Full Paper

SERVQUAL: A MEASUREMENT APPROACH FOR QUALITY OF INTERNET SERVICES IN A NIGERIAN UNIVERSITY

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ABSTRACT

As universities strive to be among the best in the world the Quality of Internet Services (QoIS) they offer remain a major determinant to rank them globally. However, within the context of the Nigerian University, much is yet to be known about the QoIS on a daily basis. What exists is the measurement of the quality of service of universities' websites, using descriptive statistics with either WebQUAL or an adapted version of the SERVQUAL model. This paper therefore, applied the SERVQUAL model with a different approach that included the Gap analysis theoretic and inferential statistics to investigate the QoIS of a university's Internet infrastructure, which include the hardware, software, and other Internet and human resources from the perspective of those who use and maintain them. The qualitative and quantitative measurement theoretic was applied using the questionnaire and interview methods to elicit data from randomly and purposively selected users and administrators respectively. Data from a focus group discussion also form part of the data that was used to validate the patterns of users' expectation and perception in the user log of 65,000 log items that were collected over three months. The final analysis of result, showed that user's expectation(s) about the QoIS was low. In future, the potential value of the QoIS of U-INET will be investigated in a longitudinal study with a much larger sample size.

Keywords: *SERVQUAL, WebQUAL, QoIS, Performance indicators, Users' expectations and perception, and Users' satisfaction*

1. INTRODUCTION

In the digital age, users of Information and Communication Technology (ICT) are viewed as champions since every digital service is conceived, design, and implemented for their satisfaction (Foko *et al*., 2017). Thus, how their needs are met by ICTs is important since what they perceive of service quality is determined by their impression of the service(s) offered. This implies that the actual services made available must consistently match what their impression of service is, which they look forward to when using an ICT or its infrastructure. Arguably, the performance of every organization depends on how it satisfies its customers' (users') every needs (Phiri and Mcwabe, 2013). This study is motivated by the significance of Service Quality (SQ) within the context of the university, which is also a service industry. Service Quality (SQ) is about the measure of how well the service(s) delivered by a system matches the expectation of its users. The way users perceive the service(s) provided by Internet infrastructure in relation to users' expectation do go a long way in determining how the Quality of Service (QoS) that is provided is evaluated. In this paper QoS, SQ, and Quality of Internet Service (QoIS) are used interchangeably. SQ is important in that it is used to conceptualise the perception of people regarding the services they are given versus what they demand vis-à-vis the services in question and the degree to which the quality of service should be understood when offered. Drawing on this understanding (i.e. knowledge) service providers can stay competitive, enhance their customer relationship and create better value for users of their services (Nawaz *et al*., 2016).

There are documented research efforts in the literature, which focus are on the investigation of QoS regarding service consumption as an influencer of user satisfaction (Alrwashdeh *et al*., 2020), the determination of business success in a significant rate, the conceptualisation of the experiences of users' of interactive systems (Raza *et al*., 2020), etc. System success as a factor has also been gauged within the context of Quality of Experiences (QoE) and QoS. SQ (SERVQUAL) has provided the wherewithal to investigate the quality of service within industries such as the health/medical service industry, banking, marketing/retail industry, tourism service industry, e-commerce industry (Ko and Chou, 2020; Raza *et al*., 2020; Shi and Shang, 2020), etc. However, despite the relevance of SQ in discovering factors that contribute to the determination of QoS in the service industry to foster success; it has not been applied to understand the factors that influence the services offered by Internet infrastructure within the university context. Year in year out

universities, particularly in sub-Sahara Africa and Nigeria as a case in point expends substantial part of their financial resources to provide Internet services. It is thus important to find out whether this investments are justified by delivering QoIS to users of University's Internet NETwork (U-INET).

The world over, it is a known fact that every university has their own peculiar culture. This culture has been shaped albeit remodelled by the advancement in ICT-based systems (e.g. the Internet) by providing new means of communication (Raza *et al.*, 2020). As a service industry, the university now rely on the Internet to deliver several services to reach sundry stakeholders in the system. Some of these stakeholders are tech-savvy users, while the others grow over time into this same status and look forward as a matter of loyalty look forward to better service delivery. As a matter of concern, and to the best of our knowledge there is no documented evidence in the literature that the QoIS of a U-INET has been investigated from the perspective of her stakeholders by drawing on the SERVQUAL model and Gap analysis theoretic in the manner demonstrated in this paper. To this end this work fills this gap by illuminating a central question regarding the QoIS of a U-INET. The question is: how do we measure the QoIS of the Internet Network services offered by universities? This central question resonates with other questions, which this work seeks to answer. That is; (i) what are the expectation of stakeholders with respect to QoIS, and (ii) what are the best PIs to measure QoIS performance from users' perspective?

This research work contributes to the service quality literature by presenting Performance Indicators (PI) that are useful to gauge the QoS of Internet services within the university context. To ensure generalizability of result the Service Quality Model (SQM) (i.e. SERVQUAL) and the Gap analysis theoretic as practiced in Shahin and Dabestani (2010), Singh and Khanduja (2010), Park *et al.* (2021), and John *et al.* (2021) were applied. The work also provided insights on the collection of data that reflects the characteristic opinion of stakeholders within the university context of Internet usage experiences, and offers a demonstrable qualitative and quantitative method with empirical findings and recommendations. The rest of the paper is structured with related work presented in Section 2; methodology in section 3; results and discussion in Section 4; and recommendation and conclusion are found in Sections 5 and 6 respectively.

2. RELATED WORK

QoIS and how users perceive it can be satisfactorily provided to become the key expectation of Internet users (Raza *et al.*, 2020). Similarly, users' perception of how services are delivered have been shown to determine and dictate the competition that exists among service providers in the service industry. Hence, most management processes now focus on users' concerns more than the product they offer. Based on current best practices the state of a university's Internet service can also become one of the major yardstick to rank and categorize university's status. Unfortunately, QoIS is quite tricky to study in an integrated way (Borzemski, 2004). The heterogeneous nature of users who use a university's Internet service, and the various research interests and pastime activities the services are used for (Osofisan, 2011), the non-homogeneous nature of the web presence, which is one of the services hosted by a university's Internet, etc all contribute to this difficulty.

Historical trace data has been used to examine cooperative caching in Web servers (Osunade *et al.*, 2001) with a view to optimise QoS. From a similar study, Obilor (2008) reported useful information, which can be used to optimize Internet connectivity and usage for academic research and communication purposes. However, the collective focus was not to seek better QoIS for users of the U-INET, but on the sustainability of network resources to make the system work. The influence of factors on network performance and its influence on system design, which in turn can impact on overall performance when understood has been highlighted in the literature (Peterson and Davie, 2011). To this end, the multi-dimensional aspect of performance in relation to SQ with different measurements was explored in Rolstadas and Andersen (2000). The demonstrable difference between QoS and network performance based on finding from Rolstadas and Andersen (2000) showed that QoS is reliant on several nuanced factors than network performance. This implies that even when the network performance of an Internet network is adjudged to be okay its QoS could be poor. Similarly, dimensions such as time, speed, availability, quality, flexibility, environmental-friendliness, and cost do have direct impact on processes, which focus are meant to improve important aspects of performance. Among these dimensions, environmental-friendliness has been mostly used in association with good service delivery. This SQ is tantamount to performance and has been reported as one of the superlative conceptualizations that capture users' satisfaction regarding service delivery (Hess, and Timen, 2008).

