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Performance Threshold Levels Of Mobile Network Portability In South South Nigeria.

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Abstract
The performance thresholds of mobile network portability (MNP) are examined in this study in the setting of South-South Nigeria. Given the speed at which telecommunications services are developing and the introduction of MNP, it is imperative that service providers and customers alike comprehend the acceptable performance standards. Using a mixed-methods approach, this study combines survey-based evaluations, qualitative interviews, and quantitative data analysis to identify the best MNP benchmarks in the area.This study attempts to provide empirical insights into the determinants that determine adequate MNP performance thresholds by looking at things like consumer preferences, network dependability, service quality, and regulatory policies. The results of this study project not only benefit academics but also provide useful implications for telecoms industry stakeholders, enabling well-informed choices to improve MNP experiences and regulatory frameworks in South-South Nigeria.
KEYWORDS; *Performance, Threshold, Mobile Networks, Portability, Providers*

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I. INTRODUCTION

According to its index of refraction, a medium's refractivity is its physical characteristic ("Refractivity," n.d.-a: "Refractivity," n.d.-b: "Refractivity," n.d.-c). It is, in essence, the amount or degree to which a wave refracts across one or more media ("Refractivity," n.d.-d). Atmospheric refraction affects all electromagnetic waves, including radio waves, as they travel through the atmosphere (Javeed et al., 2018). Radio refractivity is a better way to describe the refraction that radio waves undergo, mostly in the troposphere of the atmosphere (International Telecommunication Union — Radio communication sector [ITU-R], 2016). The calculation of refractivity requires the triplet of atmospheric temperature, atmospheric pressure, and relative humidity—of the fundamental quartet parameters of interest to meteorologists and weather scientists (Adeyemi and Emmanuel, 2011: Ali et al., 2012: Alimgeer et al., 2018: Ayatunji and Okeke, 2011: Bean and Thayer, 1959). However, as wind modifies the composition of the atmosphere, it may also impact radio refractivity. Numerous studies have shown that wind influences radio communication in the atmosphere (Chima et al., 2018: Joseph and Oku, 2016: Meng et al., 2009: Zafar et al., 2019).

Radio scientists, technologists, and engineers need to understand radio refractivity in order to design, build, and operate radio equipment that will allow for effective communication in the troposphere (Adediji et al., 2013: Segun et al., 2018). Studies have shown that radio waves at Ultra High Frequency (UHF) are significantly impacted by radio refractivity (Alam et al., 2015: Alam et al., 2016: Alam et al., 2017: Amajama, 2015b: Mat et al., 2018: Otasowie and Edeko, 2015). Additionally, following a temperature inversion, radio waves have sometimes been amplified to reach ordinary sites that were not accessible by tropospheric ducting ("Tropospheric propagation," 2015). Therefore, the focus of this study is on how certain meteorological factors, such as air temperature, atmospheric pressure, and relative humidity, interact with radio refractivity to affect the strength of mobile phone signals as they travel through the troposphere during downlink. The division of the atmosphere into spheres is noteworthy. The troposphere is the realm that essentially controls the weather and is of paramount significance to meteorologists or weather scientists. As a result, in this study's talks of the atmosphere, the troposphere will be highlighted.

II. Materials and Methods

The following techniques were used in this study:
The performance of GSM mobile networks has been evaluated and assessed using a variety of techniques up to this point. These techniques include procedures based on laboratory measurements, statistical estimates, mathematical derivations, and pure conjecture.
Regretfully, it is impossible to call any of the aforementioned techniques thorough or definitive. Consequently, it seems that the driving test was successful. Regardless of the technology used in cellular networks (GSM, CDMA, UM T S, LTE, etc.), the Drive Test (DT) is a test that is carried out in order to assess and improve the quality of the network.
Two primary features were used in this study technique, which are as follows:
The metrics included five (5) dimensions, including the call setup Success Rate (CSSR),
Standalone Dedicated Control Channel (SDCCH), call completion rate (CCR), call drop rate (CDR), and call handover success rate (CHSR).
The GSM network providers in South-South Nigeria are significantly impacted by these five (5) factors in terms of service quality.
2. Because the tests were conducted entirely autonomously, any subjectivity associated with human decision-making or interference was eliminated.

