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Effects of meteorological variables on the quality of service of mobile networks in Yenagoa – southern Nigeria

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Abstract

The nexus of this study is to investigate the dependencies of CSSR and DCR on Meteorological parameters for four mobile networks in Yenagoa. The Meteorological parameters used, temperature and relative humidity, were obtained from Nigerian Meteorological Agency. These data which span from January 2014 to December 2023 were averaged to obtain monthly mean temperature and relative humidity for Yenagoa. CSSR and DCR monthly data from January 2014 to December 2023 for Yenagoa were obtained from NCC, Abuja. Correlation coefficients between CSSR and Temperature, CSSR and relative humidity, DCR and temperature, DCR and relative humidity were 0.49, -0.47, -0.35, 0.29 for MTN network, 0.56, -0.02, -0.47, 0.31 for Airtel network, 0.21, -0.34, -0.11, -0.26 for 9mobile and 0.69, -0.04, -0.25, 0.00 for Globacom network. Graphs were plotted using QoS KPIs as the dependent variable while the weather parameters were the independent variables. Regression models were developed for predicting CSSR and DCR, provided, the temperature or relative humidity at that particular time is known. It was concluded that an increase in temperature and relative humidity led to an increase in CSSR and vice versa, while an increase in temperature and relative humidity led to a decrease in DCR and vice versa. This result will be useful to network operators and planners, enabling them to develop an efficient link margin in order to achieve a better QoS. Researchers should investigate QoS KPIs and how they are affected by other meteorological parameters.

Keywords: Call Setup Success Rate; Dropped Call Rate; Temperature; Relative Humidity; Key Performance Indicator; Handover Failure Rate; Data; Mobile Network

1. Introduction

Mobile network operators rely on transmitting signals through the troposphere without pre-evaluation and characterization of the troposphere and this is the reason for poor QoS [1]. To describe the reliability of networks, one needs to know which weather parameters affect the propagation of signal and the changing weather conditions, which may cause severe degradation in system performance [2]. To forecast, simulate, and design high performance communication systems, exact transmission characteristics of radio waves in various environments have to be known [3]. Mobile network providers need to plan and optimize their networks to find a compromise between radio coverage in different environments, the QoS and the operation of the network [4]. The basic mechanism of planning a network is to ensure that proper QoS is provided to meet subscribers need in an economical way [5]. The wave propagation characteristics between the transmitter and receiver are controlled by the transmitting antenna, operating frequencies and media between them [6] and since quality of service can be improved by eliminating the factors that affect KPIs performance both from external and internal sources [7], accurate prediction of radio frequency signal coverage in a terrain is required [8].

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In this work, the two KPIs studied are CSSR and DCR. CSSR depicts the percentage of attempts to initiate a call that results in a connection to the dialed number [9]. It is the number of unblocked call attempts to the number of seizures resulting in a successfully established call [10]. It is measured in percentage and given 98% benchmark by NCC. A call attempt, leads to a call setup procedure and if successful, results in a connected call. A successful CSSR consists of the immediate assignment procedure and the assignment procedure. The former is used in creating a signaling connection between the Mobile Station (MS) and the network while the latter is used to occupy a speech channel [11,12]. High CSSR, depicts better cell performance and is obtainable when Traffic Channel (TCH) allocation and Standalone Dedicated Control Channel (SDCCH) seizures are accessed to setup a call [13]. When there is a call setup failure, it means that the user's request is not served due to problems on the resource allocation of a signaling channel in which the negotiation for the actual traffic is performed [14]. The causes of CSSR failures are low signal strength, hardware problem, SDCCH congestion and TCH failure assignment.

Mathematically, CSSR = (1 – blocking probability) × 100% …………………….. (1)

DCR is the number of live calls prematurely terminated by a network divided by the total number of live calls within a particular time, usually calculated on hourly basis. It measures the network's ability to retain call conservation when it has been setup and is said to be prematurely terminated when being released normally, either by the caller or the called party [15]. It is measured in percentage and given 2% benchmark by NCC. DCR is caused by degraded signal quality, coverage issues, interference, frequency reuse, poor Handover Seizure Ratio (HOSR), high TCH congestion rate, hardware fault and sudden network breakdown. An exponential increase in DCR depicts serious network problem [16].

Mathematically, DCR = (1 – call complete ratio) ×100……………… (2)

The crucial part of this research is to detect the dependencies of CSSR and DCR on temperature and relative humidity.

2. Related studies

It is common knowledge that cellular network signals exposed to changing weather conditions suffer severe degradation in signal propagation and system performance. It is essential to explore weather related factors affecting network QoS in order to diminish their impact and adapt to varying conditions.

[17] studied the impact of weather conditions on Wide Code Division Multiple Access (WCDMA) signals on the MTN network in Enugu State, Nigeria. Materials used for this research were a laptop, GPS, a power inverter, a Testing Equipment for Mobile System (TEMS) V13.0 software installed in the laptop and a TEMS mobile phone. A drive test was conducted and voice calls were made for 120 seconds on the mobile phone for five years, covering both rain and dry season. Log files for dropped and blocked calls were extracted and correlation test was performed to ascertain any relationship existing between them. Results show that during adverse weather conditions, Blocked Call Rate (BCR) and Dropped Call Rate (DCR) rose. Weather condition during dry season had a blocked call rate of 8.76% compared to the rainy season with 12.89%. From the outcome of the experiment, a model was developed for predicting an unknown network call statistics variable.

[18] in Benin City, on a Glo network operating in the 900 MHz band, investigated the impacts of weather and environment conditions on mobile communication signals. Research materials used was frequency signal tracker software, version 2.5.1, configured into an Intel palm top notebook. Relative parameters data were obtained from 200 meters from Glo BTS from 28th of July to 31st of August 2016, with data obtained hourly. Morning, afternoon and evening, dry weather, fog weather and raining conditions was based on the statistical central tendency parameters. An average refractivity gradient of 613N/km was obtained. Relative humidity and pressure had -0.50 and -0.44 while temperature and refractivity had 0.50 and 0.42 correlations. At dry weather, signal strength variation was within 32dBm, within 34dBm during fog, and a higher range within 38dBm during rain. The further the mobile station from the BTS, the higher the signal loss.