Several different performance indicators has been reported as possible influencers of SQ (Accounts Commission for Scotland, 2017). For Internet performance concerning service delivery, the QoIS is important since it is not just enough for users to have access to its services. Research efforts in this direction include that of Liston (2004), whose research established SQ as the key to ensure competitive edge when examined using multiple measures (parameters) to show how users perceive performance (High Speed Experts, 2011; Huston, 2003; Roddy, 2001; Rappaport, 2002). The use of the right QoS measures and dimension has been recognized in the literature as capable of influencing appreciable and comparable performance (Folz, 2004). Surprisingly, the measurement of end-to-end Internet service performance has been reported as practically problematic (Chen and Hu, 2002) has received more attention. There are also documented evidences of quantitative experiments that considered QoS in relation to Internet commerce. In Bouch's *et al.* (2000) research in this direction showed correlation between objective and subjective (i.e. user-perceived) QoS. However, the Traditional QoS Metrics (TQM) - response time and delay – that were applied lacked the conception that is needed to fully describe how users perceived QoS because of the objective nature. The metrics could not cater for users' expectations and their perception of service delivery. Therefore, user-centric albeit subjective measures are needed to fill this gap in the measurement of the QoIS.

Two very closely related work in the context of this paper (i.e. Internet service delivery in the Nigeria university context) have also considered SQ, which research work are that of Fasiku *et al.* (2020), and Olaleye *et al.* (2018). Both work considered SQ in relation to web-based services. While Fasiku *et al.* (2020) investigated the types of Internet services (i.e. WWW, e-Mail, Chat, Instant messaging, etc,), Olaleye *et al.* (2018) considered website quality of some selected universities website with the focus of determining why the website of a university is better in terms of accessibility and quality. Both work used a modified version of the SERVQUAL model with self-reported questionnaires and did not apply the Gap theoretic nor used experts, input from a focus group discussion, and information from over 65, 000 users log items as was done in the research, whose result is reported in this paper. In this work, the drawback of the nonuse of subjective measures was circumvented through the use of the SERVQUAL Model (a.k.a. SQM) as practiced in Babiarz *et al.* (2003), Ganiyu (2016), Ko and Chou (2020), Raza *et al.* (2020), and Shi and Shang (2020). The WebQUAL model (Olaleye *et al.*, 2018) was not applied basically because it is meant

to measure the service quality of websites and not core Internet infrastructure as done in this paper. Unlike the WebQUAL, the SQM was developed by Parasuraman *et al.* (1993; 1994). The intention was to apply its conceptual guideline to provide the needed guiding principles to measure users' expectation and perception of organizational infrastructure, hence its adoption to investigate the performance of Internet infrastructure through QoS delivery. In Johnson *et al.* (1995) and Farrell (2017) it was adapted and used to investigate the needs of Universities as far as QoS was concerned, but from the objective system perspective. This papers approached the use of SERVQUAL differently howbeit from the perspective of how users perceive QoIS in relation to user satisfaction.

3. THE SERVICE QUALITY MODEL VS QUALITY OF INTERNET SERVICES

The popularity of the SERVQUAL model is not in doubt in the literature (Ko and Chou, 2020; Raza et al., 2020; Shi and Shang, 2020; Park et al., 2021). As a measurement instrument it has been used in the domain of Information Technology (IT) to investigate SQ, with focus on IT units in organizations as opposed to individual IT applications or infrastructure. The emphasis was on users' expectation and how they perceive the services IT units provides (Petter et al., 2008). In the review of Pitt et al. (1995) it was found that the SQM construct was added as an extension to the Information System Success Model (ISSM) to cater for the quality aspect that was missing (Jiang et al., 2002; Seddon, 1997). This missing aspect had made it impossible for the ISSM to fully conceptualize the quality of system support the IS and IT units deliver in an organization (Delone and McLean, 2003). Metrics such as responsiveness, accuracy, reliability, technical competence, and empathy from staff has been reportedly used in such exercises. Other metrics aside from these, which have also been used and are documented in the literature to investigate SQ are skills, experience, and the capabilities of the support staff (Jiang et al., 2002). In this work the QoIS as perceived by users based on the experience of those in the ICT unit of the case study university is what was considered (Kettinger and Lee, 1997; Pitt et al., 1995) and reported.

User satisfaction is one user-centric metrics, which versatility in the assessment of SQ is well reported in the literature. It has form the nexus to investigate the level of a university's informativeness and provision of computing support services within the context of a university system (Kettinger and Lee, 1997; Kayeser and Razzaque, 2014). It has been used in government, organisations and the web settings as well as within the context of knowledge-management to establish SQ and examine performance (Petter et al., 2008). The SQM theoretic though its underpinning and details are beyond the scope of this study, in summary it accommodates the general provision of service delivery, with emphasises on human expectations and perceptions (Gilbert and Veloutsou, 2006) of what SQ is. It remains the core benchmark for QoS evaluation (Parasuraman et al., 1993, 1994; Kumar et al., 2009). In the literature, there are identified Determinants of SQ (DoSQ), which offer the lenses to conceptualised the SQM theoretic for QoS evaluation (Ganiyu et al., 2016) as shown in Figure 1. In Figure 1, Expected Service (ES) is influenced by Word of Mouth Communication (WoMC), Personal Needs (PN), and Past Experience (PE). The Users Gap which is the perceived difference between ES and Perceived Service (PS) as indicated using the broken double arrow in Figure 1 emanates from the TDoSQ. The TDoSQ presents a unified view that serve as leverage points (i.e. each of the variables – Access; Communication; Courtesy; Reliability; etc in the TDoSQ) to reveal the gaps (User Gap) that exist in a service delivery process (Chang, 2008). In this paper the absence of all or some of the variables in the TDoSQ space as shown in the Figure 1 is conceptualised as the difference between ES and PS. This implies that when all the variables are present then the gap between ES and PS is closed, and the absence of one or more of the variables determines the extent of the gap.

