

# ICT Infrastructure Preparedness for E-Learning Implementation in Kenyan Universities

Ephantus Gichuki. Mwangi

**Abstract:** *Development of information communication technology (ICT) is making many organizations propel toward a truly global economy. Globally, many institutions of higher learning have adopted ICT with an aim of transforming education to match international standards. However the ability of institutions to compete globally is dependent on innovation, skill and knowledge impacted by the learning institutions. This has prompted many institutions of higher learning to look for innovative ways (such as E-learning) to deliver the learning process. Internationally E-learning in institutions of higher learning has gained a lot of momentum with an aim of producing graduates who are competitive in the labour market. However E-learning in Kenyan universities is still at the infancy stages. The aim of this study was to investigate on ICT infrastructure preparedness for E-learning implementation in Kenyan universities. The study targeted a population of 215 comprising of ICT lecturers, ICT staff and students from University of Nairobi and Kenyatta University, with a sample size of 140 generated using Yemen's formula. The research adopted a descriptive design where a survey was used to collect both quantitative and qualitative data. Data was collected through questionnaires and interviews. Analysis of data was done using IBM SPSS software version 20.0, then presented using frequency tables, percentages and bar graphs. The study revealed that inadequate ICT infrastructure, was a major challenge hindering the implementation of E-learning in Kenyan universities. The study recommended need for enhancement of E-learning infrastructure to enable reliable access to E-learning system by students and lecturers. Further, the findings will help universities in Kenya, the government and other stakeholders in coming up with strategies and mechanisms that will enhance successful rollout for ICT infrastructure for E-learning implementation and provide a platform through which Kenya will be transformed into a knowledge economy hence boosting its productivity and competitiveness in the constantly changing global market.*

**Keywords:** ICT infrastructure, Implementation, E-learning, University Education

## 1. Introduction

Introduction of Information and Communication Technology (ICT) has transformed the way organizations conduct their day to day operations (Thawfeek & Hussin, 2008). Globally, the integration of ICT in the educational sector has altered many concepts, characteristics and environment of traditional learning. The demand for university education by different groups of students has prompted many universities to embrace E-learning as an innovative way of curriculum delivery (Kiget, Wanyembi & Anselemo, 2014; Schurgers, Stam, Bandas & Labib, 2009). E-learning is the process of using ICT and related technologies to support the development and delivery of learning in academic and professional development institutions (Wagner, Hassanein & Head, 2008). E-Learning is an evolution of distance learning and has taken advantage of the latest tools to emerge in the context of technologies for structuring education (Sangra' et al., 2012). Through E-learning, ICT technologies have facilitated access to online learning/teaching resources and provided students with collaborative environments and tools like Web 2.0 applications which offer a set of tools and utilities for online learning (Rossi 2009).

Popularity of E-learning is attributed to the benefits it offers to the learner and trainers which include: flexibility; learners are provided courses on demand, anytime and anywhere (Tosun & Baris, 2011), convenience; courses are tailored based on learners' needs (Ely, Sitzmann, & Falkiewicz, 2009), preferred learning styles (Sun, Tsai, Finger, Chen, & Yeh, 2008), reduced learning costs, reduced learning times, consistent delivery and expert knowledge (Kiget, Wanyembi & Anselemo, 2014). Additionally, E-learning participants can participate and complete coursework in accordance with their daily

schedules. This makes it a viable option for those who have other commitments such as family or work and/or cannot participate easily, for instance due to reduced body function (Björk, Ottosson, & Thorsteinsdottir, 2008). The Internet, together with technologies such as computers, tablets, smart phones and ipads are some of the resources that facilitate E-learning to students away from classrooms (Richard and Haya, 2009; Prensky, 2009). Benefits of E-learning to institutions are enormous; institutions can reduce the cost of training, increase the availability of training, and offer new possibilities to integrate various types of learning contents (Chiu & Wang, 2008). Owing to the huge benefits offered by E-learning, universities globally have been motivated to embrace it and a remarkable growth has been experienced (Bersin, 2007).