[19] investigated tropospheric radio signal strength for UHF band and how it is affected by temperature. This research was carried out at KUSZA Observatory, East Coast Environmental Research Institute (ESERI), UniSZA, Merang, Terengganu, Malaysia. Materials used for this research were patch antenna, spectrum analyzer and a weather station. This work considered radio wave propagation up to 9GHz. Continuous-wave envelope fading waveforms was recorded over a period of one-hour using patch antenna. A spectrum analyzer was used for Radio Frequency Interference measurement and weather station for weather effect. The graphs of radio signal attenuation for temperature against time were plotted. A relationship between radio signals with changes in temperature was established. At 383 MHz, r was 0.249, at 945 MHz, r was -0.085, at 1800 MHz, r was 0.268, and at 2160 MHz, r was 0.134.

[20] accessed speech quality in GSM/UMTS networks and how it is affected by weather parameters. The meteorological station, Asterisk PBX, located in university campus provided information about temperature, rain, humidity, dew point, wind speed and atmospheric pressure. A monitoring tool which carried out a call in every five minutes and about twenty thousand measurements were made. Transmitted calibrated speech samples were compared with that received by Perceptual Evaluation of Speech Quality (PESQ) method. Computed Mean Opinion Score (MOS) to every call stored in a database was analyzed using Kmeans clustering method and about fifty percent decrease of MOS during a heavy rain was observed.

3. Materials and method

This research designed to detect the dependencies of network KPIs on weather parameters was observed for the four telecommunication operators in Bayelsa State, Nigeria. Weather parameters used in this study are temperature and relative humidity while mobile network KPIs used are CSSR and DCR. To aid in the analysis of this work, the following data were obtained:

- Temperature data for Bayelsa State, obtained from Nigerian Meteorological Agency (NiMet), presented as Table 1
- Relative humidity data for Bayelsa State, obtained from NiMet, presented as Table 2
- CSSR data of MTN for Bayelsa State, obtained from NCC, Abuja, presented as Table 3
- DCR data of MTN for Bayelsa State, obtained from NCC, Abuja, presented as Table 4
- CSSR data of AIRTEL for Bayelsa State, obtained from NCC, Abuja, presented as Table 5
- DCR data of AIRTEL for Bayelsa State, obtained from NCC, Abuja, presented as Table 6
- CSSR data of 9MOBILE for Bayelsa State, obtained from NCC, Abuja, presented as Table 7
- DCR data of 9MOBILE for Bayelsa State, obtained from NCC, Abuja, presented as Table 8
- CSSR data of GLO for Bayelsa State, obtained from NCC, Abuja, presented as Table 9
- DCR data of GLO for Bayelsa State, obtained from NCC, Abuja, presented as Table 10

Table 1 Temperature data for Bayelsa State in degree Celsius**.**

Year	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**
Jan	33.00	34.50	33.50	32.40	34.30	35.00	33.90	34.00	33.20	34.00
Feb	34.70	35.90	34.00	33.50	34.70	34.90	33.70	35.00	34.90	36.10
Mar	35.10	35.30	34.70	35.90	34.10	33.80	34.00	34.60	35.00	34.00
Apr	32.70	34.90	32.80	32.90	33.10	33.70	34.10	34.00	33.80	34.10
May	31.90	33.10	32.30	31.80	32.20	31.90	32.30	33.00	31.30	31.70
Jun	31.20	31.20	30.50	30.50	30.80	31.10	31.50	30.00	31.00	32.80
Jul	29.90	30.30	29.50	28.90	29.10	29.60	30.00	30.00	31.50	31.70
Aug	29.70	29.80	28.60	28.50	28.30	29.20	28.70	30.00	31.20	32.00
Sep	30.20	31.30	30.00	29.90	29.90	30.40	30.00	31.00	31.30	31.90
Oct	31.10	32.50	32.30	31.60	31.00	31.30	31.70	31.00	31.10	30.00
Nov	32.40	32.60	32.70	32.20	32.10	31.80	32.10	33.30	33.70	32.80
Dec	33.50	33.40	32.80	33.30	31.60	32.10	31.80	32.20	32.80	34.00

Table 2 Relative humidity data for Bayelsa State in percentage (%)

Year	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**
Jan	85	82	76	77	80	82	67	70	81	77
Feb	84	85	85	86	83	84	84	76	77	82

Mar	83	83	83	82	87	87	85	84	82	84
Apr	84	83	83	82	84	82	81	87	86	84
May	84	85	84	83	84	84	84	88	88	85
Jun	87	88	90	87	89	87	92	89	89	86
Jul	92	90	93	92	91	92	93	91	91	90
Aug	92	91	93	90	92	90	93	93	94	90
Sep	89	89	90	90	91	90	91	91	90	89
Oct	87	86	88	87	88	87	88	87	88	85
Nov	84	85	84	84	87	87	84	88	87	88
Dec	84	83	80	83	82	79	81	83	81	86

Table 3 CSSR data for MTN in percentage (%)

Year	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**
Jan	97.23	95.57	95.43	96.41	96.86	96.94	99.09	99.15	99.63	99.57
Feb	96.46	96.42	94.99	96.71	96.39	96.99	98.74	99.18	99.60	99.65
Mar	97.23	98.33	96.12	97.07	97.73	97.19	99.39	99.26	99.60	99.53
Apr	94.60	98.02	96.88	96.42	96.58	97.11	99.42	99.23	99.55	99.61
May	96.57	98.13	96.87	96.86	96.43	97.01	99.40	99.39	99.58	99.68
Jun	96.83	96.89	96.89	96.67	97.12	97.12	99.46	99.46	99.54	99.59
Jul	96.65	96.97	95.99	97.19	96.86	97.12	99.54	99.52	99.34	99.71
Aug	96.67	96.97	96.91	97.68	96.67	97.42	99.39	99.44	99.60	99.68
Sep	96.49	96.99	96.46	97.12	97.74	97.52	99.23	99.64	99.63	99.70
Oct	96.46	97.13	97.12	97.01	97.49	97.56	99.19	99.52	99.64	99.67
Nov	96.36	97.77	97.56	98.11	97.34	98.73	99.03	99.65	99.66	99.60
Dec	96.90	97.89	97.89	98.13	97.74	98.01	99.23	99.65	99.65	99.72