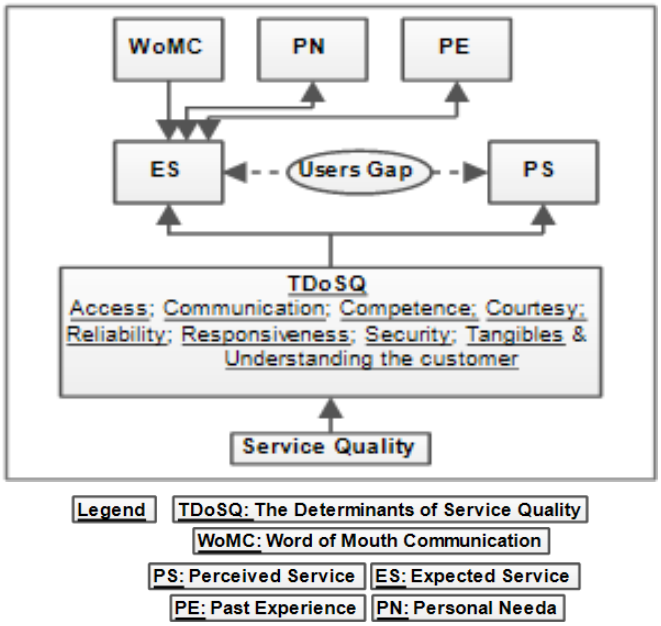

Figure 1. *The determinants of service quality (Adapted from Shahin, 2017)*

This conception of the difference between ES and PS is an adaptation that is hypothesised based on the thinking presented using Figure 1 that tries to philosophically highlight SQ evaluation as users' perceive them. That is in SQ evaluation, perception should emanate from the comparison of users' expectations about service delivery and what their perceptions of service delivery is regarding performance (Aldridge and Rowley, 1998; Ganiyu et al., 2016). In the original SQM, the foregoing conception fits into what the Gap analysis theoretic postulates, which examines the difference between the expectations and perceptions of users concerning the QoS to be provided. It is important to mention that as popular as the SQM is, it has been subjected to several criticisms (Abdulahi, 2006; Ganiyu et al., 2016; Shi and Shang, 2020). However, it still provides a suitable and logical reference point for researchers to monitor, evaluate, and interpret SQ in heterogeneous context with several interests. This cannot be avoided in the study of QoIS in the context of the Nigeria university system. This is because (i) Internet service delivery are completely heterogeneous, and (ii) the Internet is used for various purposes that are underscored by myriads of interests (Osofisan, 2011; Peterson and Davie, 2011; Shahin, 2017). This informed the adoption of the SQM (a.k.a. SERVQUAL) and the gap analysis postulation in this paper to understand the contrast (or differentiate) between ES and PS if any as hypothesised diagrammatically in Figure 1. The classic SQM offered more variables – i.e. parameters - that were adopted in this paper and they are as presented in Table 1. These variables with that of the TDoSQ in Figure 1 are significant in that they form the basis on which the data collection instrument used in the research work reported in this paper were formulated to study the QoIS. This practice is consistent with the provisions in Shahin (2017), Ko and Chou (2020), and Shi and Shang (2020). In this paper, both the TDoS of the Gap analysis theoretic in Figure 1 and the SQM in Table 1 were considered and operationlised as the true measure of SQ.

Table 1. The five adopted SQM constructs as measures

Q/P/D	SubQ/P	Conceptualizations
Empathy	Access Communication	Provided services are based on user-friendly-care policies that support individualized services, which offer emotional support and care to users
Assurance	Competence Courtesy Credibility Security	For users' confidence to be earned, the provision of services is done professionally and knowledgeable
Responsiveness	Efficiency	This is about the provision of services that are prompt with a commitment to also serve in the interest of users
Reliability	Accuracy Credibility Trustworthiness,	The provision of dependable service quality as promised and as accurately as possible
Tangibles	Accessibility, Obtainability Utility	This has to do with how personal appears. The appearance of available physical equipment and facilities, and materials for communication are also included

(Q/P/D) Qualities/Parameters/Dimensions; (SubQ/P) SubQualities/Parameters (Adapted from Rafique et al., 2012 and Shahin, 2017)

4. METHODOLOGY

This work followed the measurement process that is described and practiced in Aladwani and Palvia (2002). The process is a mix of qualitative and quantitative research methods of data analysis. In the qualitative part conceptualization of measures was carried out, while in the quantitative part normalization of measures and appropriate weighting was done and the choice of analytic techniques was also made to help independent verification and validation of result. The Performance Indicators (PIs) in this paper are constructs that were conceptualized based on the parameters that are presented in Table 1. This conception is based on the practice in Ko and Chou (2020), Raza et al. (2020), and Shi and Shang (2020). Five PIs were adopted to study SQM (see Table 1) in this work. In an investigative exercise where SQM is involved, there is often the challenge of Monitoring, Evaluating, and Interpreting (MEI) of the resultant SQ, which SQM on its own is unable to do. The Gap analysis approach was introduced as a gold standard for this based on the postulations in Shahin (2017), Ko and Chou (2020), and Shi and Shang (2020). It helped to contextualize the SQ perspective to be addressed. For instance, Empathy is conceptualise as Access and Communication; Assurance as Competence, Courtesy, Credibility, and Security; Responsiveness as Efficiency, etc. This implied that the concepts (i.e. variables) in under TDoSQ in Figure 1 are conceptualisation of the SQM constructs (PIs) in Table 1.

The interpretation of the Gap theoretic in Figure 1 served as a model tool to apply the measures of QoIS as exemplified in the Table 1. This was aligned to the case study - U-INET needs and operationalized as within the context of users' expectations and perceptions. As explicitly as possible these expectations and perceptions were conceptualized to generate appropriate questions for data elicitation. As a key part of the measurement process the sample items (i.e. questions) resulted from the refinement that happened after the process of conceptualization to birth the scale adopted to sort out operational issues such as question types and question sequence (see Appendix for sample questionnaire and question types and sequence). A stratified random sampling technique was applied to select those who responded to the questionnaire since the user population within the university is not homogeneous. In the choice of which network administrator to engage for interview, the purposive sampling technique was applied. Data was collected within a period of three months following the approach demonstrated in Tao et al. (2019).

The 24-item questionnaire was structured to elicit users' expectation and perception of the U-INET services. The interview instrument contained 15 open-ended questions targeted at the network administrators in a focus group to encourage robust interaction and data elicitation. As the need arose follow-up questions that bothers on the concept of Internet performance, PIs and other measurement strategies were asked. 81 respondents that comprises of users (student and staff) of the Internet in the university community and network administrators participated in the experiment. A response scale with 7-point was used with each question (item or scale), starting from 1 (strongly disagree) to 7 (strongly agree). It is noteworthy to state that users' log of about 65,000 were available for the analysis. This informed the use of as few as 81 real users to cross-check and validate the patterns of expectation and perception that exists in the log. The quantitative methods employed included a frequency counts and percentage description. This entailed the initiation of a numeric value process for each performance dimension. A representative ratio calculation from the measurement taken was done systematically based on factors drawn from Figure 1. Gap was therefore conceptualized as a function of n set of gaps from which the most appropriate were selected and this was formalized as follows in Equation (1);

$$Gap\ y = f(x_1, \dots, x_n);\ \exists\ n < y \quad (1)$$

where

y = *the total number of Gaps,*

x = *a member gap, and*

$n = 1 < y$

The formalism in Equation (1) was made based on the assumption that there are five (5) SQ in Table 1 that hypothesises the difference between ES and PS when they are absent regarding the QoIS of a university network. This implies that there could be n User Gaps that could possible come from the total number of y Gaps. Logically, the y will come from the data elicited using the scale employed and described earlier. Based on Equation (1) and going by the survey an average (mean) gap score was arithmetically calculated as shown in Equation (2) as follows;

$$G_S = P_S - E_S \quad (2)$$

where

G_S = gap score;

