Evaluation of the performance of mobile telephone networks: literature review

Pascal Valandi[1], Djorwe Temoa[1], Nsouandele Jean Luc[1], Tsama Eloundou Pascal[2], Dokrom Froumsia[1]
[1]Department of Telecommunications and Computer Science, University of Maroua, Maroua, Cameroon
[2]Department of Physics, University of Bertoua, Bertoua, Cameroon

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ABSTRACT

Improving the quality of service (QoS) of telephone networks inevitably involves studying previous work on the evaluation of its performance indicators. Several researchers have addressed the subject of evaluating the performance of service of mobile telephone networks. Some proceeded through user surveys and others opted for more objective methods using either professional scanners or developed: hyper text markup language (HTML) or Android applications. The results show that whether by subjective or objective methods, this work has made it possible to advance research and allow other researchers to progress further in the process of evaluating mobile networks. In this study which constitutes a review of the literature, we investigated the different approaches, methods, and most recent results mentioned by researchers to evaluate the QoS by relying much more on objective evaluation. Despite the advances and their limits, in our proposal we intend to rely on data sciences through their tools to evaluate the QoS with more precision

Corresponding Author:

Pascal Valandi
Department of Telecommunications and Computer Science, University of Maroua
46 Maroua, Maroua, Cameroon
Email: pascalvalandi20@gmail.com

1. INTRODUCTION

The 21st century has witnessed the appearance of mobile broadband (MBB) networks and its development although the application of 4G and 5G techniques is a new phenomenon in some countries. Despite this delay, we are seeing a desire to set up advanced networks in place of older generations. An element of everyday life, the telephone takes up a little more space in our daily lives every day. An international product, it represents an important consumer market for operators as well as designers and researchers. Despite technological advances in the field of telecommunications, the type of network set up and reception problems linked to the environment and frequency limitations hinder good quality of service (QoS). The alteration of signals is even greater when we find ourselves on the move. Travel is made by crossing these different environments which make communication impossible. However, for the average subscriber the need to communicate with reliability and fidelity is their most permanent concern. The increase in the number of mobile network subscribers and the dissatisfaction of these subscribers force us to question the real QoS that operators offer. This led engineers to dwell on the subject, hence the move from the first to the fifth generation which offers much wider bands. However, researchers remain unsatisfied and research work which focuses on the performance of networks is published in order to push suppliers to improve the service and better satisfy their customers.

To evaluate the performance of service which also depends on the investments and the will of operators, States through their regulatory agencies must control this QoS [1]. However, the collection of data relating to network performance turns out to be irregular because it is costly according to the regulator and the data from operators lack credibility and reach the regulator late [1].

As part of this study, we proceeded by searching for articles in engines such as Google, Google Scholar. Zotero helped us organize the references. From the different articles used, the choice fell on the articles published over the last twenty years (2004-2023) and which study the performance of networks and the evaluation of the QoS of cellular networks but with an emphasis on the articles which relate to the objective evaluation of the QoS. For each article, analysis of sources and note-taking are the method adopted to obtain our results.

For this study, the organization of the document follows an approach based first on the type of evaluation. We started first with the documents which deal with subjective evaluation and exit with those which address the aspect of objective evaluation. This part which will be the subject of our future study is much more consistent.

If laudatory results have been obtained in the field of research with the sole aim of improving the QoS, the complaints remain conclusive and it is for this reason that we offer this other solution for evaluating the QoS which relies on data sciences and its tools capable of analyzing large data and which could push actors to act more quickly [1]. For this work, the different parts are structured around the following sections:

We will present in section 1 the introduction, after, section 2 will focus on the study of previous work by highlighting the key results, their interpretation, their strengths and weaknesses and section 3 focused on the result will give an overview of our proposal. We will close with a conclusion in section 6 which will come before the similarities in section 4 section and conclusive considerations in section 5.

2. RELATED WORKS ABOUT EVALUATION OF THE QOS IN MOBILE TELEPHONE NETWORK

The collection of data through surveys of mobile network users is one of the methods of evaluating the QoS. This subjective approach to the evaluation of the QoS, [2] related to the evaluation of the quality of experience (QoE) is the one that was used by [2] to assess the QoS in Afghanistan. In this study, the researcher first uses the survey method with a group of people in Kabul. Then it extends to 1515 mobile network users. On each sheet containing 15 multiple-choice questions in three different languages to enable users to fully understand, it evaluates five differents networks in 30 provinces of this country during the period August-December 2015. The limited investigations on the education level of users, their preferred network and the purpose of using the telephone hardly demonstrate any analysis of the QoS. In view of the questionnaire and the results, they do not analyze the QoS which is based more on the different services that operators offer to customers.

