original Table) (Actual Frequencies for table 4a)

	Voice	**Data**	**both**	
Airtel	12	18	10	**40**
MTN	15	10	20	**45**
GLO	10	10	12	**32**
Etisalat	12	17	10	**39**
Visafone	2	1	2	**5**
Starcomms	2	4	1	**7**
Multilinks	2	3	1	**6**
Total	**55**	**63**	**56**	**174**

Expected Values for table 4a

	Voice	**Data**	**both**
Airtel	12.64368	14.48276	12.87356
MTN	14.22414	16.2931	14.48276
GLO	10.11494	11.58621	10.29885
Visafone	12.32759	14.12069	12.55172
Etisalat	1.58046	1.810345	1.609195
Starcomms	2.212644	2.534483	2.252874
Multilinks	1.896552	2.172414	1.931034

The Chi-square for the table 4a is computed as follows:

$X^2 = (12 - 12.64368)^2/ 12.64368 + (18 - 14.48276)^2/ 14.48276 + (10 - 12.87356)^2/ 12.87356 + ... + (1 - 1.931034)^2/1.931034$

= 0.03 + 0.85 + 0.64 +.....+ 0.70

= **10.52**

V= (Rows-1)(Columns-1)
The degrees of freedom are equal to (7-1)(3-1) = 6*2 = 12 degrees of freedom

0.03	0.85	0.64	
0.04	2.43	2.10	
0.00	0.22	0.28	
0.01	0.59	0.52	
0.11	0.36	0.09	
0.02	0.85	0.70	
0.01	0.32	0.35	
0.22	**5.61**	**4.68**	**10.52**

X^2 Calculated = **10.52**

X^2 on the table = **21.026**

Decision: Since the X^2 calculated is less than X^2 on the table i.e **10.52 < 21.026**, we then accept the null hypothesis **Ho** and reject the alternate hypothesis **H1**

IBADAN

Chi-square statistic

Observed Values

	Voice	**Data**	**Both**	
Airtel	10	18	12	40
MTN	16	8	26	50
Glo	9	18	12	39
Etisalat	8	16	10	34
Visafone	2	2	1	5
Starcomms	1	1	1	3
Multilinks	2	1	1	4
Total	**48**	**64**	**63**	**175**

Expected Values

	Voice	**Data**	**Both**
Airtel	11.03448	14.71264	14.48276
MTN	13.7931	18.3908	18.10345
Glo	10.75862	14.34483	14.12069
Etisalat	9.37931	12.50575	12.31034
Visafone	1.37931	1.83908	1.810345
Starcoms	0.827586	1.103448	1.086207
Multilinks	1.103448	1.471264	1.448276

The Chi-square for the table 4a is computed as follows:

X^2 = (10 - 11.03448)²/ 11.03448+ (18 - 14.71264)²/ 14.71264+ (12 - 14.48276)²/ 14.48276+ .... + (1 - 1.086207)²/ 1.086207

= 0.10 + 0.73 + 0.43 +.....+ 0.22

= **15.88**

V= (Rows-1)(Columns-1)
The degrees of freedom are equal to (7-1)(3-1) = 6*2 = 12 degrees of freedom

0.10	0.73	0.43	
0.35	5.87	3.44	
0.29	0.93	0.32	
0.20	0.98	0.43	
0.28	0.01	0.36	
0.04	0.01	0.01	
0.73	0.15	0.22	
1.98	**8.69**	**5.21**	**15.88**

X^2 Calculated = **15.88**

X^2 on the X^2 table = **21.026**

Decision: Since the X^2 calculated is less than X^2 on the table i.e, **15.88 < 15.88,** we then accept the null hypothesis **Ho** and reject the alternate hypothesis **H1**