## 2. State of E-Learning in Kenyan Universities

The use of E-learning in Kenyan universities has gained a lot of popularity and not only because of the number of E-courses offered but also due to the increased interests it generates from researchers' side (Mihailova, 2007). Tarus, Gichoya, and Muumbo (2015) asserts that E-learning initiatives have been introduced in Kenyan public universities in line with the government's policy requiring universities to introduce E-learning as an alternative delivery system. Waema and Kashorda (2014) state that from an E-readiness survey in thirty (30) universities in 2013, it was evident that most of the universities in Kenya were ready to use ICT for learning, teaching, research and management. Kenyan universities are allocating an average of 0.5% of their total recurrent expenditures on internet bandwidth to support implementation of E-learning. As a result, the universities in 2013 achieved Internet bandwidth increase to 4.0 Mb/s per 1,000 students compared to only 0.431Mb/s per 1,000 students in 2008 as indicated in table 1.

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**Table 1:** Demographic data and Internet availability sub-indicators for 17 universities– 2008 and 2013

Year of survey	Total students	Total PCs owned by students	Total bandwidth (Mb/s)	Internet bandwidth per 1,000 students	PCs per 100 students	% of students with PC access at home	Estimated % of students who own laptops
2008	162,319	8,907	70.8	0.436	5.5	27	21%
2013	339,418	13,815	1,431.5	4.22	4.07	30.4	53%

Source: KENET e-readiness data 2008 and 2013

Even with the above increase in internet bandwidth, it is unclear why this didn't translate into higher levels of e-readiness in most of the universities. In a research conducted by Kashorda and Waema (2014); Tarus and Gichoya (2015) universities are not investing sufficiently in campus network backbone and wireless network infrastructure that will make it easier for students to use their own laptops and smartphones on campus to access E-learning materials and other student services. For instance, according to Tarus, Gichoya, and Muumbo (2015), universities started implementing E-learning since 2004 (Nairobi in 2004, Kenyatta University in 2005, Jomo Kenyatta University of Agriculture and Technology in 2006 and Moi University in 2007). However, a critical review of the tangible steps made reveals insufficient progress in utilization of E-learning approach in these public universities due to unforeseen challenges. Most of these universities are using E-learning in blended mode since it's cheap in terms of implementation and requirements. Additionally, Motteram (as cited in Tarus, Gichoya, and Muumbo, 2015) teachers and learners prefer the blended learning approach, which mixes the traditional face-to-face teaching with online collaboration due to technological, organisational and pedagogical benefits it offers.

### 3. Methodology

The study was carried out in two universities that is University of Nairobi and Kenyatta University. Descriptive design was adopted to investigate on ICT infrastructure

preparedness for E-learning implementation in Kenyan universities. The total population of the study was 215 respondents which included; 175 students, 20 lecturers and 20 ICT staff. A sample size of 140 respondents was drawn using Yemen's formula; Stratified random sampling was used to identify members of each strata in the sample; since the population of lecturers and ICT staff was small compared to that of students, the first stratum consisted of 130 students derived from computer students who use in the two universities, the second stratum consisted of 5 ICT lecturers from the same universities and the third stratum consisted of 5 ICT staffs. A closed ended questionnaire and interview guides were designed and self-administered to collect data from the sample identified. Data was analyzed and presented using IBM SPSS statistics V20. Table 3.1 below shows representation of various strata in the total population

**Table 3.1:** Total Population

S.NO	Institution	Computer Student	ICT Lectures	ICT Staff	Total
1	University of Nairobi	95	12	11	78
2	Kenyatta University	80	8	9	62
3	Total Population	175	20	20	215

### 4. Findings

The questionnaire response rate was 93% of students, 92% of ICT lecturers, and 86% of ICT staff as indicated in table 4.1 below.

**Table 4.1:** Questionnaire Response Rate

University	Target Respondents			Actual Response					
	ICT Students	ICT Staff	ICT Lecturers	ICT Students		ICT Staff		ICT Lecturers	
				Number	%	Number	%	Number	%
University Of Nairobi	95	9	10	89	93	9	100	10	100
Kenyatta University	80	7	6	75	93	5	71	5	83
Average % Response					93		86		92

Two categories of informants (ICT lecturers and ICT staff) were interviewed and their responses analyzed as discussed in the various sub sections that follow. All the informants

availed themselves for the interviews. Table 4.2 below shows a summary of informants who were interviewed during the study.