Although retained as a method for evaluating the QoS, it is not the one used in 2017 by a group of researchers [3]. In this article, their approach consists of exploiting data from network management systems (NMS) and analyzing the main performance indicators of QoS to evaluate the cellular network service provided around the redeemed christian church of God (RCCG). From the database of the online operator's NMS, certain services such as service accessibility, latency and failed call rate are collected during the congress of the Holy Spirit of the RCCG in December 2016. Collection took place between 12 p.m. and 7 p.m. to assess the QoS during and directly after the congress. The data collected is compared to the recommendations of the Nigerian Communications Commission, the (NCC) as shown in the Table 1 from the work of [3].

Table 1. Coverage of RCCG, redemption camp lagos [4]

KPIs	NCC (%)	Normal day occurrence (%)	Statistics during events (%)
PCONG	≤ 2.00%	0.83	26.52
PCTRLFAIL	≤ 1.20%	1.87	32.97
PDROP	≤ 2.00%	1.79	1.87
HOSR	≥ 99.00%	63.60	40.50
CSSR	≥ 98.00%	98.20	42.79
PTTCH	≥ 98.50%	100.00	88.73

From this comparison, it appears that the QoS, which is degraded during the congress, is rather acceptable after the congress. He concludes that the extreme mobility of people in this area during the congress affected the QoS and that base transceiver station (BTS) must be added to streamline communications during large gatherings. It should be noted, however, that for certain stakeholders such as regulators, consumer defense associations, and customers, data from operators is not easily accessible. And even if they are available, they arrive late and lack credibility. This had already pushed scientists to develop intelligent agents in user terminals in order to evaluate the QoS [5]. In his work, Augustin RADU, to allow the user to be at the center of the evaluation, first identifies the parameters which influence the perception of the QoS of the global system for mobile (GSM) network. In this study, he chooses as a service, email, online service (www), video streaming. From his phone from which he can use these services, he develops an intelligent agent using the JAVA language, which allows him to evaluate these services. Very quickly this advance showed its limits because of the low memory of the phone which could not store data and technological progress with the transition to more advanced generations. Beyond that, the chosen services which are not the only ones a customer uses. Faced with technological progress with the introduction of general packet radio service (GPRS), universal mobile telecommunication system (UMTS), and later long-term evolution (LTE), the results of this study revealed shortcomings which led to the publication of [6]. In this article which focuses on the evaluation of an LTE network only, the researcher, for his experience in the urban center of the locality of Massachusetts in the United States, makes a comparative evaluation of the QoS in stationary and mobile mode. As a method to achieve his objectives, he uses a terminal which he connects to his computer which has collection software developed in Java. While on the move in his car, he creates video traffic that he shares on a website. It runs for 90 minutes at an average speed of 43 km/h in an environment where there are LTE and code division multiple access (CDMA) networks. He does the same test stationary for the same duration.

From the MATLAB user interface, it analyzes the collected data of channel quality indicator (CQI), signal to interference plus noise ratio (SINR), BLER, and reference signal received power (RSRP) and generates the results in graph form for both test cases. He concludes by analyzing the graphs obtained, that in stationary mode, the service is better than in mobility which requires more resources. The choice of the single geographical area, the difference in the parameters used for the two test cases and the type of service used are not sufficient to assess the QoS, hence the limits of this study.

With the arrival of smartphones and the possibility of developing Android applications [7] capable of measuring and collecting metrics from the EU, there was the establishment of a new form of evaluation [1] which led to to develop an Android application and a web page to collect data relating to network performance, evaluate the QoS and display the map in Google Map. From his work, it appears that to obtain the expected results, two measurements are carried out in this method.

Firstly, measurements are carried out from two phones Sony from Khartoum and Chrwani bus stop station, The second test, based on the measurement of the signal intensity is carried out to compare the value measured with the two phones and that measured with the professional Aaronia Spectran equipment which has a greater precision of approximately +/- 2Db. After comparing the data, the results of this study proved that it is possible to evaluate the QoS parameters from an Android application installed in a phone. Despite its laudatory results, certain limits emerge, those of collecting other parameters relating to network performance, the possibility of analyzing and displaying the map offline, the possibility of saving the data collected in a server other than the mobile.

Further research into the possibility of evaluating parameters other than the RSRP and saving the parameters in a server was published in 2018 [8]. In his work, the author evaluates the quality of six network performance parameters which are RSRP, reference signal received quality (RSRQ), SINR, received signal strength indicator (RSSI), and download (DL) (up and down) in and around a shopping center and the University of Lagos. The study [6] area covers the University of Lagos for base station 1 (BS 1), Ikorudu (BS 2) and Oniru (BS 3). The distance between the three buildings is about 20m for a height of about 15m each. To limit certain impacts, the measurements are taken at a maximum distance of 1 km with readings every 100m.