Chart on type of service and network subscribers use on phone

Chart1: LAGOS

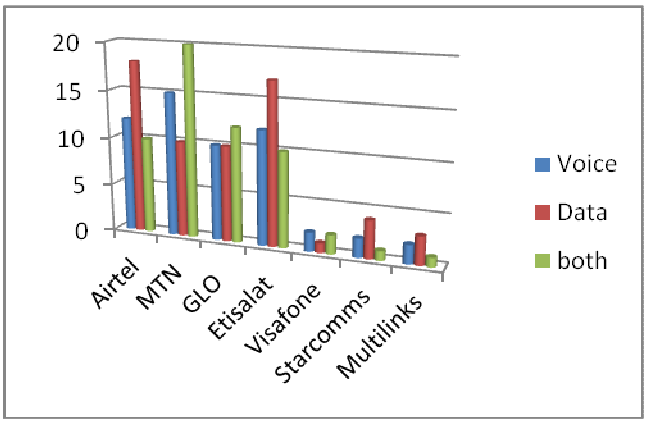
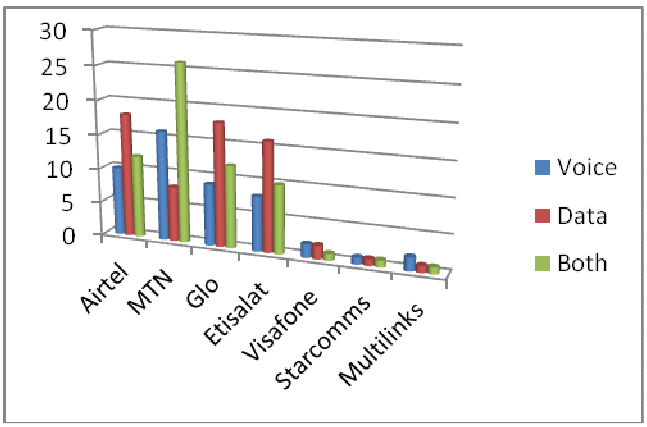


Chart2: IBADAN



Discussion of Results

Table 3a and 3b show responses and percentage responses for Lagos and Ibadan respectively on the level of awareness, first mentioned, regular users, and widest network coverage of telephone operators in Nigeria. The level of awareness on the major telecom operators are almost the same in the two urban cities. The tables show that in Lagos and Ibadan, all the 100 subscribers interviewed are aware of Glo, MTN, Airtel, Etisalat who are major players in GSM mobile telephone while just a very few of subscribers are aware of CDMA operators. In Lagos, MTN is the most regularly used with 35%, followed by Glo 25%, Airtel 20%, Etisalat 10% and others who are mostly the CDMA are below 10% . Likewise in Ibadan, MTN is the most regularly used with 35%, followed by Glo 25%, Airtel 20%, Etisalat 10% and others who are mostly the CDMA are below 10%, refer to table 3a and 3b for more on "first mentioned", "regular users" and "widest coverage".

Table 4a and 4b also display data observation on kind of services that subscribers enjoyed on their phone and the network operator(s) they use for each service. It was observed that some subscribers make use of more than one telephone line and the research probed further to know which phone line they prefer using for each of the services (i.e Voice & Data) refer to table 4a and 4b.

Chi-square test statistic was used to investigate the observed data so as to test if there is a relationship or degree of association between the kind of network a subscriber is likely to use for either voice and data. In order to do this null and alternate hypothesis were formulated and chi-square analysis was performed. The result shows that in Lagos, the X^2 calculated is less than X^2 on the table i.e **10.52 < 21.026**, we then accept the null hypothesis **Ho** and reject the alternate hypothesis **H1.** Likewise**,** in Ibadan, the X^2 calculated is less than X^2 on the table i.e, **15.88 < 15.88** we then accept the null hypothesis **Ho** and reject the alternate hypothesis **H1** meaning that there is no degree of association between the preferred network providers and the type of service enjoyed by the subscribers, this is due to the fact that in Lagos and Ibadan, large numbers of subscribers prefer using MTN for voice and use the alternative network for data, this is due to the fact that subscribers prefer data plan that is more economical and reliable than what MTN offers, though they mostly choose MTN for voice because of widest network and reliable voice services. Refer to Table 4a - b and chart 1 – 2 for the responses of subscribers in percentages and diagrammatic representations respectively. Also see below the reason why subscribers choose their preferred network for certain services;