**Table 4.2:** Interview Response Rate

University	Target Informants		Actual informants			
	ICT Staff	ICT Lecturers	ICT Staff		ICT Lecturers	
			Number	%	Number	%
University Of Nairobi	2	2	2	100	2	100
Kenyatta University	2	2	2	100	2	100
Average % Response				100		100

#### ICT Infrastructural Preparedness on E-learning Systems

To ascertain the level of ICT infrastructural preparedness, the study established the type of ICT infrastructure installed in Kenyan universities as discussed below.

#### 4.3.1 Range of Computer Laboratories in Universities

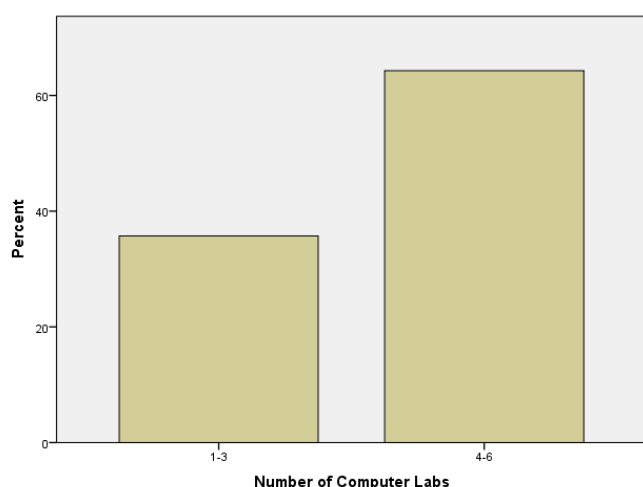
The study sought to assess the range of computer laboratories at the universities. 64.3% of the respondents indicated that the range of computer laboratories is 4-6 while 35.7% indicated that the range is 1-3 as indicated in the

figure 4.1 below. None of the respondents indicated in the range of 7-9 and above 9. Further, all the informants interviewed also agreed that the range of computer laboratories is 4-6 and many more were needed for E-learning implementation to succeed. Below are some of the comments from the respondents interviewed:

“...most schools in our university only have one computer lab while others do not even have any...”

“... majority of our lecturers and students in business and humanities related programmes do not have access to computer labs hence cannot access E-learning platform”.

These findings concur with the literature review that showed that there is inadequate number of computer laboratories at the universities; with the current ratio of computers to students in computer laboratories 1:15. Indeed universities are not equally endowed financially some are able to acquire more laboratories than others.



**Figure 4.1:** Range of Computer Laboratories in Kenyan Universities

#### 4.3.2 Frequency of Access of Computer Laboratories

The study sought to establish the frequency of access of computer laboratories on a weekly basis by the university students. From table 4.3 below, 64.3% stated that they access computer laboratories twice while 28.6% stated thrice. Further 7.1% indicated that they access computer laboratories once in a week. Further, three of the respondents interviewed stated that due to high demand of computer laboratories at the university, most students access computer labs only when their classes are scheduled for practical lessons.

This is evident due to the few number of computer laboratories versus the large student population as indicated by Kashorda and Waema (2014). This led to difficulties in setting up practical examinations and computer-administered examinations as stated by Lwoga (2012).

**Table 4.3:** Frequency of Access of Computer Laboratories on Weekly Basis

Computer Lab Access	Frequency	Percentage (%)	Cumulative Percentage (%)
Once	1	7.1	7.1
Twice	9	64.3	71.4
Thrice	4	28.6	100.0
Total	14	100.0	

#### 4.3.3 Availability of Local Area Networks

The study aimed to establish whether universities have LANs that can support E-learning. From table 4.4 below, 78.6% of the respondents were opinion that local area networks are available while 14.3% were of the contrary opinion. The key informants who were interviewed also believe that although the local area network is available, the coverage is limited; it only covers certain areas such as administration, library and sections of tuition area. Most of the hostels and recreational areas are not covered. Below are some of the comments from respondents:

“... we have both wireless and wired LAN but the coverage is limited, wireless only covers administration blocks and nearby building. It does not go to the extreme ends such as hostels, dining hall, pavilion among others”

“...Local area network is available in our university but the coverage is concentrated in the administration area and the tuition areas.”