To perform the measurements, the researcher according to application process in Figure 1 of [8] uses a computer in which is installed GENEX PROBE test software compatible with a 4th generation telephone of the Huawei model E392 type connected to the computer. All this equipment is placed in a vehicle which has a receiving antenna of approximately 1.5m. The transmitting antennas are at an altitude of 30 m for a transmitting power of 46 dB. The measured data is extracted using the MAPInfo tool and the statistical analysis is done using MATLAB. The data collected and then compared with those of the NCC show a similarity between the different measures. However, for the author it is necessary to evaluate the jitter and the latency to verify their impact on the QoS to evacuate the limits of his work.

Continuing in the same vein as [7] and not far from [8], in 2018 [9] was published. The objective of his approach is to check whether it is possible to evaluate the RSRP of a network from an Android application installed in a telephone and to store the data in this same terminal. To achieve this, he carried out his experiment in the urban locality of Melbourne, Florida at a period of mild weather to minimize signal fading which increases the drop in reception. He carries out the measurements and the collection from two phones which he names A and B, therefore an LG K20 and a Kyocera Hydro Shore. These terminals have respectively 2 Gb of Ram, 1,400 Mhz processor and 1 Gb of Ram, 1,100 Mhz. The tests are carried out on the same network indoors and outdoors at a frequency of 60 measurements/second. The figures resulting from these measurements generated using MATLAB are compared.

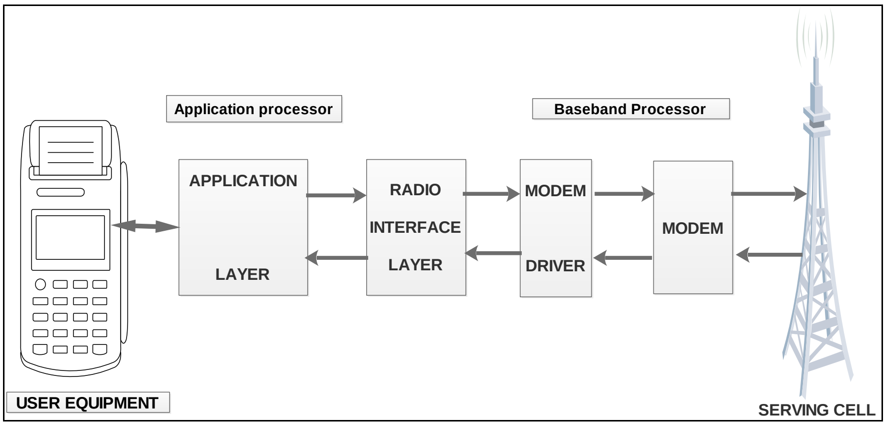

Figure 1. Application process

Indoors, the results show that phone B has good reception quality than phone A by around 0.31 dB, but phone A has a better standard deviation than phone B, proof that phone A is more stable than phone A. B. Outdoors, the same scenario repeats itself, which leads to the conclusion that it is possible to evaluate this parameter from an Android application installed in a telephone. However, the difference in results obtained with the phone shows that there are some shortcomings for its adoption. Some being more stable than others, it is worth evaluating the quality of the phone first before committing.

In the logic of confirming the possibility of evaluating network performance parameters and accuracy from an Android application installed in a terminal, in 2018 is published [9]-[12]. To achieve its objectives, the group of researchers are developing an Android application called LTENetScan which it installs in two Samsung Galaxy S7 brand phones and the LG K20 of the same version (Android 7.1). The collection of data from the serving cell with the user terminal and the verification of the KPI with the scanner is done as shown in the Figure 2 appeared in the works [10], [11].

He chose the locality of Melbourne in West Florida as the study area. The measurements relating only to the RSRP are made indoors and outdoors. To confirm his results, he compares them to those made with a professional SeeHawk brand scanner. During two days of collection in this rural area of approximately 20,000 m2 in a flat environment where atmospheric conditions are constant to avoid variations and fading which affects the quality of the signal, the researcher conducts his experiment.

The statistical analysis of the data collected from MATLAB compared to those measured with the scanner confirms the similarity of the results and therefore the possibility of evaluating the parameter from the LTENetScan application with a root mean square deviation (RSME) of 3 dB. This difference can be attributed to the measuring equipment. Antenna position, gain, processor speed and other factors can impact reception quality. But for the author it is necessary to evaluate other parameters than the RSRP to further confirm his results.

Seeking to confirm the idea that position can impact reception quality, a study was carried out by a researcher in Nigeria, this time on the GPRS and high-speed packet access (HPSA) network [13]. Measurements of the signal intensity of three networks are carried out at three sites, namely the headquarters, the academic complex and a university campus. The three networks are named A, B, and C. For 60 days, data is collected between 7 a.m.-8 a.m., 1 p.m.-2 p.m., and 7 p.m.-8 p.m. using a Tecno Y6 user terminal in which the CellInfo Android application is located. The collected data is analyzed using the statistic package for social sciences (SPSS) statistical tool and the simulation is done using MATLAB to generate graphs and compare the intensities of the three networks.