Table 4 DCR data for MTN in percentage (%)

Year	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**
Jan	0.72	1.25	1.26	1.34	1.54	1.21	0.33	0.31	0.16	0.20
Feb	0.78	1.27	1.35	1.33	1.36	1.29	0.42	0.25	0.14	0.15
Mar	1.23	1.32	1.30	1.33	1.54	1.19	0.32	0.17	0.14	0.14
Apr	1.16	1.27	1.25	1.41	1.47	1.43	0.32	0.18	0.15	0.12
May	1.22	1.32	1.26	1.25	1.60	1.33	0.34	0.18	0.17	0.15
Jun	1.23	1.48	1.29	1.32	1.34	1.30	0.36	0.23	0.22	0.20
Jul	1.30	1.34	1.30	1.54	1.48	1.23	0.38	0.20	0.33	0.18
Aug	1.33	1.60	1.41	1.60	1.32	1.22	0.36	0.35	0.27	0.08

Sep	1.43	1.47	1.42	1.36	1.27	1.16	0.40	0.17	0.22	0.13
Oct	1.19	1.54	1.41	1.34	1.32	1.23	0.37	0.23	0.20	0.12
Nov	1.29	1.36	1.39	1.48	1.27	0.78	0.86	0.17	0.19	0.19
Dec	1.21	1.54	1.35	1.52	1.25	0.72	0.32	0.15	0.17	0.17

Table 5 CSSR data for AIRTEL in percentage (%)

Year	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Jan	97.20	98.49	96.40	97.02	97.34	96.99	99.17	98.96	98.95	98.67
Feb	96.33	98.71	96.52	97.17	95.99	98.09	99.22	99.02	99.00	98.98
Mar	96.54	98.64	96.44	97.39	97.73	98.29	99.50	99.16	99.16	99.08
Apr	96.46	98.27	95.41	97.48	97.57	97.87	99.21	99.10	98.92	98.98
May	96.76	98.33	95.33	96.76	97.34	98.04	99.17	99.15	98.98	99.18
Jun	97.68	98.08	97.44	97.87	96.66	98.08	98.61	99.10	99.12	99.09
Jul	96.66	98.14	97.13	98.08	97.68	98.08	99.21	99.06	99.11	99.13
Aug	97.34	98.04	96.29	98.29	96.76	98.33	99.14	99.39	99.09	99.09
Sep	97.57	97.87	95.38	98.09	96.46	98.27	99.14	99.14	99.04	99.00
Oct	97.57	98.29	97.86	96.99	96.54	98.64	98.79	99.10	98.93	99.09
Nov	97.73	98.09	98.11	98.29	96.33	98.71	99.14	99.06	98.94	99.13
Dec	95.99	96.99	98.31	98.44	97.20	98.45	98.89	98.97	98.59	99.14

Table 6 DCR data for AIRTEL in percentage (%)

Year	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Jan	1.21	1.13	1.26	0.84	0.87	0.84	0.63	0.38	0.39	0.43
Feb	1.29	1.45	1.25	0.87	0.86	0.71	0.66	0.36	0.39	0.40
Mar	1.19	1.41	1.34	0.86	0.77	0.60	0.62	0.36	0.36	0.38
Apr	1.43	1.48	1.42	0.92	0.83	0.67	0.39	0.37	0.44	0.40
May	1.33	1.37	1.61	0.84	0.83	0.74	0.37	0.36	0.55	0.42
Jun	1.30	1.66	0.82	0.86	0.84	0.80	0.46	0.38	0.42	0.29
Jul	1.23	1.67	0.86	0.77	0.95	0.82	0.41	0.39	0.45	0.46
Aug	1.22	1.75	1.27	0.78	0.74	0.85	0.44	0.27	0.45	0.43
Sep	1.16	1.77	1.19	0.77	0.76	0.82	0.39	0.41	0.45	0.44
Oct	1.23	1.79	1.26	0.76	0.78	0.79	0.44	0.39	0.48	0.42
Nov	1.22	1.29	0.91	0.74	0.77	0.75	0.37	0.39	0.50	0.50
Dec	1.27	1.17	0.86	0.77	0.78	0.73	0.44	0.41	0.51	0.51

Table 7 CSSR data for 9MOBILE in percentage (%)

Year	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Jan	96.34	97.89	97.80	98.04	98.79	99.20	99.26	99.69	99.28	98.56
Feb	98.73	97.77	98.01	97.80	95.21	99.26	99.56	99.54	99.31	99.21
Mar	99.22	97.92	97.94	94.38	98.72	98.97	99.50	99.70	99.37	99.11
Apr	98.75	98.13	97.90	96.88	98.79	99.03	99.48	99.70	99.44	99.34
May	98.94	98.89	97.95	97.80	99.01	98.39	99.28	99.77	99.43	99.34
Jun	99.14	96.44	97.93	97.92	98.50	99.23	99.41	99.73	99.47	99.10
Jul	98.50	96.92	97.80	97.90	99.14	99.33	98.54	99.54	99.38	99.15
Aug	99.01	96.99	97.92	98.10	98.84	99.07	99.47	99.61	99.24	99.50
Sep	98.79	97.13	97.89	95.21	98.75	99.28	99.56	99.35	99.03	99.53
Oct	98.72	97.92	97.99	98.79	99.22	99.04	99.56	99.41	98.14	99.60
Nov	95.21	97.43	98.14	98.97	98.73	99.10	99.57	99.02	99.11	99.64
Dec	98.79	97.77	97.95	99.23	96.34	99.09	99.68	99.34	99.12	99.54

Table 8 DCR data for 9MOBILE in percentage (%)