**Table 4.4:** LAN Availability

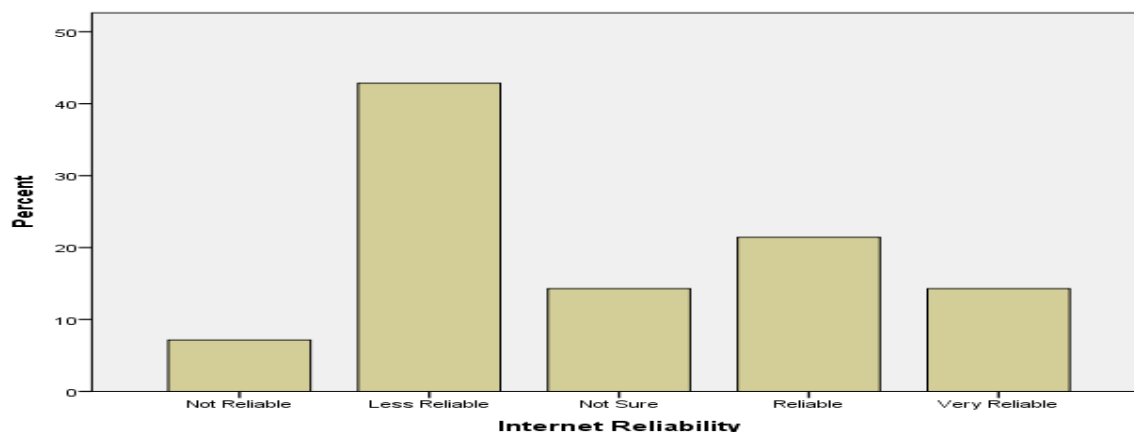
Response	Frequency	Percentage (%)	Cumulative Percentage (%)
Yes	11	78.6	78.6
No	2	14.3	92.9
No Response	1	7.1	100.0
Total	14	100.0	

#### 4.3.4 Reliability of Internet Connection

The study sought to establish the reliability of internet connection at the universities, respondents gave varied responses as indicated in figure 4.2 below. 42.9% of respondents stated that internet is less reliable while 35.7% were of the opinion that internet is either reliable or very reliable; further 14.3% were not sure of the internet connectivity status. Additionally, all the respondents interviewed concurred that internet connection is not reliable. Below is a comment from one of the respondent:

“...when most of our students are in session the internet is always slow, in fact in some sections it is usually down most of the times this makes it difficult for most of the students to access E-learning portal...”

Results show that reliability of internet connection in most of the universities is not satisfactory to support E-learning programmes. According to Fares (2008) as stated in literature review, E-learning requires reliable high speed internet access and campus network.



**Figure 4.2:** Reliability of Internet Connection in Kenyan Universities

#### 4.3.5 Range of Internet Bandwidth

The study sought to find out the range of internet bandwidth in Kenyan universities. From table 4.5 below, 42.1% of the respondents stated that the internet bandwidth ranges between 76-100 Mbps; while 35.7% of the respondent stated a range between 56-75 Mbps. Further, three of the respondents interviewed stated that internet bandwidth at their university ranges between 76-100Mbps, while one stated a range of 56-75 Mbps. From the results it is evident that the range of internet bandwidth in most of the universities is less than 100Mbps which is below the expected range of an efficient and reliable E-learning system. This concurs with Kwanya, Stilwell and Underwood (2012) who stated that 15 Mbps to 20Mbps is insufficient for effective internet usage in learning.