III. Utilizing a Drive Test Investigation Method

The most popular assessment method used by radio network operators to assess quality and address issues with the network is drive testing. Drive testing is a technique for evaluating a mobile radio network's capacity, coverage, and quality of service (QoS) (Amaldi et al., 2008). Using an RF drive test tool, it is done to verify that the cell site meets its coverage parameters. To analyze the different RF characteristics of the network, the data gathered by the drive test tool in the form of log files is evaluated. The method involves driving a car equipped with mobile radio network air interface measuring equipment, which is able to identify and document a broad range of the virtual and physical characteristics of mobile cellular service within a certain geographic region (Rieha et al, 2013).

Field measurement and network assessment often employ drive testing across the observational base stations' coverage regions.. Information like (Wikipedia, 2014) may be included in the data collection that has been gathered. Signal characteristics include GPS location coordinates, neighboring cell information, call statistics, service level data, handover information, interferences, intensity, quality, and blocked or dropped calls.

3.1 The reason for driving testing
• To identify places with inadequate coverage and to keep an eye on network performance.
• To find any Radio Frequency (RF) issues associated with traffic concerns, such missed or blocked calls.
1.To monitor networks against a gradual deterioration over time, assess any interference issues such as coverage from nearby cells, and keep an eye on the network after abrupt environmental events like electrical storms or gales.
2.Excellent source of position-specific radio frequency data that may be utilized to pinpoint and fix radio issues.
3.2 Use Test Survey Routes to Drive
All of the highways that are controlled by various sectors of the sites in Cross River, Akwa Ibom, and River State were included in the test routes for driving. Included were the main roads around the base stations.. The test routes intersected with adjacent neighbor cells in their surrounding regions. This guarantees accurate verification of the sites' real coverage areas and handover procedures.

Setting Up the Drive Test Device (Q VM)
We configure the test apparatus and store it using the save file for the KPI initial setup.
(the USB drive) toolbar option.

The qualities that were set up throughout the process are as follows:
l . Indicate the channel model, i.e., master or slave, for the phone.
1.Test type: Indicate the kind of test that the channel mode will measure, such as voice, text messaging, multimedia messaging, IP data (data transfer over the internet), or video.

The telephone (VT).
2.Master phone number: Type the master SIM card's phone number here.
3.Phone number of the slave: Type the slave SIM card's number here.
(The port on the Sim modem).
3.3 Outlining the Drive Test Measurement Instrument
This device was programmed to make calls for a certain amount of time during the commissioning procedure. This provides an insight into the customer's experience while attempting to make a call. While the system can process SMS and IP data, the QC)S commissioning in our investigation was restricted to GSM networks (phone) and did not include data. Each piece of equipment on the machine has four cell phones linked to it. The QVM3G is powered by scanner cables and external antenna connections that provide services to the phone. Additionally, it is connected to the machine's operational unit, which has a touch screen for navigation. Above 600°C, the machine is not functional at high temperatures.
When the system is in the use phase, the boot procedure is initiated by turning on the power button located on top of the operational unit. The operating unit's boot procedure resembles the booting sequence of a personal computer (PC); the bios and operating system message appears as the startup message. Depending on the program that is installed, various icons appear once the system boots up. After launching the QVM program by clicking on the QVM3G icon, we generated a KPI measurement task in order to do measurement. Installation and operation are made simple by the operational unit.
At the moment, when the calls for the measurement were being set up, a call was made inside the network between the master and slave channels of the QVM. Test mobile station (handset) calls were made, both short and lengthy. While the lengthy calls were conducted to test the networks' capacity to maintain and sustain call setup, the short calls were meant to evaluate the network's mobility and accessibility.
With four phones linked, each network pair—master and slave—consists of two phones and is made up of the same network, which is made up of GIO, MTN, Airtel, and 9mobile. The summons to the slave is often made by the master. It resembles a two-way handshake. A one-second delay is established when the master calls the slave, after which the slave calls its master back. There is often a waiting time established during equipment setup after this session ends before starting a new one. There's a time limit on this. Over the course of five days, a total of six hours of phone calls were made in order to finish the driving test in each state.
Drive testing let a group of individuals test a mobile network by posing as users and using QOS metrics to assess the network's quality of service. This test is always a statistical sample since it does not apply to the complete network.

