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Technical Efficiency of Blended Learning Infrastructure in Influencing Quality of Education in Kenya's Public Universities

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Abstract
Globally, developed countries have made huge investments in their education sectors especially in adoption of technology on how education is delivered. In the digital 21st century era and emergence of Covid-19, these investments are on digitizing education content to match the adoption of self-guided learning and student centered pedagogies. Graduates from such education systems increases that country's Gross Domestic Product (GDP). In Kenya, universities have adopted blended learning (the fusion of technology in the traditional lecture) as a new pedagogy as envisioned in the Kenya's development blueprint, *Kenya Vision 2030.* This has been accelerated by the emergence of Covid 19 in the year 2020 where all education institutions were closed and learning was to be done online. To check on the technical efficiency of blended learning infrastructure, the study sought to look at the devices used in online classes and how they are acquired by both the students and lecturers, the internet spread, provision and availability of diesel generators. The study adopted a descriptive cross-sectional survey research design and was built on Human Capital Theory. The target population was university students, lecturers and directors of Open Distance and e-Learning (ODeL) centers. The study used Cluster sampling and stratified sampling to get respondents from students and lecturers while purposive sampling was used for directors of ODeLs. The study used questionnaires and an interview schedule as research instruments. Data analysis from SPSS version 25 was presented in frequency tables, percentages and pie charts. The study collected data from 29 out of the 31 public universities in Kenya where 384 students, 354 lecturers and 29 directors of digital schools or their representatives responded. The study found that students used smart phones to access online classes and laptops for lecturers that were acquired on Bring Your Own Device (BYOD) policy. All the public universities had backup generators although a number of them were not working and the students indicated that they were not used at all. Internet accessibility was available in both Wi-Fi in various hotspots and by Local Area Network (LAN) cables for those using laptops and desktops. The study recommended more budgetary allocations to improve on ICT infrastructure, improvement on the bandwidth of the internet accessibility and new partnerships to ensure students and lecturers get more high end devices to access their classes.
Keywords: Blended learning, Technical Efficiency, e-gadgets, Quality, Synchronous, Asynchronous
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1.0 Introduction

Education is a fundamental element of economic growth and development of any country. Developed countries that have invested comprehensively on modernizing education through the use of available technology have had positive impact on their Gross Domestic Product (UNESCO, 2017, 2018). Increased use of mobile devices to access internet services and emergence of Covid 19 pandemic have found many universities and other institutions of higher learning adopting blended learning as a new pedagogy on instruction and assessment (UNESCO, 2017). Blended learning refers to the fusion of Information Communication Technology (ICT) in a traditional mode of instruction and assessment (Vaughan, 2007; UNESCO, 2017). This entails the use of e-gadgets in attending lectures online through the use of internet. Quality of education has been defined as adherence to the set standards that are shown by the various indicators of quality assurance (Aksoy *et al.*, 2013). This is in agreement with the definition of quality of education in higher education as a teaching-learning process that makes the students achieve their goals, satisfy their needs in life therefore leading to national development through increased GDP and economic development at large (Mishra, 2007). The diverse perceptions by various stakeholders on the indicators of quality especially on online instruction forms a basis or definition of quality of education (Kundu G.K., 2017; Esfijani, 2018).

In a study on 'Quality in Higher Education from Different Perspectives; A Literature Review (Kundu G.K., 2017) indicates one of the phases of quality as the quality of the infrastructure on product basis. The modern-day drift to increased technological utilization by the youth in our day to day routine has influenced how knowledge is created, presented and re-constructed. The broad usage of e-gadgets has made university education turn to blended learning through various interactive environments. These flexible learning environments are independent of time when done asynchronously, place if done synchronously and convenient on the instruction

and assessment process (Mishra, 2007; Singh and Kaurt, 2017; UNESCO, 2017). The use of the available Information Communication Technology (ICT) infrastructure efficiently will then have an impact of the quality of education offered in the universities.

Improved infrastructure in delivering educational content using ICT has improved the punctuality and interactivity with educational content in the universities across the world (Esfijani, 2018; Seaman, Allen and Seaman, 2018; Czerniewicz, Trotter and Haupt, 2019; Ginder, Kelly-Reid and Mann, 2019). The type of gadgets used in accessing online classes, the availability of internet facilities, the available Learning Management System (LMS) and the method of acquiring the electronic devices have a direct correlation with the quality of education offered in the universities either in developing or developed countries.