**Table 4.5:** Internet Bandwidth

Range	Frequency	Percentage (%)	Cumulative Percentage (%)
1-25	1	7.1	7.1
26-50	1	7.1	14.3
56-75	5	35.7	50
76-100	6	42.1	92.9
Above 100	1	7.1	100.0
Total	14	100.0	

#### 4.3.6 Connection to fibre optic Cable

The study sought to establish whether the universities were connected with fibre optic cable which is a key infrastructural component in any E-learning system. Respondents expressed their views as show in Table 4.6 below. Majority of the respondents (78.6%) indicated that their universities are connected to fibre optic cable network installed by the government. All the respondents interviewed concurred that there is fibre optic connectivity at the university, although they admitted that it does not cover all the areas of the university. From the results, it's clear that fibre optic installation is a boosts to E-learning implementation in universities if efficiently utilized.

**Table 4.6:** Fibre optic Connectivity

Response	Frequency	Percentage (%)	Cumulative Percentage (%)
No Response	1	7.1	7.1
Yes	11	78.6	85.7
No	2	14.3	100.0
Total	14	100.0	

#### 4.3.7 Access to Learning Management Platform

The study aimed to establish whether respondents access Learning Management System platforms. The findings as indicated in table 4.7 show that 35.7% of the respondents agreed while 57.1% were of the contrary opinion. This is a clear indication that most universities has either not implemented LMS platforms or awareness has not been well created to ICT staff who are the custodians of the system. Moreover, three of the respondents interviewed stated that they access LMS platforms from their workstations but they don't use them because they are not proficient in their usage. This concurs with a survey done by Ssekakubo et al (2011) that pointed out that majority of LMS platforms implemented in Sub-Saharan countries tend to fail; partially or totally due to the fact that many learners and technical staff in developing countries are not exposed to many ICT solutions .

**Table 4.7:** Access of Learning Management System

Response	Frequency	Percentage (%)	Cumulative Percentage (%)
No Response	1	7.1	7.1
Yes	5	35.7	42.9
No	8	57.1	100.0
Total	14	100.0	

#### 4.3.8 Types of Learning Management Platform Available at universities

The study sought to find out the types of Learning Management System platforms implemented by the universities to support E-learning. 50% of the respondents indicated that Moodle is the common LMS platform in use at their university while 42.9% indicated under the category of others and listed Wedusoft, Chisimba and Google classroom as popular LMS platforms in their universities. Table 4.8 below shows a summary of the findings.

**Table 4.8:** Types of Learning Management System

Response	Frequency	Percentage (%)	Cumulative Percentage (%)
No Response	1	7.1	7.1
Moodle	7	50.0	57.1
Other	6	42.9	100.0
Total	14	100.0	

All the key informants interviewed also stated that Moodle and Wedusoft (a framework of Chisimba) are the common learning management system in use at their universities and



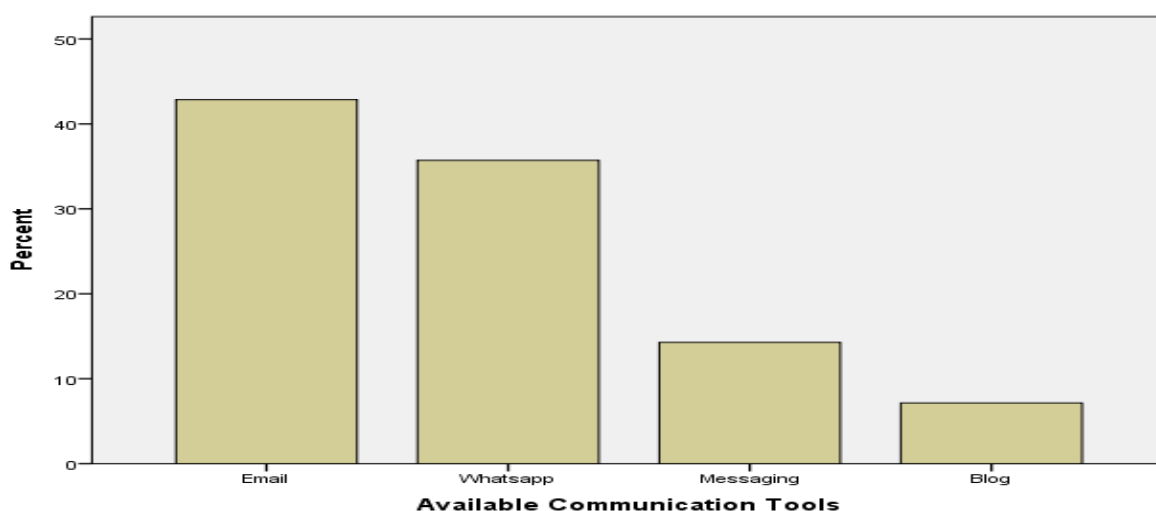
also agreed that they are important technological components necessary for successful implementation of E-learning. Below are some of the comments from respondents:

“... here at University of Nairobi, we have been using Wedusoft a framework of Chisimba for a long time and i have not had any serious issues about it”

“...since 2005 we have been using Moodle and it has been received very well by both lecturers and students. The platform is customizable hence user friendly.”

#### 4.3.9 Available Communication Tools for Use by Students and Staff

The study aimed at establishing communication tools available to students and staff in the universities for the purposes of knowledge sharing and interaction. From figure 4.3 below, Majority of the respondents (78.6%) stated that available communication tools were email and whatsapp group accounts while 21.4% stated messaging and blog. None of the respondents indicated Skype as a communication tool. Further, all the respondents interviewed stated that the most popular tool of communication was email.



**Figure 4.3:** Types Communication Tools in Kenyan Universities

#### 4.3.10.1 Adequacy of Computer Laboratories

The study sought to find out the whether computer laboratories are enough to facilitate E-learning in universities. Majority of the respondents 71.4% (who disagreed or strongly disagreed) were of the opinion that the laboratories are not adequate as indicated in table 4.9. Further, all the respondent interviewed stated that computer laboratories were not enough. Below are some of the comments from respondents interviewed:

“...we are proposing that every school be equipped with at least two computer labs for E-learning programmes to be effective...”

“...a number of schools especially in arts and humanities do not have computer laboratories of their own...”

This concurs with survey done by Kashorda and Waema (2014) that indicated that computer laboratories were few compared to population. Tarus and Gichoya (2015) noted that computers and other e-learning access devices are among the most important technological components that support successful implementation of E-learning.

**Table 4.9:** Adequacy of Computer Laboratories

Response	Frequency	Percentage (%)	Cumulative Percentage (%)
Strongly Agree	1	7.1	7.1
Agree	3	21.4	28.6
Disagree	7	50	78.6
Strongly Disagree	3	21.4	100.0
Total	14	100.0	

#### 4.3.10.2 Ease of Access of Computers by students and Lecturers

The study sought responses on whether there were difficulties on accessing the available computers by students and lecturers. From table 4.10 below, majority of the respondents 85.7% (who agreed or strongly agreed) indicated that computers are easily accessible while 14.3% were of the contrary opinion. All the respondents interviewed indicated that it's not easy for students to access computers during their free time because computer laboratories are always engaged. Computers are key technological component in any E-learning system and their ease of access is an important factor in successful implementation of E-learning.

**Table 4.10:** Ease of Access of Computers

Response	Frequency	Percentage (%)	Cumulative Percentage (%)
Strongly Agree	7	50.0	50.0
Agree	5	35.7	85.7
Disagree	2	14.3	100.0
Total	14	100.0	

#### 4.3.10.3 Availability of Network Connection Encourage students and lecturer interaction with E-learning System

The study sought to establish whether there is any relationship between availability of network connection and rate of access of E-learning system by students and lecturers. From the table 4.11 below, 78.5% of the respondents (who either agreed or strongly agreed) believe that availability of a network connection is a factor that encourages interaction of students and lecturers with an E-learning system. Further,

three of the respondents interviewed stated that availability of network connection motivates students to access E-learning system while one was of a contrary opinion. These findings concur with the literature review that showed that institutions providing E-learning must provide adequate network connections and technical support for both students and staff.