Year	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Jan	0.61	0.59	0.86	1.21	0.84	0.55	0.05	0.62	0.54	1.04
Feb	0.66	0.62	0.97	1.32	0.76	0.54	2.41	0.65	0.59	0.63
Mar	0.82	0.81	0.96	0.86	1.25	0.57	0.69	0.61	0.54	0.80
Apr	1.02	0.74	0.89	1.22	1.08	0.54	0.89	0.59	0.63	0.64
May	0.77	0.54	0.91	0.97	0.84	0.68	0.82	0.81	0.62	0.60
Jun	1.37	1.32	0.90	0.91	0.58	0.55	0.75	0.74	0.57	0.73
Jul	0.75	1.21	1.64	1.19	0.95	0.59	1.37	0.60	0.68	0.65
Aug	0.82	1.19	1.19	1.37	0.53	0.60	0.77	0.54	0.70	0.52
Sep	0.89	0.97	1.24	0.77	0.75	0.58	1.02	0.60	0.73	0.01
Oct	0.69	1.37	1.21	1.37	0.54	0.86	0.82	0.60	0.64	0.45
Nov	1.45	1.22	1.18	1.34	0.70	0.84	0.66	0.57	0.64	0.64
Dec	0.62	2.17	1.20	1.22	0.81	0.80	0.61	0.59	0.62	0.62

Table 9 CSSR data for GLO in percentage (%)

Year	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Jan	98.35	97.80	97.89	95.57	97.23	96.89	98.17	96.92	98.46	98.58
Feb	98.25	98.01	97.77	96.42	96.46	98.04	97.19	98.45	98.59	97.87
Mar	98.17	97.99	97.43	98.33	97.73	98.33	97.75	97.48	98.52	97.88
Apr	98.42	97.89	97.92	98.02	94.60	97.23	98.41	98.49	98.61	98.38

May	98.15	97.92	97.13	98.13	96.57	98.28	97.60	98.45	98.47	98.18
Jun	98.21	97.80	96.99	96.89	96.83	98.08	98.80	96.95	98.44	98.23
Jul	98.08	97.93	96.92	96.97	96.65	98.21	98.35	97.34	98.53	98.81
Aug	98.28	97.95	96.44	96.99	96.67	98.15	98.50	98.48	98.72	98.71
Sep	97.23	97.90	96.97	97.13	96.49	98.42	98.92	98.29	98.61	98.59
Oct	98.33	97.94	96.89	97.92	96.46	98.17	98.57	98.49	98.61	98.72
Nov	98.04	98.14	98.13	97.77	96.36	98.25	98.09	98.39	98.64	98.80
Dec	96.89	97.95	97.92	97.89	96.90	98.35	96.82	98.70	98.69	98.69

Table 10 DCR data for GLO in percentage (%)

Year	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Jan		1.13		1.81	1.17	1.19	0.71	3.16		
Feb	1.29	1.45	1.42	1.78	1.29	1.85	0.70	2.55	0.75	0.93
Mar	1.06	1.41	1.40	1.13	1.79	1.83	0.75	2.57	0.75	0.63
Apr	1.26	1.48	1.62	1.17	1.77	1.43	0.59	3.34	0.61	1.37
May	1.03	1.37	1.49	1.43	1.75	0.78	0.74	3.55	0.87	1.17
Jun	1.12	1.66	1.50	1.19	1.67	0.85	0.54	3.53	1.12	1.46
Jul	1.19	1.67	1.71	1.12	1.66	0.81	0.35	2.70	0.74	0.86
Aug	1.43	1.75	1.42	1.03	1.37	0.78	0.35	2.56	1.03	0.93
Sep	1.17	1.77	1.42	1.26	1.48	0.81	0.36	2.43	1.26	0.85
Oct	1.13	1.79	1.50	1.06	1.41	0.91	0.34	2.73	0.98	0.70
Nov	1.78	1.29	1.41	1.29	1.45	0.96	0.76	2.01	1.06	1.06
Dec	1.81	1.17	1.43	1.37	1.13	0.86	3.14	0.64	0.90	0.90

Using Excel, the following analyses were made:

- Correlation of mean temperature against CSSR for MTN network. A regression model was obtained and a plotted graph labelled Figure 1
- Correlation of mean temperature against DCR for MTN network. A regression model was obtained and a plotted graph labelled Figure 2
- Correlation of mean relative humidity against CSSR for MTN network. A regression model was obtained and a plotted graph labelled Figure 3
- Correlation of mean relative humidity against DCR for MTN network. A regression model was obtained and a plotted graph labelled Figure 4
- Correlation of mean temperature against CSSR for AIRTEL network. A regression model was obtained and a plotted graph labelled Figure 5
- Correlation of mean temperature against DCR for AIRTEL network. A regression model was obtained and a plotted graph labelled Figure 6
- Correlation of mean relative humidity against CSSR for AIRTEL network. A regression model was obtained and a plotted graph labelled Figure 7
- Correlation of mean relative humidity against DCR for AIRTEL network. A regression model was obtained and a plotted graph labelled Figure 8
- Correlation of mean temperature against CSSR for 9MOBILE network. A regression model was obtained and a plotted graph labelled Figure 9
- Correlation of mean temperature against DCR for 9MOBILE network. A regression model was obtained and a plotted graph labelled Figure 10

- Correlation of mean relative humidity against CSSR for 9MOBILE network. A regression model was obtained and a plotted graph labelled Figure 11
- Correlation of mean relative humidity against DCR for 9MOBILE network. A regression model was obtained and a plotted graph labelled Figure 12
- Correlation of mean temperature against CSSR for GLO network. A regression model was obtained and a plotted graph labelled Figure 13
- Correlation of mean temperature against DCR for GLO network. A regression model was obtained and a plotted graph labelled Figure 14
- Correlation of mean relative humidity against CSSR for GLO network. A regression model was obtained and a plotted graph labelled Figure 15
- Correlation of mean relative humidity against DCR for GLO network. A regression model was obtained and a plotted graph labelled Figure 16

4. Result analysis

Effects of weather parameters (temperature and relative humidity) on mobile network KPI (CSSR and DCR) were studied. Statistical analysis (correlation and regression) were made and graphs plotted. The correlation between weather variables and network KPIs was done to establish a relationship between both parameters while the regression analysis was used in obtaining a prediction model between the parameters. In each graph plotted, the weather variables were the independent variables while the KPIs were the dependent variables as described in Figures 1 to 16.