Institutional support through policy developments and having administrators who are digitally supportive makes the implementation of the ICT infrastructure possible. The universities need to be ready for the implementation of blended learning by having the required Wi-Fi bandwidth, LMS, e-gadgets and other needed infrastructure in place for blended learning to happen (Porter *et al.*, 2014). In a study on 'An Evaluation of Quality of University Education in Kenya during this Massification Era' Kaburu & Embeywa (2014), noted that facilities that are required in implementing both blended learning and e-learning need to be improved. Stable and continuous supply of power is very important in the offering of quality education through online platforms. The university design and age may have a direct relationship with the availability of such continuous power supply (Ramírez *et al.*, 2018; Seaman, Allen and Seaman, 2018). Proper use of the LMS in place in interacting with educational content improves performance in blended learning environments and thereafter the students get more satisfied with the offered education. (Piccoli, Ahmad and Ives, 2001). Efficient and extensive use of the LMS will therefore enable the proper achievement in blended learning (Delone and McLean, 2003).

In Kenya, on a study on 'Use of Social Media Platforms and Content Delivery in Higher Education' Gichuhi et al. (2020) found that majority of the university students use their mobile phone in accessing the LMS and digital content generally. Lecturers used variety of the e-gadgets like smart phones, tablets, laptops or university desktops to delivery and conduct online instruction and assessment. In a closely related study on 'The E-readiness Survey of Kenyan Universities (2013),' Kashorda & Waema (2014), found that the e-gadgets used by the university students did not have the ability to download and save the downloaded content from the LMS. This was because the devices used were of low end and did not support 4G or 5G internet capabilities as well as having enough memory space for saving the downloaded files. In the same study, universities lacked senate approvals for policy guidelines on the Bring Your Own Device (BYOD) directives as issued to students.

Commission for University Education in Kenya, a body mandated with the responsibility of ensuring quality education is delivered in the universities came up with *Universities Standards and Regulation, 2014. Under Schedule four of the standards,* standard number twelve states that a university will ensure that the technical as well as ICT infrastructure is available and adequate. Technical support should also be consistently given to students and lecturers on infrastructure use. There should be backups and enough server space as indicated in the subsequent standards (Commission for University Education, 2014). This makes it possible for online classes to be conducted seamlessly without any buffering.

1.1 Statement of the Problem

Covid -19 pandemic and increased student riots have led to the closure of universities in Kenya making, traditional classes not appropriate. Online classes emerged from then with anecdote evidence showing that those universities that had not invested in ICT had their academic programs altered. According to a study on 'Use of Social Media Platforms and Content Delivery in Higher Education,' Gichuhi et al. (2020) identified that students and lecturers use social media platforms to access educational contents. Other universities have adopted the use of various video conferencing tools like Zoom, google meet or Microsoft Teams to teach students in the public universities. With all this happening, there is policy guideline missing in Kenya on the implementation, efficient and effective usage of blended learning ICT infrastructure that is in place. Various studies have been conducted to investigate the 'Status of E-Learning in Public Universities in Kenya' (Makokha and Mutisya, 2016) and leaving out the aspect of blended learning as a new pedagogy used in Kenyan universities.

The Commission for University Education Kenya is a body mandated by the government to ensure quality education is offered in Higher Institutions of Education. The commission has published two reports in 2018 and 2020 where data on blended learning ICT infrastructure implementation and level of usage is missing. Student to computer ratio of 1:45 as indicated in the Kenyan education ICT policy is also not checked (Republic of Kenya, 2006; Commission for University Education, 2018, 2020). The increase in effective demand in the last decade has been faced with the faculty size that is not increasing. This had made the public universities conduct relatively huge classes and also increase the number of universities in Kenya from seven to 36 in the year 2023 without lowering the cost of education in the public universities. The accommodation cost is also a main drawback for students having classes while on campus (Republic of Kenya, 2018, 2020, 2023).

Amid interruption by students strikes, Covid 19 pandemics, purging numbers in Kenyan public universities

and increased student-lecturer ratio, the infrastructure that is in place in the traditional lectures is no longer appropriate. There has been the implementation of the new blended learning - global flexible learning environment that uses ICT devices as envisioned in Kenya's development blue print, *the Kenya Vision 2030.* The ICT infrastructure in place has to be used in this new pedagogy of blended learning. This has necessitated the need to investigate the technical efficiency of using blended learning infrastructure and its implementation in delivering quality of university education in Kenya's public universities.