Response analysis on why subscribers prefer using favourite operators for data

1. Because of their data plan which is economical 55%
2. Because of the bonus data I used to enjoy 10%
3. Because of the fast and reliable Internet access 65%
4. Because of the amount of data attached to their plan 10%

Response analysis on why subscribers prefer using favourite operators for voice

1. Because of their tariff which is economical 65%
2. Because of the bonus credit I used to enjoy 40%
3. Because of the reliable network services 70%
4. Because of the wide coverage 71%
5. Because of the Bonanza 12%

Findings

From the analyses of questionnaires, findings show that the CDMA has low level of awareness among the subscribers, larger percentage of the subscribers prefer using GSM than CDMA, due to the quality of services they enjoyed and availability of services when travelling from one location to another. Also, findings reveal that MTN has the widest network coverage and largest subscribers in the country. Finding also reveals that 80% of subscribers spoken to, are aware of old NITEL/MTEL, and gave mismanagement as the killer of the government

owned telecommunication company that gave birth to mobile telecommunications in Nigeria. On whether they will use the network, 65% said yes provided the service improves from what it used to be, while 20% said no, and 15% is undecided.

Also, this study reveals that 75% of the subscribers have more than one line being used for different services due to some reasons given under the "discussion of result' section that shows percentage responses. It was found out that bonanza, affordable tariff, affordable data plan etc are not enough but reliable services, and wide area network

Lastly, this research also found out that GSM has higher percentage usage than CDMA in most parts of the world at a rate of 75% to 25% except in US that CDMA is mostly common. As already discussed PDC is a CDMA system and it operates by splitting or multiplex each channel into several time slots and thereby allowing several users to use the same frequency channel. Considering each channel, it is possible to support three users under normal circumstances. However, when traffic levels are high, it is possible to use half data rate speech band. Although this reduces the speech quality, it enables six calls to be supported by each channel. This compares very favourably to GSM that manages eight within each 200 kHz channel.

Speech cryptography is a very important thing about CDMA. PDC uses a special encoder on IS54/IS136. The quality rate is 9.6 kbps alongside similar technologies like GSM, however once 0.5 rate cryptography is employed, this falls to 5.6 kbps. Though, this offers a major reduction in voice quality, it is still equal to maintain comprehensibility and allows the network capability to be inflated to accommodate any calls.

Deductions on GSM

1) From the first idea of a pan-European normal, it presently becomes clear that GSM is a gorgeous choice to operators around the world as well as USA, and has become the amount one digital cellular normal.

2) Low terminal and repair value is a gorgeous feature for the users.

3) It is conjointly associated emergency service, wherever the closest emergency service supplier is notified by dialing 3 digits kind of like 911.

4) Apparently, the key drivers for GSM square measure pan-European roaming to supply compatibility throughout Europe and interaction with Integrated Services Digital Network (ISDN) and bill to home.

5) The SIM (Subscriber Identity Module) card that contains the IMSI is to establish the subscribers to the system, a secret key for authentication, and alternative info. The International Mobile instrumentation Identity (IMEI) and also the International Mobile Subscriber Identity (IMSI) square measure freelance, thereby permitting personal quality. The SIM card could also be protected against unauthorized employee by a countersign or personality variety.

Recommendations

Based on the analyses of data and discussion of results, this paper presents the following recommendations to future telecom operators, investors, subscribers and researchers:

1. It is hereby recommended that the existing service providers should create more new cell sites by erecting more masts and towers so as to expand their base stations and network. This is strongly recommended most especially for CDMA service providers that haves limited coverage unlike GSM providers, although the GSM providers need to expand their base stations and improve their services as their subscribers grow in size. Most of the GSM providers also have roaming capabilities; the CDMA counterpart should work towards that as well.