The study is carried out in two phases [14]. The first consists of measuring the signal intensity of each network and the second consists of carrying out a statistical study of the data. The average of the signal intensities of the different networks collected shows that each network has the best signal in its collection area and that the quality depends on the density. Which pushes the researcher to conclude that the quality of the signal intensity depends on the position of the user in relation to their home network and on time. Some limits are revealed in its approach, especially with the entry onto the scene of LTE networks.

In the same logic of evaluating the quality of the signal in a GSM network and verifying this quality which depends on position and time, was published the same year [14]. The study consists of evaluating the quality of coverage of four GSM mobile networks namely MTN Nigeria, Airtel, Globacom, and Etisalat in the locality of Ogoni in the South-South of Nigeria. The collection lasted five days with one-hour intervals. To achieve his objectives, the researcher used as equipment:

– A Tecno D3 brand cell phone with the CellInfo application placed 1.5 m from the ground considered to be the average height of a user. It simultaneously measures the intensities of the different networks;
– A GSM signal controller to monitor and analyze RSSI and signal quality;
– A laptop.

The collection data is subjected to statistical analysis using GraphPad Prism 7. Microsoft Excel is used to generate the graphs and measured quantities versus time. The results obtained for each network are compared to assess the performance of each network. In view of the collection, the author concludes that MTN which has the best intensity also has the best network but adds that during off-peak hours the signal intensity is affected and that the flow varies depending on time. This study remains limited to a single parameter, a single geographical area and only the GSM network.

Using a similar approach but this time to tackle the rural area, the same year saw the publication of [4]. The four localities chosen are located in the South East of Nigeria. For each locality, the collection lasted eight days. The measurements carried out using two GIONEE M5 brand phones in which the CellInfo application is installed took place between August 18 and September 16, 2018. The collection took place in the centers of the four villages during the day and at night at specific times. Although the application is able to determine the intensities of the LTE, wideband code division multiple access (WCDMA), CDMA, and GSM networks, the collection focused only on the GSM network. The networks evaluated are Aitel, Globacom, MTN, and 9Mobile. The data obtained is analyzed and determines the GSM coverage, the availability of the signal and the quality of the network provided in these localities. The results of the experiment reveal that the network in certain localities is non-existent, it is a little present in the localities where the density is a little high with a level of coverage also a little higher. For this study limited to GSM, we cannot conclude from the low coverage because there are other networks (LTE) in this area which have not been evaluated, hence this new publication in 2020 which deals with evaluation of the QoS of an LTE network from an Android application called CoverMe installed in a GM8 mobile terminal [15]. The collection carried out in the province of Isparta is done in two ways:

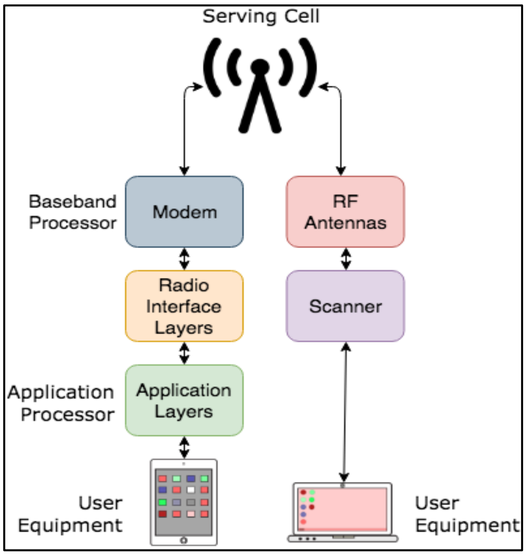

Figure 2. Process of obtaining RSRP by Android application and scanner

The data measurements, collection and analysis process is based on the diagram in Figure 3 of [15]. Automatically passive measurements are carried out and the data is saved in SQLlite without clicking on the application with the receipt of a message to confirm the effectiveness of the storage.

By clicking on the application for active measurements, in the latter case the application downloads a 100 MB file and divides it by time to evaluate the download speed. As for latency, it is achieved using Ping and is used just to confirm the precision during measurements. 85% of the measurements were taken on foot and 15% by car at a speed of around 40 km/h, i.e., a total of 1186 RSRP, RSRQ, RSSI, and CQI measurements.