1.2 Purpose of the study

This article is part of the study on 'Influence of Blended Learning on quality of education in Kenya's Public Universities.' The article's main purpose was to look at the technical efficiency of blended learning infrastructure in influencing the quality of education in Kenya's public universities. The following questions guided the study:

1. What are the electronic devices that are used by students and lecturers in attending online classes in Kenya's public universities?
2. Are there any operational automatic backup diesel generators in Kenyan public universities?
3. How spread in the internet services in Kenya's Public universities' premises?

2.0 Literature review

Research has demonstrated that learning process has shifted from traditional lectures to a blended version of instruction. Education is now being offered by use of electronic gadgets that both students and lecturers use for other purposes in life. These gadgets however need to be evaluated on their usefulness, their efficient and how the universities support them. This has an effect on how the internet is spread in the universities and if public universities have automatic diesel generators that make online classes uninterrupted (Kashorda and Waema, 2014). There is a lot of literature in research about how universities in the world have managed their ICT infrastructure to ensure that their use improves on the quality of education that is offered online. The installed infrastructure in the lecture halls and computer laboratories also need to be efficiently used to ensure quality of education as offered (UNESCO, 2017).

2.1 Electronic devices used by both students and lecturers in the implementation of blended learning

Education in the universities is being offered partly in traditional means and also in online platforms using e-gadgets like mobile devices which include smart phones, tablets, laptops or even desktops among others (Jessica *et al.*, 2015; UNESCO, 2017). The level of the devices used have an impact on the quality of the offered education in the universities (UNESCO, 2017; Xiaoqing, 2017). In various studies conducted in Asia Pacific on Blended Learning for Quality Higher Education, universities that embraced the use of high end electronic devices experienced high quality of education as a result of efficient and effective way of following the lectures either synchronously or asynchronously (UNESCO, 2017). The method of acquiring these devices in institutions of higher education in various parts of the world is BYOD. This has however been found to have some drawbacks as indicated in two similar studies on 'Exploring BYOD usage in the classroom and policies in United Arab Emirates and BYOD implementation in university: balancing accessibility and security in Malaysia' (Santos and Bocheco, 2016; Halimaton *et al.*, 2018). These studies recommend the use of desktops, laptops or tablets in accessing online classes or LMS content due to their ability to have a better experience while in synchronous or asynchronous class.

2.2 The use of diesel generators to enhance uninterrupted power supply

Uninterrupted power supply during online classes makes the servers stable and therefore making the online class seamless. This makes learning process achieve the set objectives therefore impacting on quality of the offered education. There are diesel generators in Kenyan public universities with 77% of them having the Uninterrupted power supply installed where the generators go on automatically once the main power lines go off (Kashorda and Waema, 2014). This ensures that there is no data loss or server downtimes. This information needed to be confirmed in a research that is cross-sectional survey.

2.3 Internet provision and spread in universities' premises and hostels

Internet connectivity and usage by students and lecturers in the last decade has been on the rise at an exponential rate globally and more particularly in Kenya (Kashorda and Waema, 2014). In developing countries, the challenges of poor connectivity caused by low bandwidth, poor ICT infrastructure by the universities and lack of proper support dominate the sector. The spread of internet through Wi-Fi or by Local Area Network (LAN) in the university premises has mainly been hindered by low allocation to the universities from the government and generally lack of enough resources. The strength efficiency of internet bandwidth as used in online classes done either synchronously or asynchronously has a direct impact on the quality of education (Allen, Seaman and

Garrett, 2007; UNESCO, 2017; Xiaoqing, 2017; Allam, 2020). Low bandwidth, poor ICT infrastructure and poor internet connectivity negatively impacts on the quality of education offered in blended learning pedagogies (Kashorda and Waema, 2014; Makokha and Mutisya, 2016; Singh and Kaurt, 2017).