2. It is also recommended that any new investors or provider coming to the market should be ready to tackle some of the problems facing the providers such as network failure, high tariff, unfriendly data plan etc. They should be ready to make the market more competitive by being ready to provide quality services at more affordable prices.

3. The future studies should expand the scope of this study by covering more cities and increase the sample so as to make the sample a good representation of the entire subscribers, if possible, the future studies should also cover rural areas to know truly which of the telecom providers are reaching people far from cities. Also, more test statistics should be implored for data analysis and measurement of the degree of association.

Conclusion

From the result of the analysis, it could be concluded that GSM is more popular and widely used in the two cities (Lagos and Ibadan) under study in Nigeria and nearly all the subscribers are aware of the major GSM operators, namely; GLO, MTN, Airtel and Etisalat. On the other hand, CDMA remains unpopular among the subscribers and only few subscribers are aware of few numbers of CDMA operators. This is as a result of wider area network coverage and reliable services provided by GSM operators. Among the GSM operators also, MTN is the most widely used because of the better and reliable services. X^2 statistics calculated also shows that there is no degree of association in the type of services subscribers use on their phone as most of them maintain more than one sim card for different services of voice and data.

It can be finally concluded that any telecom operators or investors coming to Nigeria should think of investing in GSM rather than CDMA and be ready to provide better services for voice and data. GSM and CDMA have their own special features that satisfy diverse needs of mobile communication system in 36 States in Nigeria.

References

Ajayi, G.O., Salawu, R.I., & Raji, T.I. (1998) 'A century of telecommunications development in Nigeria: What next?' 10th anniversary lecture for 2-way communications Ltd, Lagos.
Attah, M.E.(1998) 'Current trends and future development in Telecommunications in Nigeria' Presented at the Annual Conference of the Nigerian Association of Radio Science, Lagos.
Ayuba, A.T (1986) Address by the Minister of Communications on the occasion of the 18th World Telecommunication Day, Lagos,
AMEMBASSY(1994) Telecommunications Overview. Lagos: American Embassy.
Bitature, C.(1989) Development of an effective Pan-African Telecommunications (PANAFTEL) Network. An unpubished M.sc Thesis, Obafemi Awolowo University, Ile-Ife.
Devore J. L. (1995) Probability and Statistics for Engineering and Sciences. Fourth Edition, USA: wadsworth, inc.
Iromantu, O.C. (1994) 'Models of Deregulation and Liberalization of Telecommunications for Africa and the Middle East,' Paper Presented at Africa Telecom '94, Cairo, Egypt 25-29 April 1994 T.U.
Lucey T. (1996) Quantitative Techniques. Fifth Edition, London: Continuum.
Mark, D.A.B.(1990) Address by the Minister of Communications on occasion of the 22nd World Telecommunication Day, Lagos.
Okafor, Uzo (1993). Nigeria - Cellular Telecommunications Equipment Lagos: American Embassy.
PANAFTEL(1987) T he Pan-African Telecommunication Network, Geneva, 1987.
Pandya, R.(2003) 'Mobile and Personal Communication Systems and Services' Prentice Hall of India, 4th Indian Reprint.
Rick Ayers Sam Brothers & Wayne Jansen (2008) Guidelines on mobile devices forensics (draft), NIST Special Publication 800 – 101, US Department of Commerce.
Salawu, R.I.(1991) 'Telecommunications in Focus' 10th Anniversary Lecture for 2-Way Communications Ltd, Lagos.
Wayne J. & S. Scarfone (2008) 'Guidelines on cell phones and PDA Security' NIST Special Publication 800 – 124, US Department of Commerce.
William C.Y.(1995) Lee, "Mobile Cellular Telecommunication – Analog and Digital Systems", MCGraw Hill International Edition, 1995.
Yi_Bing L. &, I. Chlamtac(2002) "Wireless and Mobile Network Architecture", Wiley.
Prabhakar L. (2013) The Service Aspects Of Three TDMA Digital Cellular Mobile Systems (GSM, IS-136 NA-TDMA AND PDC)- A Comparative Study.

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