IV. DATA PRESENTATION AND RESULT

We aim to examine the key performance indicator (KPI) data summary gathered from its network operators in Cross River, Bayelsa, Akwa Ibom, and Rivers State in this chapter. The call pattern with regard to CSSR, CDR, CHSR, CR, and SDCCH is shown in this data. The performance of these networks throughout the study period is also shown in the paper.

4.1 Information analysis

During peak hours at the Base Station Controller (BSC), the Network Operating Centers (NOCs) of the Mobile Network Operators provided the Quality of Service (QOS) key performance metrics for Airtel, 9mobile, Glo, and MTN in Appendix I to XLVd via quality voice machine. The performance of each operator was then determined by using monthly weighted averages to assess the data.

The information in Appendix I to XLVd covers the months of October 2019 through September 2020.

The Nigeria Communication Commission's (NCC) audit thresholds are shown in Table 6 in accordance with the guidelines provided in the Appendix's tables. The measured data were compared to the NCC-set threshold. By 8:00 am, there was a lot of call attempt traffic during the peak hour. The investigation also took into account the peak period's length, which runs from 7:00 am to 10:00 am and corresponds with the usual peak times used by the majority of networks.

4.2 Outcomes

Minitab application software was used to examine the main data in Appendix I to XLVd. We assessed the Quality of Service (QOS) provided by GSM network providers in the states of Rivers, Akwa Ibom, Cross River, and Bayelsa. Additionally, interval charts are shown. Failure to reach the QOS Key Performance Indicator (KPI) objective for that time is shown by data points that dropped below the NCC threshold target areas. In order to assess the Quality of Service provided by the four GSM network providers in the research regions, a descriptive statistical analysis was done. There is no discernible difference in the QOS provided by the four GSM network providers in the research locations, according to the null hypothesis. The ANOVA was used to test the hypothesis.

Furthermore, the Turkey Post Hoc Test was conducted to ascertain the degree of differences across the four mobile network providers.

4.1.2 Study Area I: Cross River State Description

Situated in the tropical rainforest zone of Nigeria's Delta region, Cross River State is known as "The People's Paradise". It is flanked to the north by Benue State, to the south-west by Akwa Ibom State, and to the west by the states of Ebonyi and Abia. It is located between latitudes 5°32' and 4°27' North and 50' and 9°29' East. The state's Atlantic coastline lies to the south, where the Calabar River meets the sea, and it has an internal border to the east with the United Republic of Cameroon.

The state, which has a population of 1.8 million and an area of 23,074 square kilometers, is split up into 18 local government areas. Calabar serves as the state's capital, and other significant cities include Ikom Obubra, Odukpani, Ogoja, Boki, Ugep, Obudu, Obanliku, and Akpabuyo.

Cross River State has a tropical humid climate with both rainy and dry seasons. The annual precipitation ranges from 1300 to 3000 mm, and the average temperature is between 15°C and 30°C. This research examined all six (6) Local Government Areas in Cross River State. These regions were chosen due to their high population density and thriving economies.

Fig. 1 shows the map of study 1.