E_S = expectations score;

P_S = perceptions score; and

Note: $S_{Sub\text{-}script}$ = Score

For gap score to be properly calculated to capture gaps in SQ or the absence of all or any of the five(5) SQ, some assumptions were made with respect to some possible discrepancies between Expected Internet Service (EIS) and Perceived Internet Service (PIS). These assumptions are presented as follows. (1) The case in which EIS › PIS. The hypothesis here is that perceived quality is less than satisfied (i.e. being satisfactory) with the QoIS. This could also tend towards QoIS being totally unacceptable as the possible discrepancies between EIS and PIS increases. (2) In this second case EIS = PIS. The hypothesis here is that perceived quality is satisfactory. (3) In this third case EIS ‹ PIS. The implication of this hypothesis is that perceived quality is more than satisfactory and will tend towards the ideal regarding the QoIS, even with increased discrepancies between EIS and PIS.

Data analysis was done suing both descriptive and inferential statistics of Post-hoc and ANOVA test within the conception of the Duncan Multiple Range. The research work adopted the Margin of Error (MoE) statistic due to the context of this work using a confidence interval of 95%. This was used to confirm the result obtained based on Equation (2). The MoE was computed as shown in Equation (3) as follows;

$$MoE = +196 \times Std \quad (3)$$

where Std = standard deviation

It was important to test for homogeneity of variance. This helped to find out if the groups the data collected is divided into have equal variance across the groups. This led to three groups of data, namely Unweighted SQ (USQ), Weighted SQ1 (WSQ1), and Weighted SQ2 (WSQ2). This split could have been done differently, except that it was needful to align with the aim of the investigation. This test was carried out using the Levene's Homogeneity-of-Variance Test technique. The splitting was meant to reflect the independent random samples from the normal population. The studentised range statistic was used to arrive at the Duncan variance, with a contrast polynomial of degree 5 and coefficient of 4.762 as recommended in Olson (1991). It was therefore possible to test the means that are equal with the variance technique based on the extension of the two-sample t test. As a result, the post hoc and a priori contrasts tests were also used to establish the trends across the categories and the difference amongst the means based on comparison (Olson, 1991).

5. RESULTS

As postulated and presented using Figure 1 and Table 1 Users' Gaps were derived from the difference between user expectations and perceptions based on Equation (1) and (2). The gaps identified as what was responsible for Internet performance were found to be up to 14 in number. Based on the formalization in Equation (1), and following the provisions in Clement and Selvam (2017), the 14th Service Quality Gaps (SQG) in Table 2 becomes the intermediary between the remaining 13 Gaps to be analyzed based on the five determinants in Table 1. This conforms therefore to the formalization in Equation (1). The 14th SQG could have been any of the other Gaps. Looking at the gaps in Table 2; it is easy to tell that the 14th gap captures (although coincidentally) service quality as evaluate-able regarding the dimensions of performance to be measured (see Figure 2). The dimensions of performance presented in Table 2 were measured following the practice in Candido et al. (2000) and as conceptualized in Figure 2. The SQ analysis as service gap yielded the results presented in Table 3. The study adopted user's expectation and perception for the quantitative aspect of this study. The results in Table 3 are representative of 24 statements (or items). The SQM instrument applied were modified by them. The results (in Table 3) thus captured the state of the Internet service and measure its performance. The items (i.e. statements/dimension) with the largest gap of perception and expectation were ranked the highest. This indicates the dimension that need less attention or that will come next in priority going by the ranking from the analysis carried out. Going by the result in Tables 3 and 4, the gap score for Tangible measure is lower than the measure of reliability that got the highest gap score. The users' gap between expectation and perception with the largest score is also from the reliability dimension. These results are further presented graphically for easy inferentials in Figure 3.

The graph in Figure 3 shows that the tangible dimension also has a large gap score for the tangible dimension. The large gap is the second largest after the Reliability score. The graph shows that the average overall dimensional weighted score for WSQ1 and WSQ2 are -65.17256944 and -65.41483796 respectively, though recorded negatively.

Table 2. *Gaps and their inferences*

Gap #	Gap types	Inferences
Gap1	Mgt perceptions:	Identified gap b/w user expectation & University management
Gap2	SQ strategy:	Gap that provides orientation about QP, spell CIPS, and the PoIMUPS
Gap3	Designing QoS specifications based on QD:	Identified Gaps that exists amidst IQS and IDG that influence users' point of view
Gap4	Quality supporting financial Function:	Recognized quality control, planning, billing payment, and the need to dedicate funds and seek grants
Gap5	Internal communications:	Mgt to communicate repeatedly to all concerning SQ. This was absent
Gap6	Co-ordination/Integration:	MUSD is avoided
Gap7	Peoples' co-ordination &/or Mgt:	Users, and their benefiting was not organized to provide value
Gap8	Equipping the staff in IT department/unit:	Selection, training, and adequate level of APRP were identified
Gap9	Delivery of Services:	This Gap 9 highlights reliability indicator with strategic quality dimensions (N). managers' failure; technical quality inconsistency
Gap10	External communications:	communication and promise inconsistency were identified regarding what service delivery could offer users
Gap11	Perceptions of contact personnel's of U-Expect:	This gap spelled the difference between how the NAPUE and the URE
Gap12	Perceptions of contact personnel's of U-Exper:	Same as Gap 11, but focus on PSIDD of offered services
Gap13	Consumer/user observations (i.e. about consumption):	The focus is the difference b/w users' expectation & how service is perceived. This was obvious.
Gap14	Service quality evaluation:	SQ & personal observation that mirrors and validate the strategy for Internet performance was missing. So standards was absent PI

(MUSD) *Misunderstandings;* ***(SQ)*** *Service Quality;* ***(U-Expect)*** *Users' Expectations;* ***(U-Exper)*** *Users' Experience;* ***(APRP)*** *Autonomy, Power and Rewards to Personnel* ***QP*** *(Quality Principles),* ***(CIPS)*** *Coherent Internet Performance Strategy,* ***(PoIMUPS)*** *Provision of Infrastructure, Maintenance and Updated Performance Scope;* ***(QD)*** *Quality Design;* ***(IQS)*** *Internet Quality Specification;* ***(IDG)*** *Internet Delivery Gap;* ***PSIDD*** *(Professional Services, and Influence on Design and Delivery)* ***(NAPUE)*** *Network Administrators Perceive Users' Expectations;* ***(URE)*** *Users' Real Expectations;* ***PI*** *(Performance Indicators)*