2.4 Theoretical Framework

The study was anchored on Human Capital Theory as proposed by Gary Becker (1964) and later developed by (Debrulle, Maes and Sels, 2014; Wuttaphan, 2017). The theory finds investment in education and training having a positive impact in the economic growth and development of that particular country. Education generally is found to increase the efficiency and also the worker's productivity. The developments done in 2014 and 2017 proposes use of new era pedagogies that are ICT driven to improve on a country's productivity.

3.0 Research Methodology

The study used a descriptive cross-sectional survey research design due to its ability to measure blended learning infrastructure factors affecting the quality of education in Kenyan universities. Survey was necessary in measuring the areas as applied in social science research. This research design allowed the researcher to collect huge volume of data in a short time and also get the respondents opinions on the implementation of blended learning infrastructure (Mwituria, 2012).

3.1 Target population, sample size and the sampling procedure

The study targeted the 31 public chartered universities in Kenya that were published by Commission for University Education Kenya in the year 2020. The registrars or the directors of various digital schools were interviewed on the state of blended learning infrastructure and how the LMS was being adopted by both the students and the faculty members. The students and the lecturers were randomly sampled to fill in the questionnaires that was to collect data on the devices they use to access online classes, the internet availability and the state of blended learning infrastructure. The total population was as indicated in Table 1. below.

Table 1. Student Enrollment, Lecturers and Directors of Digital Schools in Kenya's Public Universities 2022

Category	Year 2019/2020
Students	448,482
Lecturers	13,267
Directors of digital schools	31
Total	**461,780**

Kenya National Bureau of Statistics, 2022

When sample size is large, it is considered adequate and reasonably representative (Mugenda and Mugenda, 2009). The Krejcie and Morgan (1970) model adopted by Memon et al. (2020), was used to determine the size of the target population at 95% confidence level. The study collected data from 29 out of the 31 universities. The study sampled 384 students selected randomly from the universities, 354 lecturers selected randomly and 29 directors of digital schools from the universities under survey.

3.2 Research instruments

The study used student and lecturer questionnaires to collect data. An interview schedule was prepared to collect data from the directors of various digital schools, or as delegated to the office administrators or ICT experts in the directorate. The study used content validity where experts in economics of education assessed the content to be included. On the instruments reliability, to check the consistency of the scores obtained (Mugenda and Mugenda, 2009; Bell, 2010), a pilot study was conducted in five universities. On a book on 'Educational Research: Competencies for Analysis and Applications,' (Gay, Mills and Airasian, 2014) also emphasizes the need to first undertake small scale trial before doing the full scale trial.

3.3 Data collection and analysis procedures

Permission to collect data was requested from the University of Nairobi and National Commission for Science, Technology & Innovation (NACOSTI). Once the permit was granted, a letter was given to the 31 vice chancellors in the chartered public universities where the various universities responded. Appointment was booked in the different universities to conduct interviews to the directors of digital schools and thereafter questionnaires given to students and lecturers. Once data was collected from the universities, it was sort for completeness and accuracy and inconsistencies removed. Coding for Data analysis was done using SPSS version 25 because it can analyze large complex data sets. The findings were then analyzed using various statistical techniques which include frequency tables, pie charts, line graphs, percentages, and bar charts.

3.4 Ethical considerations

Clearance for ethical consideration was sought from Kenyatta University Ethics Review Committee (KUERC). After the review by the committee through the chairperson, approval was granted with the set informed consent form being availed to the researcher. This clearance was necessary because data was sought from human beings. To observe, Covid-19 regulations and adhere to community health considerations, the researcher wore masks in the entire data collection time, sanitized frequently and kept social distance.

4.0 Results and discussions

Data from SPSS version 25 was gotten in term of graphs, pie charts or tables. Various indicators in terms of the e-gadgets that are used in online classes, the spread of internet connectivity in the universities and the availability of automatic backup diesel generators were represented. The study sought to identify areas in the university that Wi-Fi was available as either in the university hostels, restaurants, lecture halls, computer laboratories and the strength of the signal. The provision of data bundles to students and lecturers while on campus or off campus was also investigated.

The study found that universities were using LMS that are customized to fit the specific university. This included Moodle powered LMS, Abno and Kusoma platforms due to their cost effectiveness. On admission, the students are uploaded on the LMS and can access the educational content at their convenience. The students were then trained through webinars, availing self-directed materials or on face to face. The study also found that the students and lecturers embraced Bring Your Own Device (BYOD) policy to acquire their e-gadgets. The collaboration to offer laptops to lecturers and students between Kenya Education Network (KENET) and the universities was found to be present although will low uptake due to the structure.