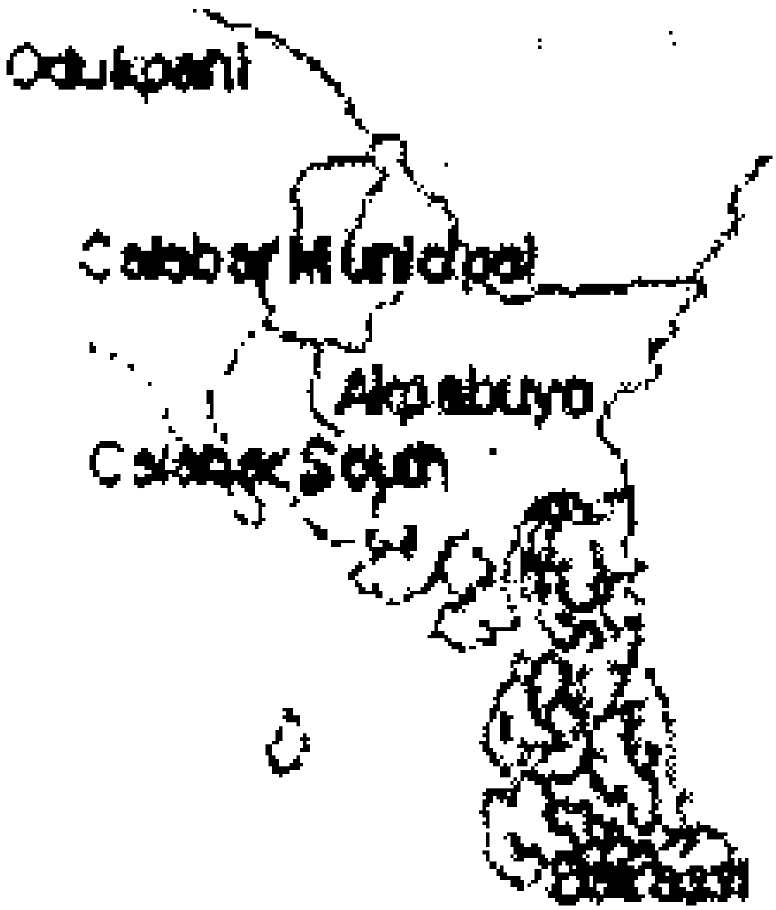

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FIG 2: Map of Cross River State

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Technical details for the study area I: Cross River State

Study region: State of Cross River

3G network being observed

Data collecting procedure: Measure radio frequency (RF) using a drive test

Utilized instrument: TEM 13.1 high-quality voice recorder

Test types include Quality of Service (QOS) tracking.
Call Setup Success Rate (CSSR) is the Key Performance Indicator (KP1).
Fig. The performance of the four (4) GSM network carriers in Cross River State is shown in Appendices I and II. The mean call setup success rate (CSSR) for MTN, Glo, Airtel, and 9mobile from October 2018 to October 2019 is shown in this result.
With an average CSSR value of 98.87% in 2019, MTN had its highest performance to date, according to Fig. 3, which displays the time series plots for average CSSR values in Cross River State. This figure was within the NCC's cutoff (≥98%) for all Nigerian mobile network providers.
October 2018, December 2018, and August 2019 had the greatest performance from the Glo mobile network, with average CSSR values of 98.32%, 99.20%, and 98.46%, respectively. These results were within the NCC's upper limit (>98%) for all Nigerian mobile network providers.
In November 2018, January 2019, July 20, 2019, and September 2019, 9mobile network also shown exceptional performance, with average CSSR values of 98.27%, 98.79%, 98.02%, and 8%, respectively. These results were within the NCC-established criterion (>98%) for all Nigerian network providers.
Conversely, Airtel's mobile network performed appallingly in Cross River State throughout the study period since not a single figure for the months under examination went below the 98% threshold that the NCC established for all mobile network providers.
In conclusion, the average CSSR of mobile network operators in Rivers State is topped by 9mobile network, which is followed by Glo mobile and MTN. A few factors contributing to the low CSSR in Rivers State were faculty hardware, particularly in rural areas, radio interface congestion, and a lack of allocation of radio resources, such as SDCCH.
The crucial F-value at the 0.05 level of significance was 3.357. We reject the null hypothesis and come to the conclusion that there is a significant difference between at least two means for each network since this value was smaller than the F-value of 7.43. The null hypothesis is in Appendix II and reads, "There is no significant difference between the mean CSSR for each network." The alternative hypothesis, which declared that "there is a significant difference between at least two mean CSSRs for each network," was evaluated against this one."

4.3 **Modeling Key Performance Indicators (KPIs)**

Sequel the results of findings in Appendix I - XXXVIII several observations were made on the average CSSR, average CDR, average CCR, average CHSR, and SDCCH for the networks: MTN, Glo Mobile, 9mobile and Airtel in relation to their NCC threshold for Cross River, Akwa Ibom and River States. Here, with the use of time series analysis (a statistical tool in MINITAB 17), a general forecast model yt = β0 + Bi + β11t2 was obtained for each network key performance indicators (KPI) with a view to making forecast of the observation for the next 24 months. For the development or proposal general forecast model.
yt = Bi + β11t2 + β0
yt = New finding or prediction
Each unique model has two model parameters: Bii (for I = 1) and βi = (for i = 0,1).
105
To calculate the predictors for t = 13, <, 36 for every network KPI, or
KPTs).
In order to analyze and anticipate each KPI's future trend for the period under investigation, the following models were developed: Bayelsa, Cross River, Akwa Ibom, and River States GSM operators will be able to monitor, access, and manage the quality of service in the future thanks to these forecasts..