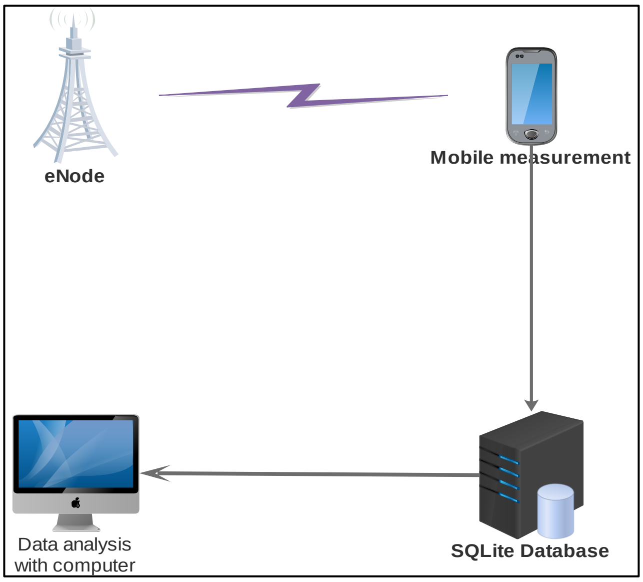

Figure 3. Equipment used for measurements

The object is to study the relationship between the measured values of RSRQ, RSRP, RSSI, and reference signal signal to noise ratio (RSSNR) in the field and the correlation of these values with the download speed [5]. Based on the analysis, we realize that the variation of the measured parameters that are the RSSI and the RSRQ increase the average of the data download speed but they do not provide precise information on the performance of the data or the data rate. In other words, a good data rate can be obtained at a point where the RSRQ is low.

Despite these technological advances with their limits, the will and the commitment to validate the measurements with the application installed in a terminal, question of putting the user at the center of the evaluation is the objective of [16]. There was talk of testing the drive test (DT) SignalDetect application in three terminals, namely the Nokia 6, the Samsung A-6 and the Samsung S7 Egde. In their design, the three terminals do not have the same components, the operating systems differ from one phone to another with different interfaces. The collected data is simulated with a correlation of 0.99. The signal strength graph obtained for this experiment indicates that the data obtained is different, which suggests that the value picked up by the phone depends on the hardware and software, something which confirms previous research. He concludes that before evaluating performance with the DT it is necessary to first validate its results.

The evaluation of the performance of networks from 2G to 4G being made possible from certain terminals with Android applications, this time the researchers are tackling the evaluation of broadband networks [17]. In the study published in 2021, made on the broadband network providing 3G and 4G in Ibra City in Oman, the author from an Android application developed by Gyokov Solution called G-Net track installed in two Samsung Galaxy collects RSRP, RSRQ, CQI, down and upload from each operator, namely Omantel and Ooredoo. The download file weighs one Gigabit. The data from the two terminals fixed in a vehicle traveling at a maximum speed of 70 km/h are continuously recorded in the phone’s memory. The methodology to collect and to analysis data in Figure 4 in [17] is not very different than [15].

The handover and reselection of cells are also recorded during thetest. Considering the parameters collected outdoors, all networks cover the tested area in 4G and at all measurement times with a good signal level and a good data rate. For the author, the good QoS from each operator depends on different factors such as bandwidth, the number of sites, the number and type of active subscribers. All these factors have significant effects on the data rate and consequently degrade the network performance. However, he notes as a limitation of his work:

– The unique character of its research area;
– The unique character of the environment (outdoor);
– The unique nature of the test period (peak time) therefore low demand at this time;
– The uniqueness of the service (web page), you can try voice or video streaming.

To add more to his work, another article is published [18]. For this experiment carried out around the Polish capital, Warsaw, the professional measurement working group is working on two operators and is interested in the performance of voice calls, video streaming and web page downloading [18]. Of the two operators, one uses UMTS and LTE and the second only LTE.