4.1 Electronic devices used to attend online class

The students were asked to indicate the devices they used in attending an online class. The results are presented in Table 2 below

Table 2. Electronic Devices used by Students in Accessing Online Classes and Digital Content

Electronic device	**Frequency**	**Percent**
Desktop Computer	6	1.6
Laptop	92	24.0
Tablet	1	0.3
Smart Phone	284	74.0
None (Use Computer Lab only)	1	0.3
Total	**384**	**100.0**

The students who responded to be using desktops were 1.6% of the total sample. Another 24%, indicated that they use laptops to access online classes while those who use a tablet or computers in universities' computer lab to attend the lectures were represented by 0.3% in each case. The largest proportion was those who were using their smart phones to access digital content represented by 74%. These findings are in line with those that were found in a study on 'Delivering Education through Mobile Learning' (Regin, Hyun and Haeng-Kon, 2015). Moodle powered LMS was identified to have offline application where they can download content while on Wi-Fi and then access it later when out of the Wi-Fi hotspots. They can also work while not in the Wi-Fi hotspots and save the information while offline to be uploaded immediately they go to the internet zones.

Students reported that they could contribute to buy bundles so that they can use one smart phone to access a synchronous online class as a team. When marking the register, the students would then indicate to the lecturer that they were more than one using the same smart phone. The aspect of using the gadgets the students have to access the online class was found in universities in Malaysia as indicated in a study on 'BYOD Implementation in University: Balancing Accessibility and Security,' (Halimaton *et al.*, 2018). In a similar study on 'Use of Social Media Platforms and Content Delivery in Higher Education,' a big percentage was reported to use their mobile devices in accessing educational content through various social media platforms (Gichuhi *et al.*, 2020).

The study sought to know the devices the lecturers were using in attending online classes or meetings. These would include laptops, tablets, desktops or even smartphones. The lecturers are the ones who initiate online classes and he devices they used was of great influence on the success of the online class that they were conducting. The details for are presented in Table 3 below.

Table 3. Devices the Lecturers use to Attend an Online Class or Meetings

Electronic device	Frequency	Percent
Computer	314	88.7
Tablet	40	11.3
Total	**354**	**100.0**

The study found that lecturers in Kenyan public universities use desktop computers, laptops or tablets to conduct online classes. This was represented by 88.7% of the total lecturers' respondents who used computers and 11.3% who use tablets. These findings were the same as those found on a study on 'E-readiness Survey of Kenyan Public Universities (2013),' Kashorda & Waema (2014) and another on 'Use of Social Media Platforms and Content Delivery in Higher Education,' Gichuhi et al. (2020). The lecturers indicted that when using these two, they would take control of the lectures online.

4.2 The method of acquiring the e-gadgets used in online classes

Students were asked on the method they used to acquire the electronic gadgets they were using in online classes. The details are represented in Table 4 below.

Table 4. The Method of Acquiring Electronic Device by Students in Kenyan Public Universities

Electronic device	Self	From KENET programme	Loan from University	Other	Total	%
Desktop Computer	6				6	**1.6**
Laptop	75	17			92	**24.0**
Tablet	1				1	**0.3**
Smart Phone	284				284	**74.0**
None (Use Computer Lab only)				1	1	**0.3**
Total	366	17	0	1	384	**100.0**
Percent	**95.3**	**4.4**	**0.0**	**0.3**	**100.0**	

The students in Kenyan public universities responded variedly on the method they used to acquire their electronic gadgets. A small percentage comprising of six students indicated that they use desktop computers to access online classes representing 1.6% of the total respondents and they had acquired them by themselves. Another group of 92 students representing 24.0% of the total respondents used laptops and 75 of them acquired the devices by themselves while the remaining 17 were given by KENET (Kenya Education Network Trust) programme which allows students to get the laptops and pay for them in installments. In this programme, the student has to be recommended by the university by writing.

A representation of 74.0% used smartphones that they had acquired by themselves. In a similar study in Malaysia, same results were found where students were reported to have adopted the BYOD policy in acquiring the e-gadgets Halimaton et al., (2018). In Kenya, contrary to the findings in this study, the *Universities Standards and Guidelines, 2014* require that the universities and other institutions of higher education should be in control of e-gadgets on the method used to acquire them (Commission for University Education, 2014).