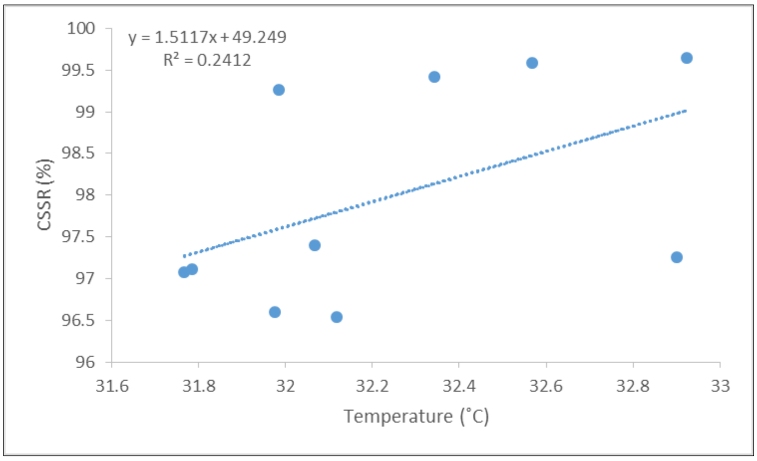

Figure 1 Graph of CSSR against temperature for MTN network

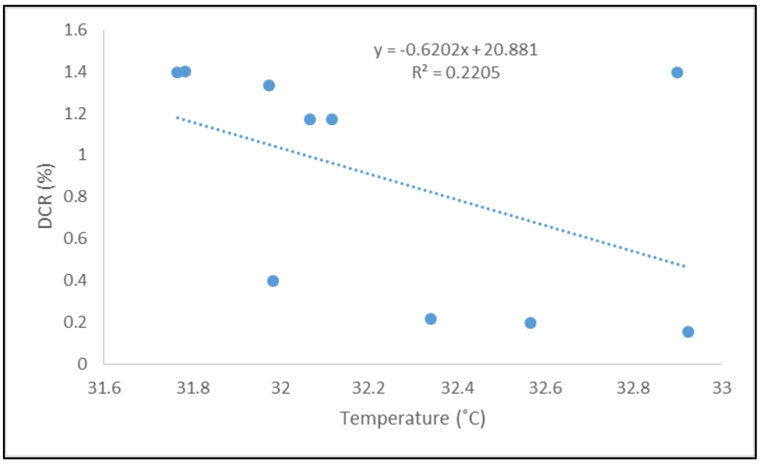

Figure 2 Graph of DCR against temperature for MTN network

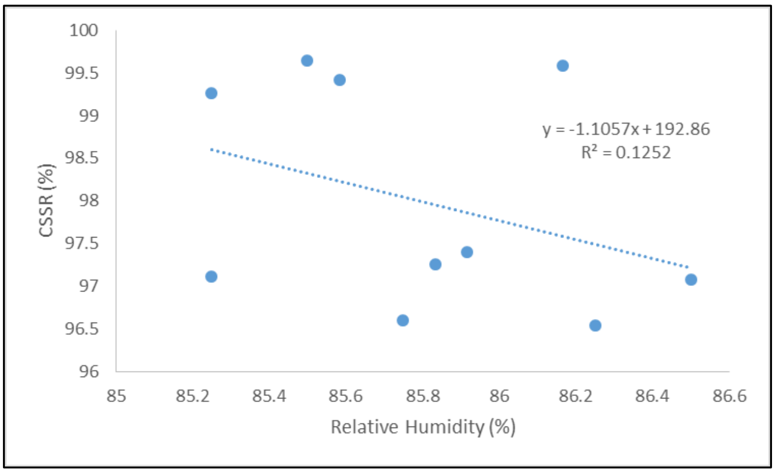

Figure 3 Graph of CSSR against relative humidity for MTN network

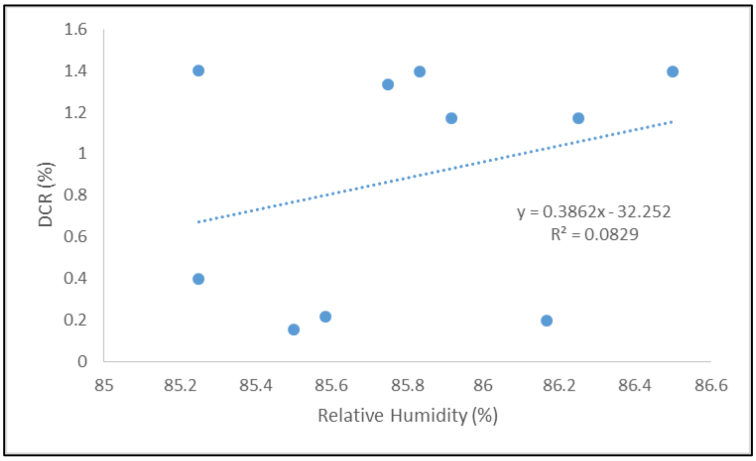

Figure 4 Graph of DCR against Temperature for MTN network

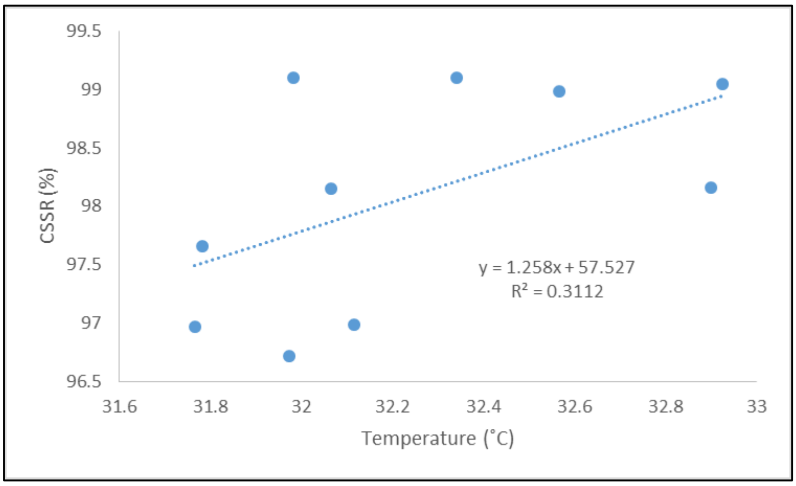

Figure 5 Graph of CSSR against temperature for AIRTEL network

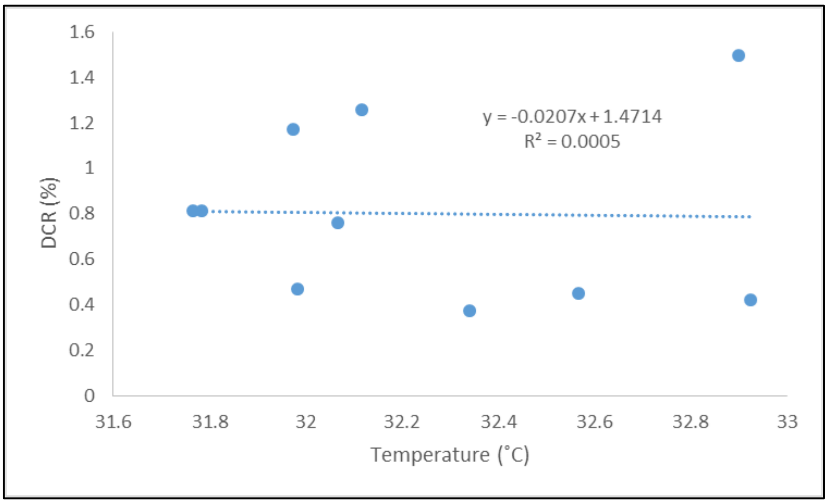

Figure 6 Graph of DCR against temperature for AIRTEL network

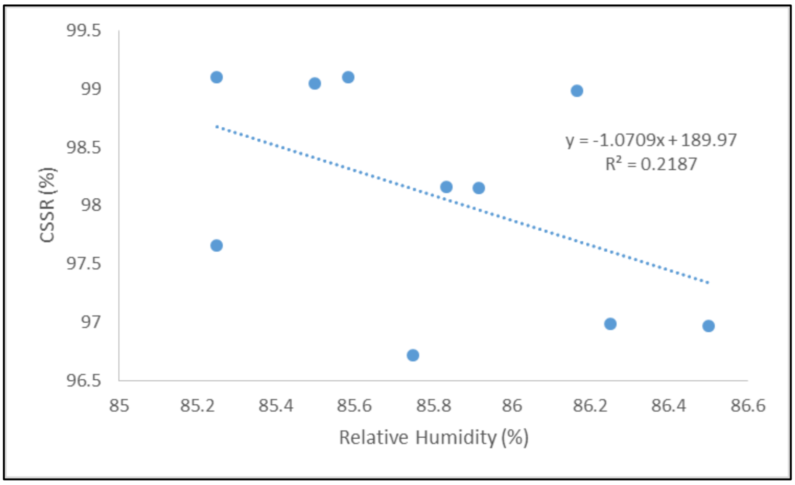

Figure 7 Graph of CSSR against relative humidity for AIRTEL network

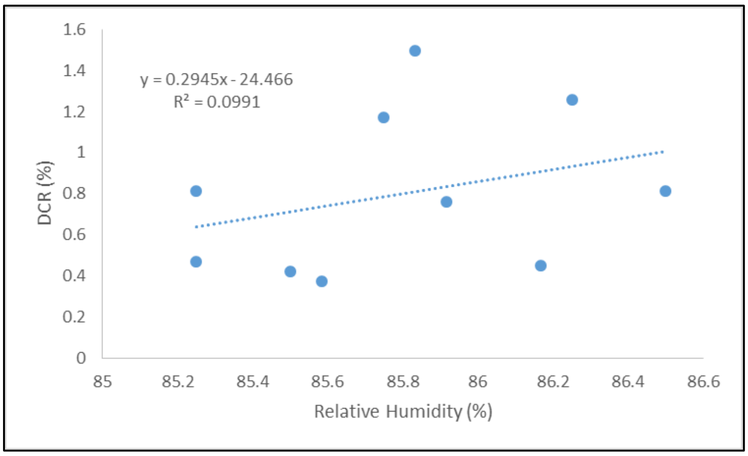

Figure 8 Graph of DCR against relative humidity for AIRTEL network

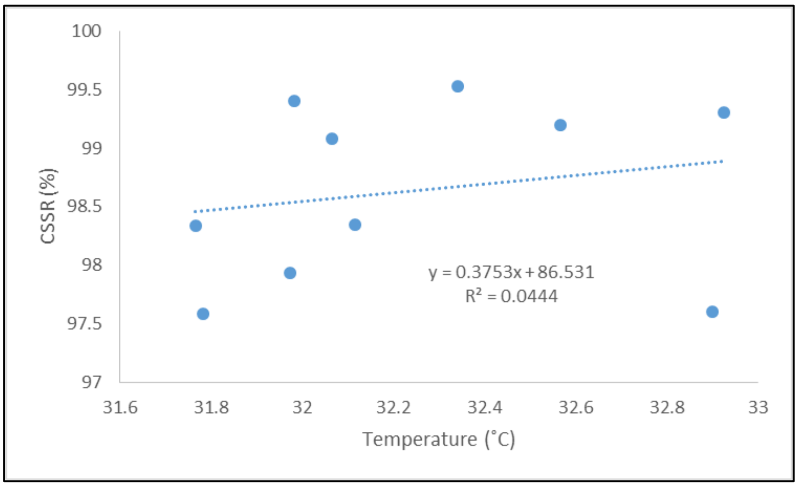

Figure 9 Graph of CSSR against temperature for 9MOBILE network

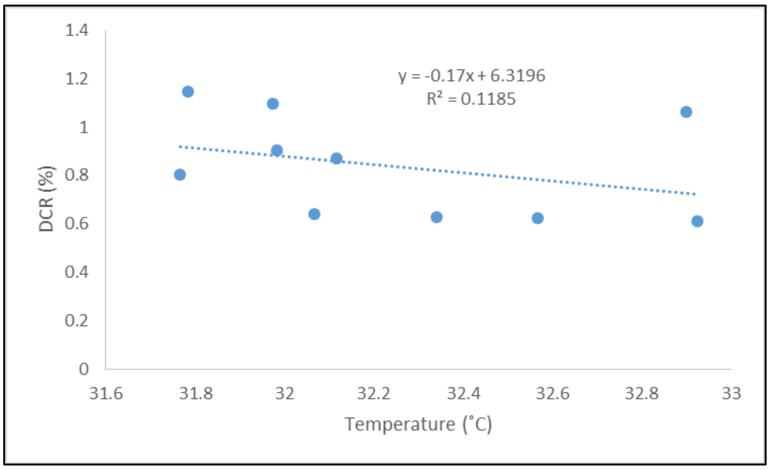

Figure 10 Graph of DCR against temperature for 9MOBILE network

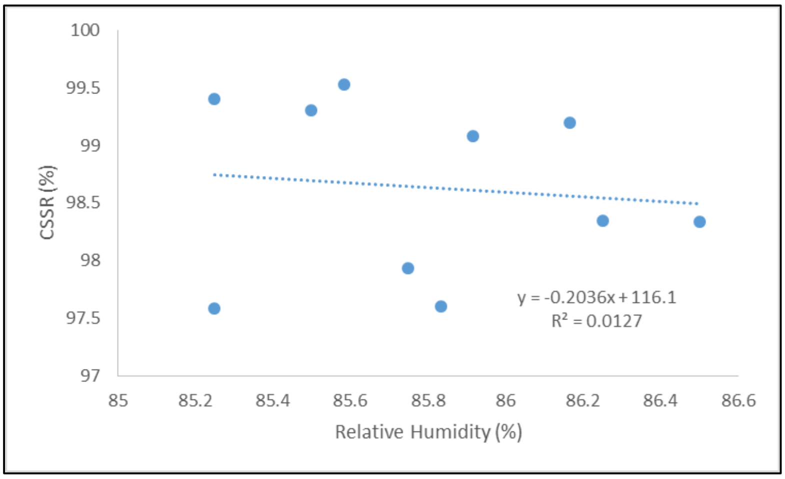

Figure 11 Graph of CSSR against relative humidity for 9MOBILE network

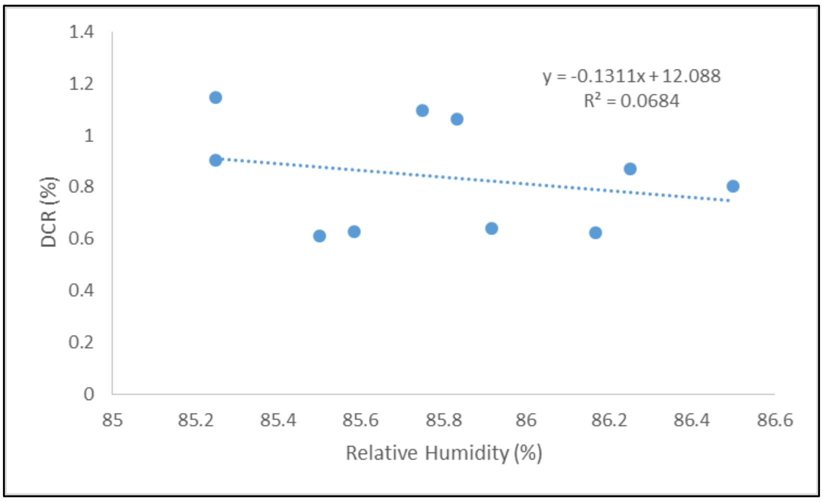

Figure 12 Graph of DCR against relative humidity for 9MOBILE network

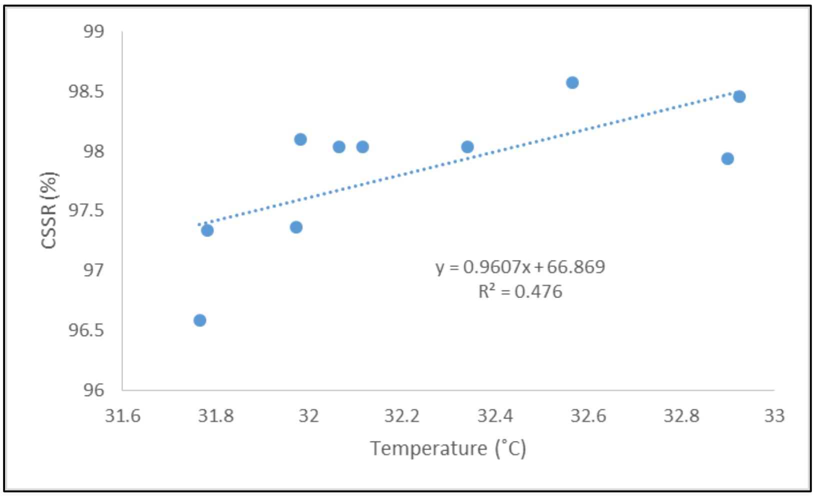

Figure 13 Graph of CSSR against temperature for GLO network