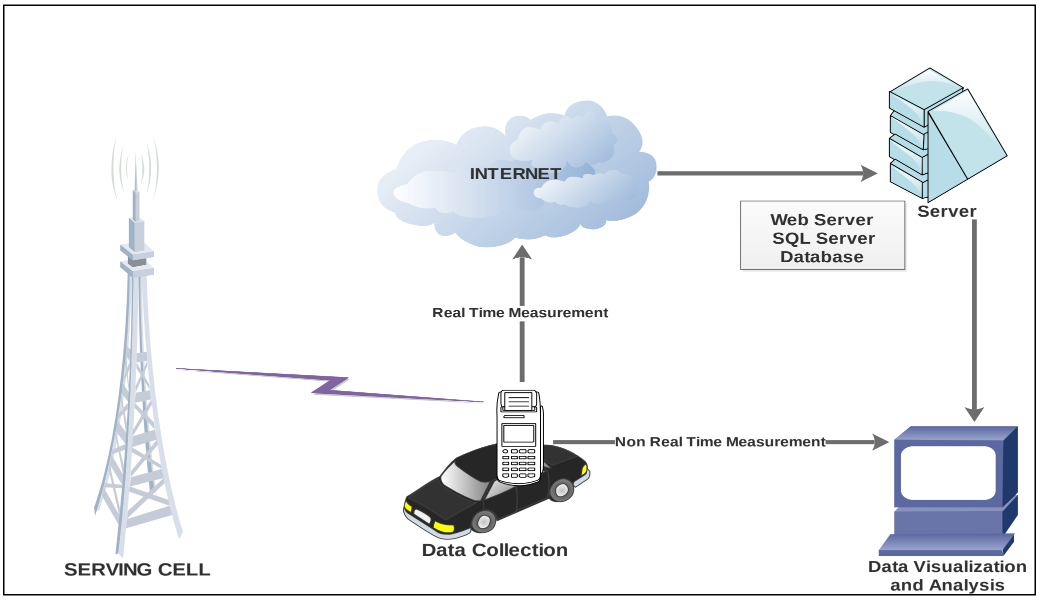

Figure 4. General methodology for data collection and analysis

In several scenarios, the data collection campaign was conducted in both urban and rural areas [18]. A Samsung Galaxy M20 equipped with the measurement application was used to collect parameters such as RSRP, SINR, and RSRQ, while a professional scanner was employed to evaluate signal reference strength, overall signal quality, and radio channel quality across the different networks. Overall, this study enabled a comparison of the QoS between the two networks [18].

The analysis of a network integrating multiple standards, namely UMTS and LTE, reveals a lower level of data collection performance compared to a network operating exclusively on LTE. In this configuration, UMTS resources are occasionally utilized by LTE [18]. The results indicate that the QoS of the operator using only LTE is superior, as during DTs involving handovers between base stations supporting both standards, the number of failed or dropped calls is higher than in networks operating with a single standard. Furthermore, the analysis highlights that evaluating QoS is essential for service providers and plays a key role in the development and optimization of mobile networks [18].

When a multi-standard network (UMTS and LTE) encounters difficulties during handovers, it becomes relevant to focus the evaluation exclusively on the UMTS network, especially since several studies have already addressed LTE performance. This rationale led to the publication of studies [19], [20]. These works focus on the evaluation of four UMTS networks (MTN, Globacom, Airtel, and 9Mobile) in Calabar, Nigeria. The measurement setup used is similar to that employed in earlier studies and consists of four mobile phones equipped with SIM cards from the four operators, as well as a laptop for data storage and analysis using TEMS discovery software [19] and [20]. The collected data were analyzed and presented in the form of tables and figures, after which the results were compared with those published by the NCC [3], [4] to identify the operator with the best key performance indicators (KPIs). This comparison shows that the measured parameters are consistent with NCC results; however, it highlights the need to increase the number of base stations in order to optimize network performance.

Although new generations of mobile networks provide higher capacity, improved security, and enhanced quality control mechanisms, they still require regular performance evaluation, as complaints related to QoS remain widespread. Another study published in 2023 [21] focused on the evaluation of QoS based on the performance indicators of three LTE operators (labeled 1, 2, and 3) in Najaf city, Iraq. Using a DT approach, the study assessed the KPIs of the three operators operating on the 1,800 MHz band with a bandwidth of 20 MHz. Data collection included RSSI, SINR, RSRP, RSRQ, and downlink throughput across 377 cells located along a 19 km route, with the test vehicle moving at an average speed of approximately 30 km/h.

To obtain the results, the analysis of KPIs was made possible thanks to SPSS, MATLAB and PYTHON. The results obtained show that the KPIs of the three operators are good with one of the operators standing out compared to the others. Despite this desire to advance science, the study was limited to certain operators, at a single hour of the day and in mobility without also taking density into account [21]. KPI analysis was performed using SPSS, MATLAB, and Python [21]. The results indicate that the performance of the three operators is generally satisfactory, with one operator outperforming the others. Despite its contribution to scientific advancement, the study presents certain limitations, notably its focus on a limited number of operators, a single time period of the day, and measurements conducted only in mobility, without considering user density [21].

In an effort to address these limitations, a subsequent study published in 2023 [22] aimed to analyze MBB performance without directly comparing the evaluated networks. Conducted in Cyberjaya, Malaysia—a city regarded as a smart city due to its advanced technological infrastructure—the study assessed five operators (Maxis, Celcom, Digi, Umobile, and Unifi), labeled A, B, C, D, and E, operating on 3G and 4G networks [22]. Performance metrics measured during drive tests included signal quality, throughput, transfer rate, and ping, with parameters such as RSRP, RSRQ, and SNR. Measurements were carried out using an Android application developed by Gyokov Solutions, installed on an OPPO F1 smartphone, with a data file size of 1 GB.

Data collection was conducted outdoors during two key periods of the day—between 7:00 a.m. and 8:00 a.m., and between 2:00 p.m. and 4:00 p.m.—using a vehicle traveling at approximately 70 km/h. Indoor measurements were performed on three floors of a building serving as the city's central shopping mall. Indoor results show that the five mobile network operators provide good coverage and acceptable throughput, which could be further improved by increasing the number of access sites [22]. However, higher frequencies used by 5G experience greater propagation losses through building materials compared to 4G frequencies. Outdoors, improvements in SINR are required through noise reduction and enhanced signal strength. Most operators achieved data rates of up to 20 Mbps with acceptable SINR and ping values, and four out of the five operators provided 4G coverage along the test route.