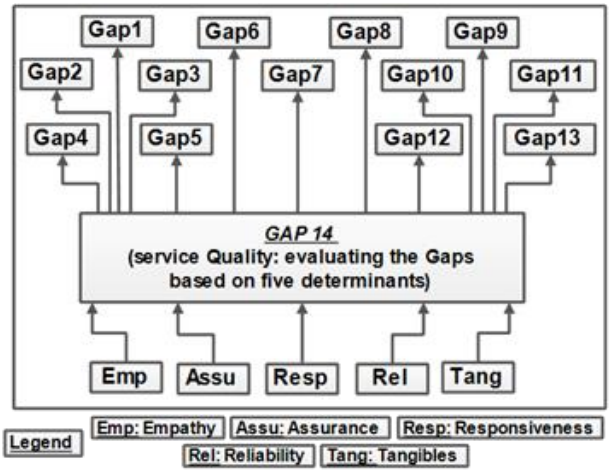

Figure 2. *A model of service quality at the University based on Tables 1 and 2*

The results presented so far indicate users' expectation was not met regarding SQ. The reliability item (R5), which is the number 9th statement revealed that the largest gap of perception and expectation among the reliability dimension (see Tables 3 and 4, and the result in Table 4 is a continuation of Table 3). Similarly, the focus of this paper is on how to meet the expectation of users' and exceed them in terms of SQ provision. The results of MoE confirming the order of result obtained in ranking the five determinants are presented in Table 5 and Table 6 using the number of lower bound, their mean, and their upper bound as well as their standard deviation, and confidence interval.

The result of the two-sample *t* test, a priori contrasts, and post hoc tests are presented for each dependent performance indicators. The mean, standard deviation, standard error of the mean, were presented with 95% confidence intervals (see Tables 5 and 6). Results from the Levene's homogeneity-of-variance test are also presented as shown in Tables 7.

Table 3: *Resut of service gap (Perception (minus–) Expectation) of UINET Users*

NofED	Expts	Pcpts	USQ	Rk
T1	7.250	3.617	-3.633	
T2	6.100	3.017	-3.083	IV
T3	6.083	3.417	-2.667	
T4	6.317	3.033	-3.283	
R1	6.167	3.300	-2.867	
R2	5.033	2.967	-2.067	
R3	6.000	2.917	-3.083	V
R4	6.433	3.183	-3.250	
R5	6.350	2.533	-3.817	
RS1	6.067	2.767	-3.300	
RS2	6.200	2.667	-3.533	
RS3	6.083	2.767	-3.317	III
RS4	6.083	2.467	-3.617	
RS5	6.333	2.150	-4.183	
A1	6.267	2.750	-3.517	
A2	5.767	2.617	-3.150	
A3	6.167	2.683	-3.483	II
A4	6.250	2.117	-4.133	
A5	6.300	2.550	-3.750	
E1	6.150	2.333	-3.817	
E2	5.683	2.633	-3.050	
E3	5.583	2.317	-3.267	I
E4	5.267	2.100	-3.167	
E5	5.567	2.300	-3.267	

Dimensions (Tangible - T; Reliability - R; Responsiveness - RS; Assurance - A; Empathy - E) (NED) No of each Dimension; (Expts) Expectations; (Pcpts) Perceptions; (USQ) Unweighted Service Quality; (WSD) Weighted Score of each Dimension; (WSQ) Weighted Service Quality; and (Rk) Rank

Table 4: *Result of service gap (Perception – Expectation) of UINET users (contd. from Table 3)*

ND	USQ	WSQ1	WSQ2	Rk
T1	22.800	-68.833	-82.840	
T2	22.800	-78.083	-70.300	IV
T3	22.800	-65.000	-60.800	
T4	22.800	-76.783	-74.860	
R1	24.333	-72.333	-69.756	
R2	24.333	-51.917	-50.289	
R3	24.333	-80.500	-75.028	V
R4	24.333	-84.167	-79.083	
R5	24.333	-97.917	-92.872	
RS1	18.400	-62.050	-60.720	
RS2	18.400	-63.633	-65.013	
RS3	18.400	-60.750	-61.027	III
RS4	18.400	-65.617	-66.547	
RS5	18.400	-77.883	-76.973	
A1	17.233	-58.700	-60.604	
A2	17.233	-53.117	-54.285	
A3	17.233	-58.000	-60.029	II
A4	17.233	-67.900	-71.231	
A5	17.233	-63.950	-64.625	
E1	16.483	-61.833	-62.911	
E2	16.483	-45.750	-50.274	
E3	16.483	-50.783	-53.846	I
E4	16.483	-48.400	-52.197	
E5	16.483	-50.242	-53.846	

Dimensions (Tangible - T; Reliability - R; Responsiveness - RS; Assurance - A; Empathy - E) (ND) No of each Dimension; (Expts) Expectations; (Pcpts) Perceptions; (USQ) Unweighted Service Quality; (WSD) Weighted Score of each Dimension; (WSQ) Weighted Service Quality; and (Rk) Rank

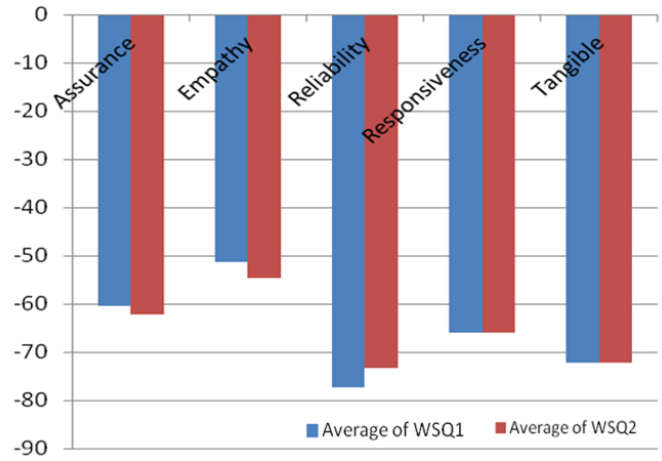

Figure 3: *Average of WSQ1 and WSQ2*

Table 5: *Result of Internet users' analysis of their perception & expectation*

		N	Mean	Std. D	Std. E
		L B	Upper Bound	Lower Bound	Upper Bound
E	T	4	6.4375	.55200	.27600
	R	5	5.9967	.56401	.25223
	RS	5	6.1533	.11390	.05094
	A	5	6.1500	.21985	.09832
	E	5	5.6500	.31994	.14308
	Tt	24	6.0625	.43518	.08883
P	T	4	3.2708	.29545	.14773
	R	5	2.9800	.29472	.13180
	RS	5	2.5633	.26151	.11695
	A	5	2.5433	.24989	.11175
	E	5	2.3367	.19090	.08537
	Tt	24	2.7167	.40878	.08344
USQ	T	4	-3.1667	.40346	.20173
	R	5	-3.0167	.63716	.28495
	RS	5	-3.5900	.35874	.16043
	A	5	-3.6067	.36393	.16275
	E	5	-3.3133	.29519	.13201
	Tt	24	-3.3458	.45774	.09344
W	T	4	22.8000	.00000	.00000
	R	5	24.3333	.00000	.00000
	RS	5	18.4000	.00000	.00000
	A	5	17.2333	.00000	.00000
	E	5	16.4833	.00000	.00000
	Tt	24	19.7271	3.20576	.65437
WSQ1	T	4	-72.1750	6.29265	3.14633
	R	5	-77.3667	16.96612	7.58748
	RS	5	-65.9867	6.89431	3.08323
	A	5	-60.3333	5.71243	2.55467
	E	5	-51.4017	6.15425	2.75226
	Tt	24	-65.1726	12.76979	2.60662
WSQ2	T	4	-72.2000	9.19883	4.59941
	R	5	-73.4056	15.50421	6.93370
	RS	5	-66.0560	6.60082	2.95198
	A	5	-62.1549	6.27171	2.80480
	E	5	-54.6148	4.86576	2.17604
	Tt	24	-65.4148	11.00101	2.24557