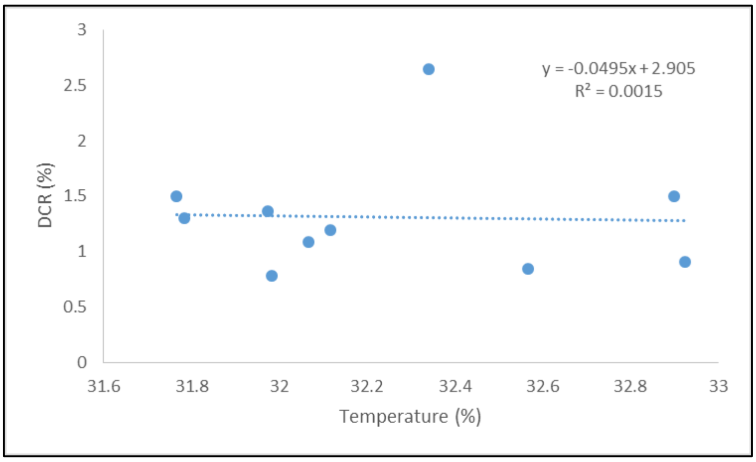

Figure 14 Graph of DCR against temperature for GLO network

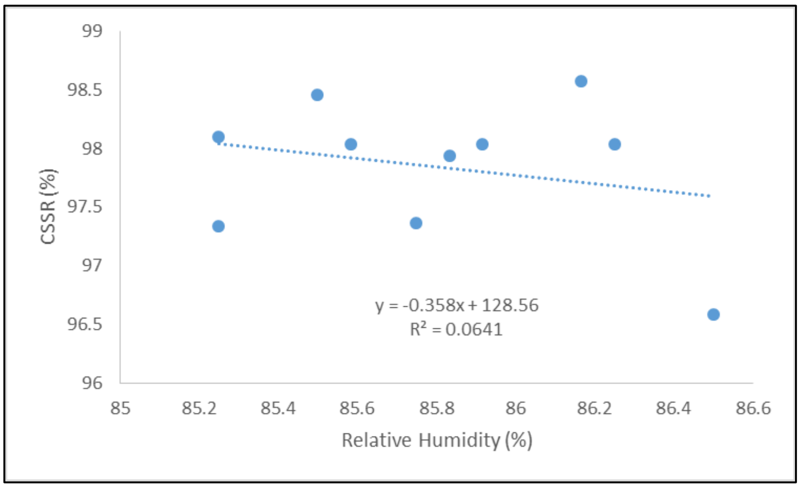

Figure 15 Graph of CSSR against relative humidity for GLO network

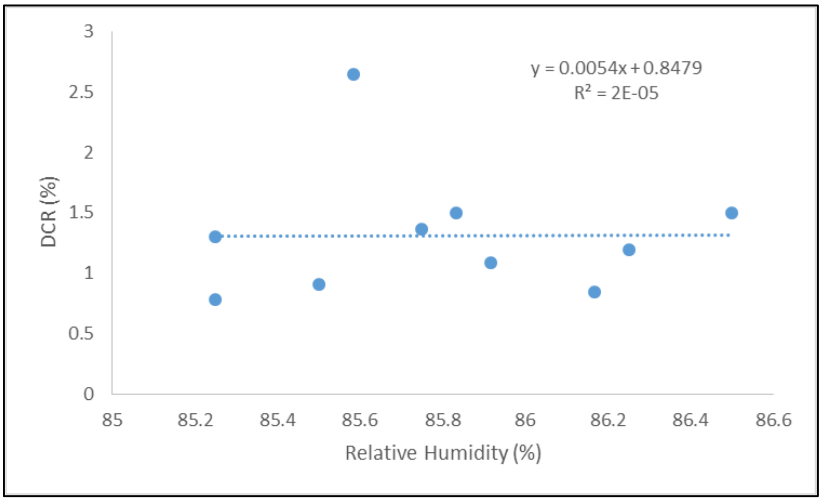

Figure 16 Graph of DCR against relative humidity for GLO network

For MTN network, graphs of CSSR against temperature, DCR against temperature, CSSR against relative humidity and DCR against relative humidity were represented as Figure 1, Figure 2, Figure 3 and Figure 4 respectively. Correlation coefficients obtained between CSSR and temperature, DCR and temperature, CSSR and relative humidity, DCR and relative humidity were 0.49, -0.47, -0.35, 0.29. Correlation coefficients 0.56, -0.02, -0.47, 0.31 were obtained between CSSR and temperature, DCR and temperature, CSSR and relative humidity, DCR and relative humidity for Airtel network and their corresponding graphs were displayed as Figure 5, Figure 6, Figure 7 and Figure 8 respectively. Graphs labelled as Figure 9, Figure 10, Figure 11 and Figure 12 are graphs of CSSR against temperature, DCR against temperature, CSSR against relative humidity and DCR against relative humidity for 9mobile network and their respective correlation coefficients were given as 0.21, -0.34, -0.11 and -0.26. Globacom network has