Despite the positive findings regarding broadband accessibility, the study did not address services such as video streaming, web browsing, customer support, or billing. Additionally, it was limited to a single study area and did not consider dynamic spectrum sharing, which could be explored in future research.

3. RESULTS AND DISCUSSION

With the complexity of networks, we are now witnessing the introduction of data sciences for the analysis of data relating to network performance [23]. The conclusive results of this study demonstrated the interest and feasibility of using data science in the operation of operator networks. These glowing results can be used in future evaluation work. For assured quality and appropriate regulation, regularly monitoring the QoS is very necessary by the various stakeholders.

As networks evolve, the services requested also increase, which generates new contracts between operators and the regulator and between operators and customers. If this is the case, the evaluation must be permanent and follow not only technological developments but the needs of users and new agreements, hence our penchant for this other study based on the objective evaluation of mobile networks in Cameroon where the complaints are patent, where the operators' data lack credibility and where the evaluation is irregular because it is costly according to the regulator [1]. To achieve this objective, it will be a question for us of relying on the existential by proceeding with an objective evaluation of the QoS of the telephone networks. The KPIs selected for the evaluation are those retained by the regulator and which fall within the specifications of the operators [24].

More precisely, it will be a question of selecting a user equipment (UE) capable of precisely measuring the performance indicators by validating it through comparison tests with the professional scanner and through the Android application installed in this phone to continue to collect the performance indicators. performance with other information concerning the type of networks, the collection period, the speed of movement of the terminal, over a long period (at least six months, day and night taking into account the climatic variations of each season). The measurements taken will be stored in the user's terminal under the comma separated values (CSV) extension. The next step will be to analyze these indicators using data science tools. For this analysis phase, we will use Python to write our algorithm and its library will be used to generate the figures and statistics as stated in Figure 5. For a somewhat global assessment of the situation, the study will take into account rural and urban areas considered to have high permanent or temporary density, the evaluation of stationery and mobility on our roads connecting the capitals of the department or region, border areas will also be taken into account to assess the situation in localities bordering other countries.

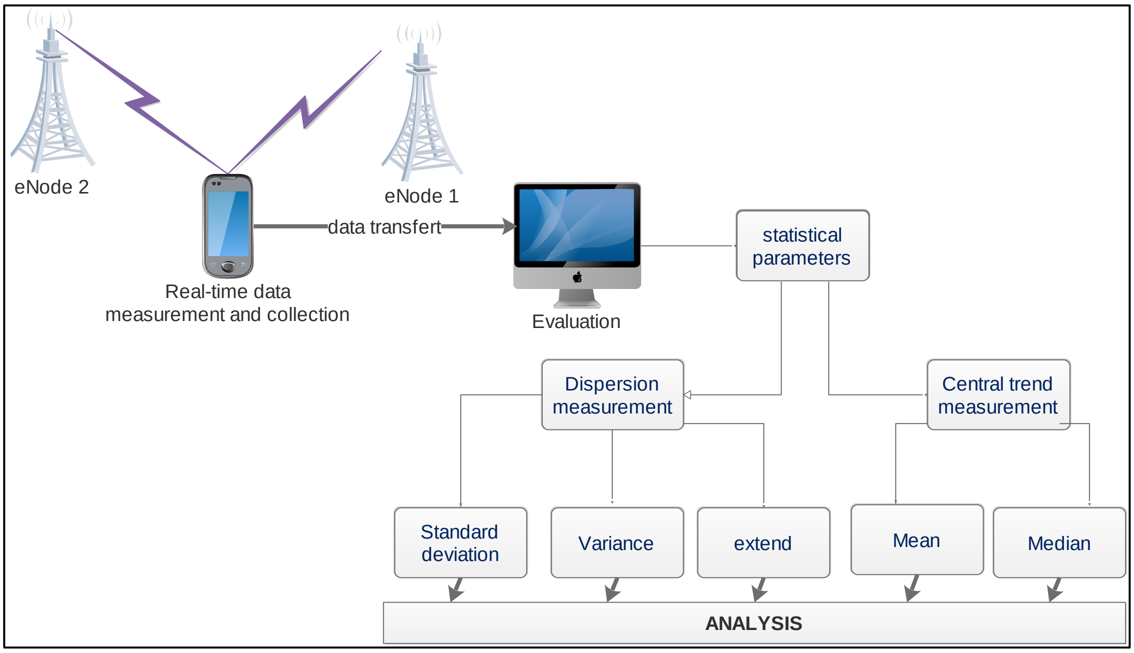

Figure 5. Data collection, storage and analysis process [25]

4. COMPARATIVE APPROACH OF WORK CONSULTED

Several points in common exist between the different articles selected.