Lecturers were also asked how they acquired the devices they were using to conduct online classes. The details are presented in Table 5 below.

Table 5. The Method of Acquiring Electronic Device by Lecturers in Kenyan Public Universities

Electronic device	Self	University	Other	Total	%
Computer	303	11		314	88.7
Tablet	40			40	11.3
Smartphone					0.0
Others					0.0
Total	343	11		354	100.0
Percent	**96.9**	**3.1**	**0.0**	**100.0**	

Lecturers who used self-acquired computers were represented by 96.5% and the 3.5% were given the computers by their respective universities. The lecturers who were given laptops by the universities were found to be in management positions. Those who were using the tablets represented by 11.3% had acquired them by themselves. Similar studies in Malaysia and Philadelphia found that lecturers acquired their own devices that

they used in online instruction, with an exception of those who preferred to use the university computers in the respective computer laboratories (Jessica *et al.*, 2015; Halimaton *et al.*, 2018). Those who opted to use the university computers enjoyed the benefit of getting internet connectivity while using them within the university premises.

4.3 Availability of automatic backup diesel generators in Kenyan public universities

Students were asked whether there are automatic generators in their respective universities that switched on incase the normal power line went off. This was to make sure that those having online classes were not interrupted by loss of internet connection. The findings are presented in Figure 1 below.

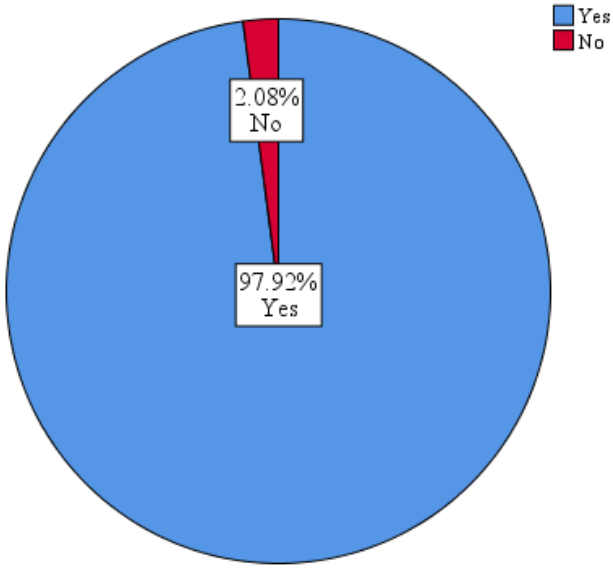

Figure 1. Availability of Backup Generators in Kenyan Public Universities

Students representing 97.92% of the total sample indicated that their universities had a backup generator. The remaining 2.08% of the students reported that they were not aware of the backup generator installed in their universities. For those who said that the generators were available, some reported that the generators were faulty and others were not automatic and did not have the uninterrupted power supply (UPS) units. In case of power failure, the online classes were then interrupted before the manual generators were powered on. In those universities where the generators were faulty, once the power went off, then the servers would go off thereby interfering with synchronous and asynchronous classes that were ongoing. These findings are similar to those reported in a study by KENET in 2014 that found that all public universities in Kenya had diesel generators of which 77% had uninterrupted power supply installed (Kashorda and Waema, 2014).

4.4 Provision of internet in Kenya's public universities

All the students, lecturers and directors of digital schools reported that there was internet provision in all the public universities in Kenya provided as both Wi-Fi and Local Area Network (LAN) cable. There were Wi-Fi hotspots in designated places near the lecture halls, restaurants, hostels or near libraries. Many universities have subscribed to internet bandwidth from KENET at subsidized costs. The ICT infrastructure installed in the universities to support internet connections or the small size of the bandwidth subscribed into made the signal of the Wi-Fi poor or unreliable. These findings are line with those reported on a study by KENET on "E-Readiness Survey of Kenyan Universities (2013) Report", which found that there is connection of internet in Kenyan public universities but the strength of the Wi-Fi is very poor due to the substandard ICT infrastructure or low bandwidth that they have subscribed into (Kashorda and Waema, 2014).