(NLB) Number of Lower Band; (LB) Lower Bound; (Tt) Total; (M) Mean; (UB) Upper Bound; (D) Deviation; (CIMD) Confidence Interval for Mean Dimensions (e.g. Tangible - T; Reliability - R; Responsiveness - RS; Assurance - A; Empathy - E); (WSQ) Weighted Service Quality (USQ) Unweighted Service

Table 6: *Result of analysis of Internet users' perception and expectation (contd. Result from Table 5)*

		N	95% CIMD		Min	Max
		L B	Lower Bound	Upper Bound	Lower Bound	Upper Bound
E	T	4	5.5592	7.3158	6.08	7.25
	R	5	5.2964	6.6970	5.03	6.43
	RS	5	6.0119	6.2948	6.07	6.33
	A	5	5.8770	6.4230	5.77	6.30
	E	5	5.2527	6.0473	5.27	6.15
	Tt	24	5.8787	6.2463	5.03	7.25
P	T	4	2.8007	3.7410	3.02	3.62
	R	5	2.6141	3.3459	2.53	3.30
	RS	5	2.2386	2.8880	2.15	2.77
	A	5	2.2331	2.8536	2.12	2.75
	E	5	2.0996	2.5737	2.10	2.63
	Tt	24	2.5441	2.8893	2.10	3.62
USQ	T	4	-3.8087	-2.5247	-3.63	-2.67
	R	5	-3.8078	-2.2255	-3.82	-2.07
	RS	5	-4.0354	-3.1446	-4.18	-3.30
	A	5	-4.0585	-3.1548	-4.13	-3.15
	E	5	-3.6799	-2.9468	-3.82	-3.05
	Tt	24	-3.5391	-3.1525	-4.18	-2.07
W	T	4	22.8000	22.8000	22.80	22.80
	R	5	24.3333	24.3333	24.33	24.33
	RS	5	18.4000	18.4000	18.40	18.40
	A	5	17.2333	17.2333	17.23	17.23
	E	5	16.4833	16.4833	16.48	16.48
	Tt	24	18.3734	21.0808	16.48	24.33
WSQ1	T	4	-82.1880	-62.1620	-78.08	-65.00
	R	5	-98.4329	-56.3004	-97.92	-51.92
	RS	5	-74.5471	-57.4263	-77.88	-60.75
	A	5	-67.4262	-53.2404	-67.90	-53.12
	E	5	-59.0432	-43.7602	-61.83	-45.75
	Tt	24	-70.5648	-59.7804	-97.92	-45.75
WSQ2	T	4	-86.8374	-57.5626	-82.84	-60.80
	R	5	-92.6566	-54.1545	-92.87	-50.29
	RS	5	-74.2520	-57.8600	-76.97	-60.72
	A	5	-69.9422	-54.3675	-71.23	-54.29
	E	5	-60.6564	-48.5731	-62.91	-50.27
	Tt	24	-70.0602	-60.7695	-92.87	-50.27

(NLB) Number of Lower Band; (LB) Lower Bound; (Tt) Total; (M) Mean; (UB) Upper Bound; (D) Deviation; (CIMD) Confidence Interval for Mean Dimensions (e.g. Tangible - T; Reliability - R; Responsiveness - RS; Assurance - A; Empathy - E); (WSQ) Weighted Service Quality (USQ) Unweighted Service

Table 7: ANOVA between and within groups (46,31)

	Groups	SoS	Df	MS	F	Sig.
E	BGs	*1.5139*	*3.91*	*.3787*	*2.533*	*.0739*

	WGs	2.8391	18.92	.149		
	Tt	4.3559	23.1			
P	BGs	2.5649	3.91	.640	9.529	.000
	WGs	1.2777	18.7	.066		
	Tt	3.8427	22.8			
USQ	BGs	1.3137	3.8	.3279	1.779	.1749
	WGs	3.5048	18.8	.1839		
	Tt	4.8187	22.7			
W	BGs	236.367	3.9	58.9	5.000	.000
	WGs	.000	19	.000		
	Tt	236.368	23			
WSQ1	BGs	2008.210	4	502	5.475	.004
	WGs	1742.342	19	91.7		
	Tt	3750.551	23			
WSQ2	BGs	1141.810	4	285	3.304	.032
	WGs	1641.701	19	86		
	Tt	2783.511	23			

(BGs) *Between Groups;* ***(WGs)*** *Within Groups;* ***(Tt)*** *Total;* ***(SoS)*** *Sum of Squares;* ***(MS)*** *Mean Square;* ***(WSQ)*** *Weighted Service Quality* ***(USQ);*** *Unweighted Service Quality*

Additionally, Tables 8 and 7 contain the mean result of a group in the subsets of homogeneous scores for perception using the WSQ1, USQ, and WSQ2 parameters. The sample Size of 4.762 of Harmonic Mean (HM) was applied since the group sizes were unequal. By this, it was possible to manage the consequences of having uncertified level of type 1 error in the result from the Post Hoc test. Data from the 81 participants were partitioned to validate this unequal sized group in the 65,000 user log as demonstrated using the HM. The HM further depicts that the series of observation from the user log was consistent with the findings, and thus the sample size of 81 real users for its validation was satisfactory.