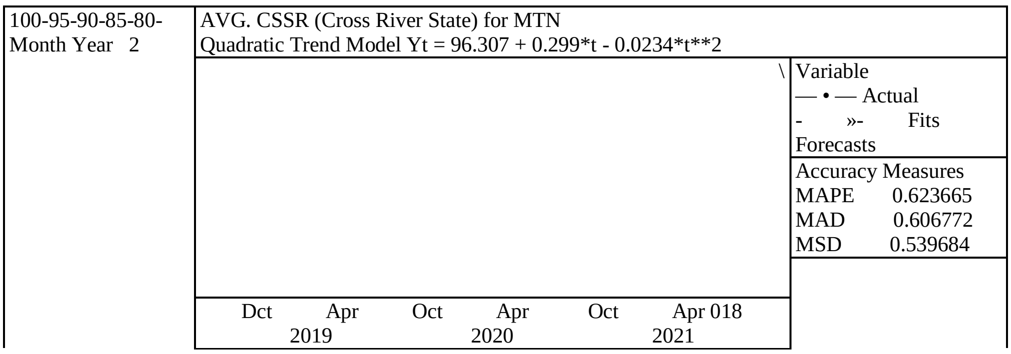


Fig 20a: Model plot of average CSSR for MTN in Cross River State

Fig. 20a and appendix 1l1a shows the average CSSR for MTN in Cross River State.
The result of our analysis gives a quadratic trend model in % as presented in equation 4.1 below

y_t 96.3070 + 0.299t-0.0234t^2 ………………………………………4.1

where t = 13. 14, 15, ….36 (predictors)

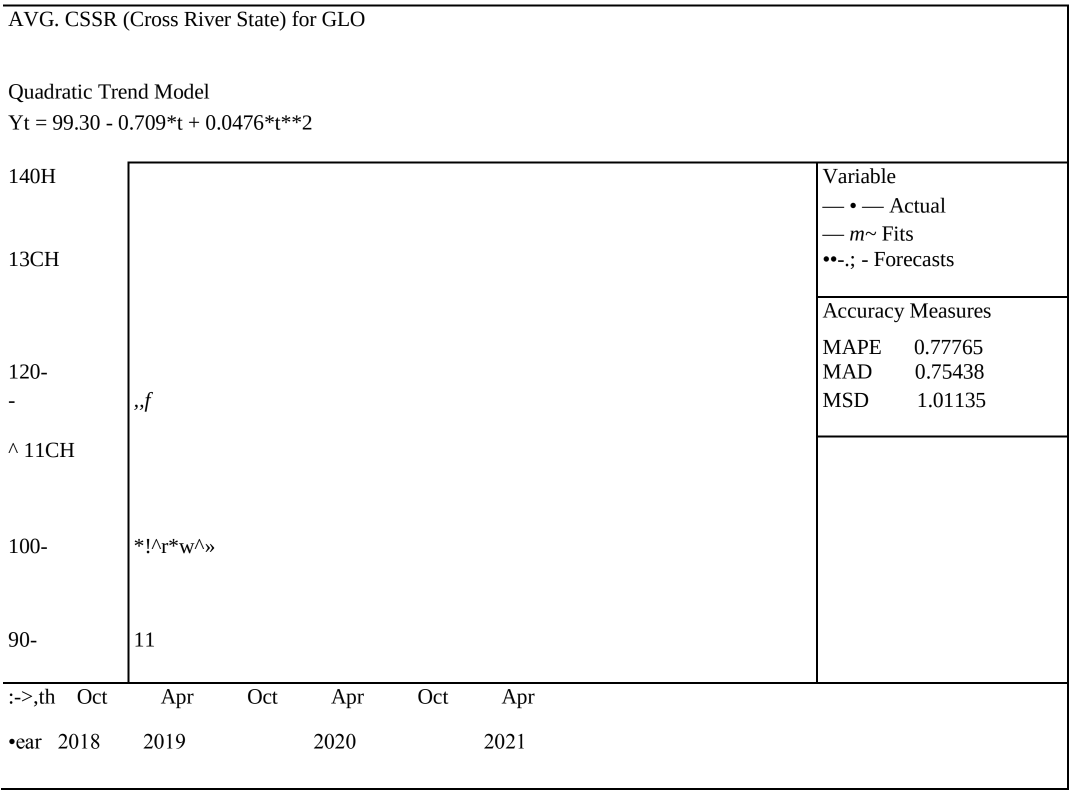
y_t = forecast value of average CSSR (%) for MTN networks in Cross River State for t=13