correlation coefficients of 0.69, -0.04, -0.25, 0.00 and in each case, corresponding graphs of CSSR against temperature, DCR against temperature, CSSR against relative humidity and DCR against relative humidity represented as Figure 13, Figure 14, Figure 15 and Figure 16 respectively. On each graph labelled Figure 1 to 16, regression models were displayed. These regression models were used in predicting and forecasting network's CSSR and DCR, provided, the weather variable (temperature and relative humidity) at a particular period of time is known

5. Conclusion

We can conclude that an increase in temperature and humidity increased CSSR and vice versa after briefly analyzing how weather variables (relative humidity and temperature) correlated with network KPIs for networks in Bayelsa State.

Additionally, DCR decreased with increasing temperature and relative humidity and vice versa, assuming that the propagated signal's frequency is not low. An increase in temperature raised DCR at low frequencies. Network planners will find great value in this outcome because propagation prediction models need to take weather variables into account. They will be able to create an effective link margin and budget for the area in this way, enabling them to meet the necessary network coverage and quality of service requirements.

Recommendation

To verify adherence to their suggested standards, the NCC should routinely obtain network statistics data from operators and perform network drive tests. To ensure that the network can accommodate the increased demand from subscribers, operators should modernize and maximize the capacities of all currently operating base stations. This will lead to an enhancement in CSSR.

In addition, the BTS coverage area shouldn't be too far away to prevent signal fading due to meteorological factors. DCR will drop as a result of this. Therefore, rather than using the lump sum to inform decisions, it is crucial for stakeholders to use performance metric measurements for various regions of the nation.

To ensure that QoS is set up to satisfy subscriber demands, the government, NCC, and other regulatory bodies should impose frequent monitoring of network operators and the submission of reports on their performances at very short intervals. It is recommended that service providers perform routine system checks and, if needed, upgrade their systems. In order to determine the actual quality of service provided by mobile operators, the NCC should conduct drive tests on a regular basis instead of depending solely on the data that the operators provide.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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