In a similar study on "Online teaching in response to student protests and campus shutdowns: academics' perspectives", universities and institutions of higher education in South Africa found comparable findings where Wi-Fi was extensively used due to the ease of connection to the mobile digital gadgets (Czerniewicz, Trotter and Haupt, 2019). The use of Wi-Fi to do the connection in e-gadgets has been rated as the most effective was of connection worldwide. The strength of the Wi-Fi is however considered the main determinant of the success in the connection.

4.5 The spread of internet in Kenyan public universities' premises

Students were allowed to pick more than one response in this question that was to investigate the ease of the students to access internet services in their universities. The details are presented in Table 6 below.

Table 6. The Spread of Internet Services in Kenyan Public Universities' Premises

Areas in the university	Responses	Percent of Cases
Hostels	161	42.3%
Library	339	89.0%
Lecture halls	200	52.5%
Restaurants	103	27.0%
Computer Laboratories	280	73.5%
Everywhere in the university	88	23.1%
Total	**1171**	

A representation of 89.0% of the students indicated that there were internet services in the Library or in the surrounding area. This was either through Wi-Fi or by Local Area Network cable. While in the library premises, a student would either use Wi-Fi if the gadgets they were using is supported or may also use the LAN cable in case they are using a laptop or desktop computers that are found in the libraries. Another area that had a huge response to have internet services at 73.5% was in the computer laboratories followed by the lecture halls at 52.5%. These areas are considered the most frequently visited by students when either having discussions or lectures.

These percentages varied because the students picked more than one option making the total cases to be 1171. There was also internet provision in the hostels at 42.3%, restaurants at 27.0% and another group of 23.1% said that there was internet everywhere in the universities. Some hostels were found to be far from the administration blocks and tuition blocks hence the reason why connection was not there. In similar studies conducted in Asia Pacific universities, same diverse views on the spread of internet was also identified where hotspots were evident (Kashorda and Waema, 2014; Lim and Wang, 2017; UNESCO, 2017).

5.0 Conclusion

The study concluded that the students in Kenyan public universities used smartphones to attend online classes, do assessments, submit the assignments and access digital content either synchronously or asynchronously. The students use of laptops, tablets or desktops was minimal due to the high cost of buying them and the insecurity concerns in the hostels. However, the lecturers used laptops, desktops or tablets to conduct online instruction in their respective universities. The study also concluded that both students and lecturers were using BYOD policy as a method of getting their e-gadgets. Where collaboration was initiated by KENET, the universities were not willing to guarantee the students get the laptops on hire purchase and this made the uptake very minimal.

The study also concluded that there were backup diesel generators in all Kenyan public universities across the entire country. In some universities, the generators were faulty and therefore did not provide any backup after the main power went off. This made the servers to go offline and therefore affecting the classes that were being conducted at that moment. Few generators were found to have been connected to uninterrupted power supply (UPS) units and therefore they required manual interventions to bring the power supply on again. The generators available in the universities were also found not to cover all the university premises. They were reported to cover the administration blocks leaving hostels, restaurants, computer laboratories among other essential areas.

The study concluded that there was internet connectivity in different parts of the university premises. There are different Wi-Fi hotspots in various parts of the university and LAN cables in the library, lecture halls, offices and computer laboratories. The strength of the Wi-Fi was however found to be weak in majority of the universities in Kenya. This was attributed to the poor ICT infrastructure set up by the universities and the low bandwidth that the universities had subscribed into.

Generally, the study concluded that the technical efficiency of ICT infrastructure in the Kenyan public universities has negatively affected the quality of education that is offered through blended learning. The ICT infrastructure that has been set up in the universities has not been efficiently utilized to impact on the quality of education that is offered using blended learning. The policy on BYOD has also made the students and lecturers have low end e-gadgets that affect the quality of education offered using blended learning pedagogies.

6.0 Recommendations

The study made the following recommendations;

1. That the universities in conjunction with ministry of education needs to have collaborations with the computer suppliers to offer low cost gadgets that university students can use to access educational content and online classes.
2. The ICT infrastructure developed by the universities need to be enhanced as advised by the service providers who are KENET.
3. The internet bandwidth needs to be expanded by the universities to ensure that the speeds for Wi-Fi improve.

4. The universities install uninterrupted power supply to the diesel generators to ensure that their steady supply of power after the main lines are out.
5. The universities need to come up with more computer laboratories that are fully equipped to offer online classes either synchronously or asynchronously.

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