y_{13} = 96.307 + 0.299x13 - 0.0234%13^2

y_{13} = 96.307 + 3.887 - 3.9546

y_t = 96.2394 ^96.24% ……….4.2

Equation 4.2 is the forecast average CSSR for MTN in Cross River for the 13th month as shown in appendix IlIa. Hence, based on our results, equation 4.1 can be used as a model equation for evaluating, predicting and controlling CSSR for MTN in Cross River State for the next 24 month.



A model plot of average CSSR for Glo in Cross River State.

Fig 20b and Appendix Illb displays the average CSSR for Glo mobile network operator Cross River State. The result of our analysis gives a quadratic trend model in (% as presented in equation 4.3 below.

y_t = 30-0.709t + 0.0476t^2…………………………………………………………… 4.3

Where t = 13, 14, 15,…………………36 (predictors)

y_t = forecast value of average CSSR (%) for Glo networks in Cross River State

for 30 - 0.709x13 + 0.0476xl3^5

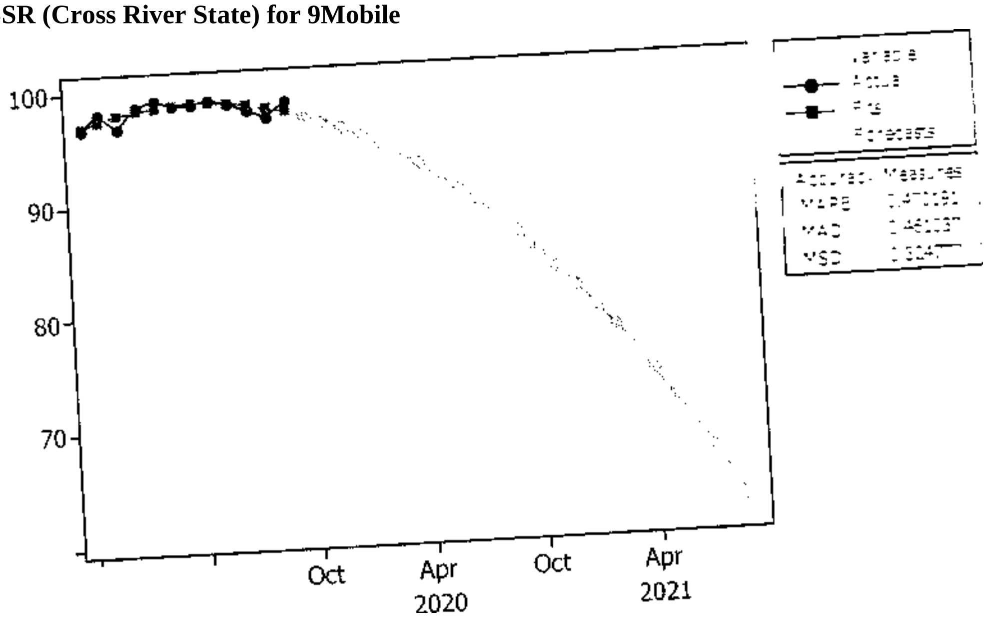
:-,30-9.217+ 8.0444

-.3444-9.217

y_t 13%. .4.4

Equation 4.4 represents the forecast average CSSR for Glo mobile network in Cross .River State for the 13th month as shown in Appendix Illb (the forecast for Oct, 2019). Therefore, based on our observation, equation 4.3 can be used as a model equation for $_r$. predicting and controlling CSSR of Glo mobile network in Cross River State next 24 months.