Table 8: *Means for groups in homogeneous subsets*

Dimension	N	Perception		(USQ)
	1	2	1	1
Empathy	5	2.3367		-3.3133
Assurance	5	2.5433		-3.6067
Responsiveness	5	2.5633		-3.5900
Reliability	5		2.9800	-3.0167
Tangible	4		3.2708	-3.1667
Sig.		.217	.100	.070

N (no. of items for each dimension)
Subset for alpha = .05

Table 9: *Means for groups in homogeneous subsets*

Dimension	N	(WSQ1)			(WSQ2)	
	1	2	3	1	2	1
Empathy	5			-51.4		-54.6
Assurance	5		-60.3	-60.3	-62.2	-62.2
Responsi - veness	5	-66.0	-65.99		-66.1	-66.1
Reliability	5	-77.4			-73.4	
Tangible	4	-72.2	-72.18		-72.2	
Sig.		.098	.085	.166	.101	.087

N (no. of items for each dimension)
Subset for alpha = .05

6. Discussion of Results

The performance measurement carried out and reported in this work measured the purported gap that exist using the expectation and perception differentials of the U-INET users. However, the result from the performance measurement was not affirmative. It thus showed that the services provided by the U-INET did not satisfy or lived up to the gold standard for performance indicators. This highlighted the finding that there were inadvertent violation of *de facto* standards, hence the low performance of the U-INET. It was also evident from the results that how users of the U-INET perceive SQ matters. For most of the values that showed low perception, the SQG was larger, thus affirming the findings that as users' perception increases, it meant that SQ also increased. This makes users' perception and opinion regarding the satisfactory delivery of services very important. Earlier findings by Boulding *et al* (1993) supported these claims based on their report that there is a correlation between perception and SQ. Among the tangible dimensions shown from the result in Table 4, items or statements T1 and T4 got high gaps. This shows that there was always the lack of availability of Internet provision, which hinged on the issue of reliability. This also agrees with the claim of Johnson *et al.* (1995) that outdated equipment that are also poorly maintained does not support the delivery of quality Internet performance. The result like others (e.g. Hizam and Ahmed, 2019; Raza *et al*., 2020) also suggests that Internet performance can be understood when multiple dimensions are applied in conjunction with supporting specific PIs to investigate users' perception regarding QoIS. This also reveal that for such PIs multiple dimensions should form a basic requirements for the improvement of QoIS. Hence, decisions based on what dimension of service provision is expected should be included as inputs, and outputs versus expected outcomes must be made before measuring the overall QoIS of Internet performance as demonstrated in Raza *et al.* (2020).

It was found also that SQ could be understood from the perception of users based on performance vis-à-vis QoIS. The perception of users about Internet performance as understood from the purposeful sample used in this research work showed that Internet performance is tantamount to "when output from an Internet transaction is fast, and that the Internet link is stable". This is as far as users of the U-INET is concerned. From the perspective of the Network staff and/or administrators Internet performance is comparable to "when there is no complaints about QoIS from users and the absence of collusion in the Network". In the context of Internet performance this equates to Internet speed and availability; no packet loss; low latency (i.e. fast connection); less downtime and more uptime; the regular availability of bandwidth; minimal and manageable cost; uninterrupted service delivery regarding Internet access; prompt response to fixing any problem within a node; and the availability of up-to-date equipments. These attributes are also the lens through which SQ is understood when they are not violated since they speak clearly of users' expectation. Judging from the view point of findings from the "Tangibles" performance indicator perspective and the gap context, it was obvious that more modern and up-to-date equipments are needed for the U-INET to justify the purpose of establishing it. Similarly, the culture of maintenance must also be upheld with best practices in mind. Accordingly, the view of respondents about the performance dimension of U-INET as they see it, is the same as Internet speed, which equates to bandwidth, prompt response (i.e. during output as well as input), and video and voice clarity during streaming. They also considered quality as all-round service availability, security, and the presence of competent human resources that are adequately trained. What was found quite interesting is that once a while a staff with some level of competency is employed, and the staff effort at turning things around were really commendable.

As observed from the perspective of the "Empathy" PI, human resource challenges were observed. This occurred often as staff left the system after offering their services for a while due to lack of user-friendly-care policies. The emotional and other sundry support they deserve are poor and would always not come and as such staff are not able to grow on the job. The few ones that are left often struggle to cope with support services. This is in complete agreement with earlier findings that (i) when a few hands are on deck they usually do not have the luxury of time to give their best (Ko and Chou, 2020) and (ii) the absence of emotional concern and care impede the drive to work (Shi and Shang, 2020). There were lots of pending cases that need the attention of the authorities. Unfortunately, responses hardly come talk less of meeting the needs that require finance. This underpins the "Responsiveness" performance indicator. As such, it was evident that users of the U-INET are often left guessing on what to do when there were obvious challenges. This is because responses from handlers of the system often delay. This accounted for why users' level of assurance of possible solution from the authority was poor as observed from their view as found from analysed data that showed that users' perception of staff and the authority over them were not credible and as such users' confidence in them were poor. Aside from the fact that there was gross under-staffing challenges in the Unit in charge of the day to day running and management of the Internet Infrastructure, there were also the absence of important equipment to work with. As a result, system trouble shooting was not usually done properly and in accordance with industry standard. The situation on ground was quite complex and as such what obtained was far below expectation in an ideal situation.

In the literature, the norm is for stakeholders to provide all the technical support that are needed to make services available promptly. This was obviously absent and contributed to the poor perception of users about assurance. The "Reliability" performance indicator highlights the implication of lack of confidence in the services users expect based on how they perceive it. It also highlighted the frustration of users when using the U-INET services. A strong correlation was observed between faulty equipment due to mechanical and electrical faults and incessant electric power outage. It is important to state that maintenance issues are to be taken seriously. It does not profit anything when maintenance is not done when the need arises and should not be only when the University is ready. The bottlenecks in the University administrative system is a major challenge due to the many bureaucracies always bedeviling the receipt of funds. Sustaining the U-INET must be given utmost priority because the financial contribution of staff and students on a monthly and daily basis respectively to have access to Internet service can no longer sustain the system. The results presented so far support this claim. Thus, stakeholders need to demonstrate sufficient responsiveness - i.e. willingness in this regard. This argument correlates favorably with findings in Ko and Chou (2020), where it was reported that up to 80% of technology related projects often fail due to the lack of willingness on the part of organizations to change. Adequate sustenance mechanism must therefore be encouraged to satisfactorily provides QoIS that satisfies the "Tangibleness, Empathy, Responsiveness, Assurance, and Reliability" PI towards the provision of better U-INET services.

7. CONCLUSION

This study provided a first step towards enhancing the understanding of how users perceive the U-INET based on five performance indicators that include – tangibleness, empathy, responsiveness, assurance, and reliability. From the result, it was evident that the perception of users was negative. The implication of this is that there is a significant shortfall in U-INET's capacity to meet user's expectations based on how they perceive the QoIS. The correlation between the performance of the U-INET and how users perceive such performance was clear enough to corroborate the foregoing significant shortfall in delivery capacity. For indicators with low perception, the SQ gap of the performance indicators was clearly large. This shows that an increment in users' perception is comparable to the delivery of adequate QoS vis-à-vis an increase in the performance of the Internet.

Conclusively, we recommend a regular survey to investigate the level of QoIS, which a U-INET is providing. As a matter of policy, users should be encouraged to use the SQ rating, which could be made available online. The University IT unit should oversee this and ensure that that the client survey is upheld with the focus to determine the level of users' satisfaction with Internet services. One of the possibilities with this practice, is the availability of information that will guide routing adjustments on a regular basis towards improving the SQ of the U-INET. This online approach would encourage anonymous input from users of the U-INET because it is their data that will be learned from to better the QoIS of the U-INET.