- The objective: it is a question of evaluating the performance of the networks in order to improve the QoS by collecting network KPIs.
- The hardware used: most use Android applications for measurements and indicator collection, the computer or terminal for storage and only the computer and integrated software to analyze and generate the figures.
- Data collection: To achieve their objectives, data must always be collected. It is done either through the Drive test, questionnaires or by using the operators' servers.
- Conventional values: for comparisons of RSRP and RSRQ values in Table 2 of [26], the various studies rely on these values to assess the QoS [26].

Table 2. Comparison table of performance parameter values [26]

RSRP	RSRQ	Conditions	Connectivity
≥ -80	≥ -9	Excellent	Fast and lossless
-80 to -90	-9 to -10	Good	Fast and lossless
-90 to -100	-10 to -15	Normal	Normally a little longer latency
-100 to -120	-15 to -20	Bad	Long latency, low data speed,
≤ - 120	≤ - 20	Very bad	May not connect

5. CONCLUSIVE CONSIDERATION

In view of the results of the various researchers, we should note notable advances concerning the techniques for evaluating the QoS. Today the customer or user is at the center of this evaluation. With data science helping, it is necessary to combine this software and algorithmic progression for an effective evaluation of networks by taking into account aspects linked to the regularity of collection, the geographical position of the user, the duration of collection and the type of tool to be used for analysis.

6. CONCLUSION

Our study consisted of shedding light on the articles which focused on the evaluation of mobile networks based on the analysis of performance indicators. Of the more than twenty articles selected, there are several similarities in the methodology and tools used to conduct the experiments. The results of the collection and analysis of the different articles allowed us to know the approaches, the results obtained and the strengths and weaknesses of each article.

It is with these advances that in perspective we can consider the evaluation of the QoS of mobile telephone networks in Cameroon over a very long period by using data science tools to analyze the performance indicators that we will have collected from a terminal in which an Android application is installed. These results will allow decision makers to integrate the users in the process of evaluation of QoS, to evaluate at a lower cost and to propose a consequent improvement in the QoS.

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Djorwe Temoa	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓
Nsouandele Jean Luc	✓	✓		✓						✓	✓	✓	✓	
Tsama Eloundou Pascal	✓	✓		✓						✓	✓	✓	✓	
Dokrom Froumsia	✓	✓		✓							✓			

C : **C**onceptualization
M : **M**ethodology
So : **So**ftware
Va : **Va**lidation
Fo : **Fo**rmal analysis
I : **I**nvestigation
R : **R**esources
D : **D**ata Curation
O : Writing - **O**riginal Draft
E : Writing - Review & **E**diting
Vi : **Vi**sualization
Su : **Su**pervision
P : **P**roject administration
Fu : **Fu**nding acquisition

CONFLICT OF INTEREST STATEMENT

Authors state no conflict of interest.

INFORMED CONSENT

We have obtained informed consent from all individuals included in this study.

ETHICAL APPROVAL

The rechearch related to human use has been complied with all the relevant national regulations and institutional policies in accordance with the tenets on Helsinki Declaration and has been approved by the authors.

DATA AVAILIBILITY

The data that support the findings of this study are available from the corresponding author.

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BIOGRAPHIES OF AUTHORS

Pascal Valandi holds a master's degree in research with a telecommunications option obtained from the National Advanced School of Engineering in 2019. Since 2021 he has been a thesis student at the National Advanced School of Engineering of Maroua, University of Maroua. His rechearch interests focus on mobile telephone network more specifically on quality of service. He can be contacted at email: pascalvalandi20@gmail.com.

Djorwe Temoa received his Ph.D. in 2019. He is currently q Senior Lecturer in the University of Maroua Cameroon. His research interest includes radio resource management. He focuse on the application of Machine learning and artificial intelligence in QoS optimization in Telecommunication networks. He can be contacted at email: djorwe@gmail.com.

Nsouandele Jean Luc holder of a Ph.D. in Thermodynamics-Energy obtained at the University of Yaoundé 1, currently teaching thermal, thermodynamics, senior lecturer in National Advanced School of Engineering of Maroua, University of Maroua. He can be contacted at email: jlnsouandele@yahoo.fr.

Tsama Eloundou Pascal he is a radiocommunication engineer, master of science with thesis at the Bontch Brouevich telecommunications institute in St Petersburg in Russia, Ph.D. in electrical engineering and signal processing in the National Advanced School of Engineering of University of Yaoundé 1, University of Bertoua, Department of Physics. He can be contacted at email: pentsama@yahoo.fr.

Dokrom Froumsia obtained his Ph.D. In 2024 in Telecommunication in the National Advanced School of Engineering of The University of Maroua. His research interests focus on antennae more specifically on Fractal antennae. He can be contacted at email: fdokrom@yahoo.fr.