AVG. CSSR (Cross River State) for 9Mobile



Quadratic Trend Model Yt = 96.498 + 0.655*t - 0.0451*t**2
60 :h Ocf Apr
ar 2018 2019
Fig 20c: model plot of average CSSR for 9mobile in Cross River State
Fig 20c and Appendix IIIc displays the average CSSR for 9mobile mobile in Cross River State. Based on our analyses, the result gives a quadratic trend model in (% as presented in equation 4.5 below.
':.} equation 4.5 below.
-8+ 0.655t-0.0451t^2 4.5
∴ 14, 15, 36 (predictors)
. : /recast CSSR (%) for 9mobile in Cross River State
.3+ 0.655x13 - 0.0451xl3^2
•3+ 8.515-7.6219
13-7.6219
Y_{13} = 97.39%...4.9
Equation 4.6 represents the forecast average CSSR for 9mobile network in Cross River State for the 13th month as shown in appendix (IIIc) (i.e. forecast for Oct, 2019).
Equation 4.5 can be applied to forecast Oct, 2019 - Sept. 2021. Therefore, based on our result, equation 4.5 can be used as a model equation for evaluating, predicting and controlling CSSR of 9mobile network in Cross River State for the next 24 months.

AVG. CSSR (Cross River State) for Airtel
Quadratic Trend Model

Yt = 98.427 - 0.659*t + 0.0527*t**2

150^J

Variable
• Actual
—a- Fits Forecasts

140-
130-
120- .••*y*
110-

Accuracy Measures MAPE 0.600100
MAD 0.581623
MSD 0.449507

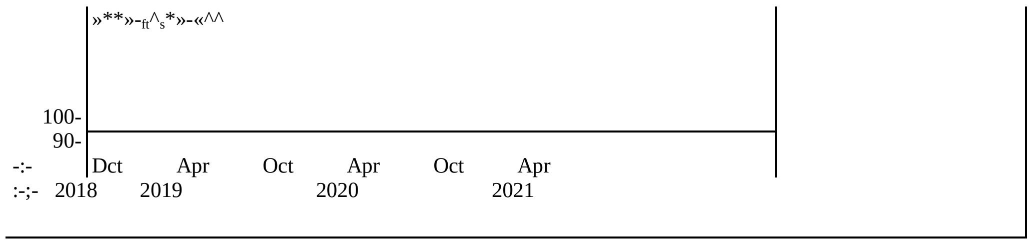


Fig 20d: A model plot of average CSSR for Airtel in Cross River State

Fig 20 and appendix (llld) displays the average CSSR for Airtel mobile network in Cross State, Nigeria. Our observation gives a quadratic trend model in (%) as shown in the equation below.

$y_{t} = 98.427 - 0.659t + 0.0527t^2$ ………………4.7

Where t=13, 14, 15, 36 (predictors)

y_t = is the forecast CSSR (%) for Airtel mobile in Cross River State

For t = 14

$y_{14} = 98.427 - 0.659x14 + 0.0527xl4^2$

$y_{14} = 98.427 -9.226 + 10.3292$

$y_{14} = 108.7562-9.226$

$y_{14} = 99.53\%$ ……………….4.8

Equation 4.8 shows the forecast average CSSR for Airtel mobile network in Cross River State, Nigeria for the 14th month as shown in appendix Hid (i.e. forecast the Nov, 2019). Equation 4.7 can be applied to forecast CSSR for Airtel mobile in Cross River State for Oct, 2019 - Sept, 2021. Therefore, equation 4.7 can be used as a model equation for evaluating, predicting and controlling CSSR for Airtel in Cross River State for the next 24 months.

V. Conclusion

To sum up, this research thoroughly examined the dynamics of mobile network portability within the distinct framework of South-South Nigeria. We have determined vital benchmarks that are essential for promoting efficient mobile network portability procedures by careful examination of performance threshold levels, taking into account variables like network dependability, service quality, and user preferences. The significance of customizing tactics to improve service offerings and operational efficiencies to reach or exceed these levels is highlighted by our findings. Mobile network providers can proactively enhance their services by knowing the precise thresholds that impact consumer decisions. This will ultimately lead to a more competitive and customer-focused telecoms ecosystem in the area. Moving forward In the future, our study offers a crucial basis for legislators, regulators, and industry participants to put into practice policies that improve mobile network portability experiences, empowering users and spurring innovation in South-South Nigeria's telecommunications sector."

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