There are far-reaching implications of the findings presented in this study considering the context of this research work. Firstly, the result is generalizable since universities in Nigeria often build their ICT centres using the same philosophy and mandate. Secondly, the result has consequence in that it highlights performance measurement as existing under the umbrella of the quality management framework, which is a major tool to achieve improvement. Thirdly, in terms of research contribution, this work provided the methodology and information that is capable of stimulating and guiding the continuous evaluation of a U-INET. As an essential process in understanding the gold standard for delivering QoIS, the ultimate objective of this paper was to identify important performance indicators, which have been presented. These indicators could be drawn on to systematically improve the performance dimension of a U-INET's QoIS. In future, we will be interested (among other things) in investigating the application and potential value of the QoIS of U-INET in a longitudinal scale with much larger sample size.

ACKNOWLEDGEMENT

This research work did not receive grant from any agency, whether from the public, not-for-profit, or commercial sectors. The research work was from a self-sponsored Ph.D. research effort by the first author, while the remaining authors contributed in terms of critique, writing, reformatting and structuring of the presentation and supervision.

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APPENDIX I:

A: DATA COLLECTION INSTRUMENT

Dear Sir/Ma,

This data collection instrument is strictly for research intention. The information you will provide will be analysed and inference made from it will be used to develop different models to help improve Internet performance within the Nigerian university context. We affirm that the information provided by you will be treated with utmost confidentiality. We appreciate the time taken to respond.

i. What is the name of your University?:
ii. Unit/ Department Name?:
iii. Choose from these Status: ○ Students ○ Staff ○ Others
iv. Do you Surf/browse the web? ○ Yes ○ No
v. Do you use a modem/phone hotspot or the Internet Service of the University (ISoU)? ○Yes ○No
vi. If yes, for how long have you been using the ISoU to surf/browse the Internet?
○ 0 to 2 year(s); ○ 3 to 4 year(s); ○ 5 year(s) or more; and state others -

Five important features of a University Internet and the services provided are listed below. Please respond as frankly as possible to help us know how important they are to you. Rate each feature under points from 1 to 20. This is because they all add up to 100 points should the full 20 points be awarded.

S/N	Features	Points: Score from 1 to 20
i.	Appearance of the equipment, Physical facilities, communication materials, and Staff of U-INET	
ii.	The ability of the U-INET to perform the service it is built for accurately and dependably	
iii.	The level of willingness exhibited by the administrators/staff of the U-INET support users and offer prompt and satisfactory service	
iv.	The level of confidence, trust demonstrated by U-INET staff	
v.	The level of care and attention given in an individualized manner by U-INET staff to users	
	Total:	

Kindly rate/rank the following statements. They are meant to convey you expectation and experience about the U-INET services that are offered. Please rate based on the scale of 1 (Strongly Disagree) to 7 (Strongly Agree). So just score from 1 to 7 as it appeals to you based on you expectation of and experience with the U-INET

S/N	Question statements for rating on an ideal Internet Network for a university	Score
1	The U-INET has equipments that are modern and up-date in place	
2.	The U-INET uses up-to-date and licensed Antivirus that is centralized	
3.	The U-INET has ICT plan, policy, vision, strategies, & mission to eliminate & prevent gaps	
4	The U-INET has a culture of maintenance, and documents the system state at all times & situations	
5.	The U-INET staff have good Salary, benefits, allowances & are well motivated	
6.	The U-INET keep their promises whenever and at whatever time	
7.	Units under the U-INET formation show sincere interest in solving users' problems	
8.	The U-INET offers to users quality Internet speed	
9.	The U-INET make Internet services to be available at all times	
10.	The U-INET allow staff users easy & flexible access	
11.	The U-INET offer flexible & easy Internet access to students and sundry users	
12.	The U-INET provide flexible and easy access to the University community at large	
13.	The U-INET provide the exact Internet services users pay for	
14.	The U-INET is able through her managers to communicate to users faulty services when it occur	
15.	The U-INET staff are always willing to help sundry users courteously	
16.	The U-INET handlers are often available to attend to users requests	
17.	The U-INET handlers behaviour does instills confidence and win users trust	
18.	The U-INET provide 24-hours Internet access in the Unit/Department/Faculty and the ICT office	
19.	The university provide regular training for U-INET staff/handlers to help them perform better	
20.	The U-INET have enough staff/handlers hence individualized attention is available	
21.	The U-INET is structured such that the operating hours for users are well defined	
22	The U-INET staff made provision for users to have the equipment needed to enjoy Internet services	
23	The U-INET unit offers hand-on training to help users	
24	The U-INET handlers understand the specific desires/needs of users	

Note: **The Ideal University Internet Network is the University Internet Network **(U-INET)**

Appendix II: Data collection instrument from Focus Group Discussion and Interviews

This 15-survey-questions was used during the focus group discussions with handlers

1. Do you go on vacation and What do you always do to enjoy it?
2. What are the likely performance indicators?
3. What are the likely performance dimensions?
4. How do you monitor network performance & what do you use?
5. Explain the strategies used for Internet network performance monitoring?
6. What is the most reliable source of electricity? Do you have any standby?
7. Any antivirus? If yes, is it for individual?
8. What is the expected speed?
9. What is your bandwidth?
10. How many and what type of UPS do you use?
11. Any observation about performance overtime improvement?
12. How much of communicate do you have with the Network Administrator?
13. What kind of problem do you have mostly with the Network Administrator?
14. How do you respond to payment?
15. How do you measure performance indicators?

Appendix III: Documentation of Internet Network details

1. What type Internet network is available?
   i. (e.g. WAN, LAN, MAN)
2. Internet network Category:
   i. Client/server Network
   ii. Or/& client (i.e. P-2-P),
3. Plan for Nwk design: core ICT, Hybrid, supply
   i. to faculty, heterogeneous Nwk service convergence,
   ii. & M-M Nwk (i.e. mixed-media NWKs)
4. NWK design Limitations: Trees, Hills, Mountain,
   i. valley, the absence of well-established
   ii. optimization network performance standard? Then
   iii. what are the implementation moves for the future?
   iv. Any plan for additions, upgrades and changes?
5. What is the largest number of nodes to be
   i. accommodated:
6. The limitations of cable lengths; what is it like? Is it less than 100 m or?
7. Nwk Topology: tree, bus, mesh, star, ring
8. Design rules documentation for topological reasons: wiring map - connect & end points, types of cabling, and cable labelling management, switches/hubs location
9. More on documentation: for IRQ settings configuration of hardware parameters, memory base address?
10. What are the precautions often taken? For example do you exceed the maximum length of cables, do reliable mechanical connections by jiggling connectors, double check continuity of cable. Do you do cable installation such that noisy electrical devices are far away to avoid noise interference from motors of fluorescent lighting, power lines of ACs or transformers? What of surge protectors' installation for devices as an alternative to electricity supply (e.g. UPS) for backup equipments and servers dedicated for file purpose