**Table 4.11:** Network Connection Encourages E-learning Interaction

Response	Frequency	Percentage (%)	Cumulative Percentage (%)
Strongly Agree	8	57.1	57.1
Agree	3	21.4	78.6
Not Sure	1	7.1	85.7
Disagree	2	14.3	100.0
Total	14	100.0	

#### 4.3.10.4 Adequate Internet Bandwidth Encourage students and lecturer interaction with E-learning System

The study aimed to establish whether the amount of internet bandwidth allocated to E-learning system is adequate to influence students and lecturers degree of interaction with the system. The findings as indicated in table 4.12 show that 71.4% (who disagree or strongly disagree) were of the opinion that amount of internet bandwidth allocated to E-learning systems at the universities is not adequate to influence the degree of user interaction with the E-learning system. Additionally, all respondents interview indicated that internet bandwidth available at the university is not enough to successful support E-learning system. Kashorda & Waema (2014) indicated that increase

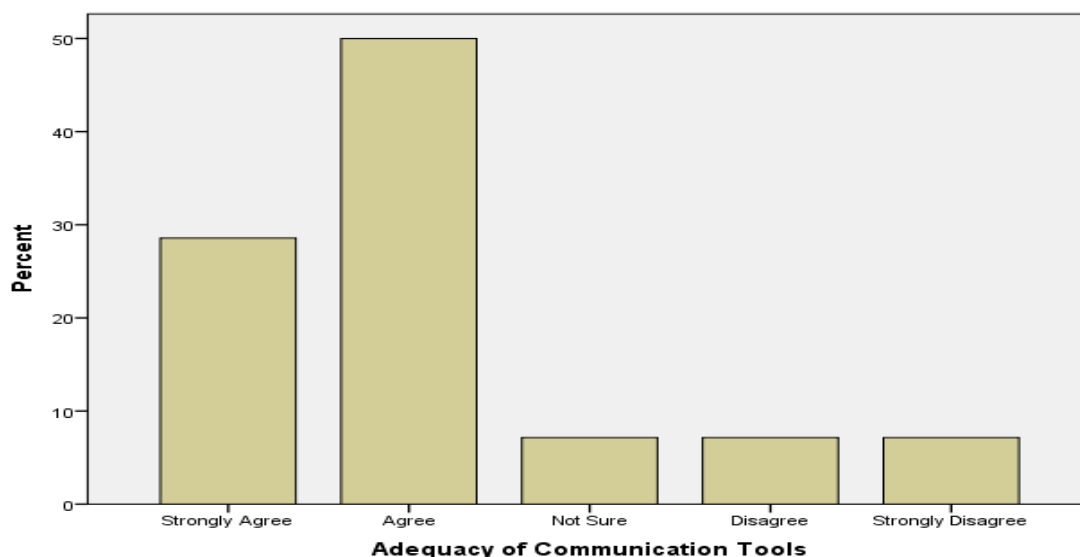
in student enrolment increased internet bandwidth usage per 1,000 students across universities. Further, Tarus and Gichoya (2015) indicated that although cost of internet bandwidth is still high for universities to afford, internet connectivity is critical for any institution using E-learning to support teaching and learning.

**Table 4.12:** Adequate Internet bandwidth Encourages E-learning Interaction

Response	Frequency	Percentage (%)	Cumulative Percentage (%)
Strongly Agree	1	7.1	7.1
Agree	2	14.3	21.4
Not Sure	1	7.1	28.6
Disagree	8	57.1	85.7
Strongly Disagree	2	14.3	100.0
Total	14	100.0	

#### 4.3.10.5 Adequacy of Communication tools

The study sought responses on whether available communication tools at the universities are adequate to facilitate communication between students and lecturers in an E-learning system environment. From figure 4.4 below, 78.6% of respondents (who either agree or strongly agree) stated that communication tools available are adequate to facilitate interaction between students and lecturers. The four respondents interviewed stated that there are adequate communication tools in the university LANs. This concurs with E-readiness survey of Kenyan universities by Kashorda and Waema (2014) that pointed out communication tools as prerequisite components of a successful E-learning system.

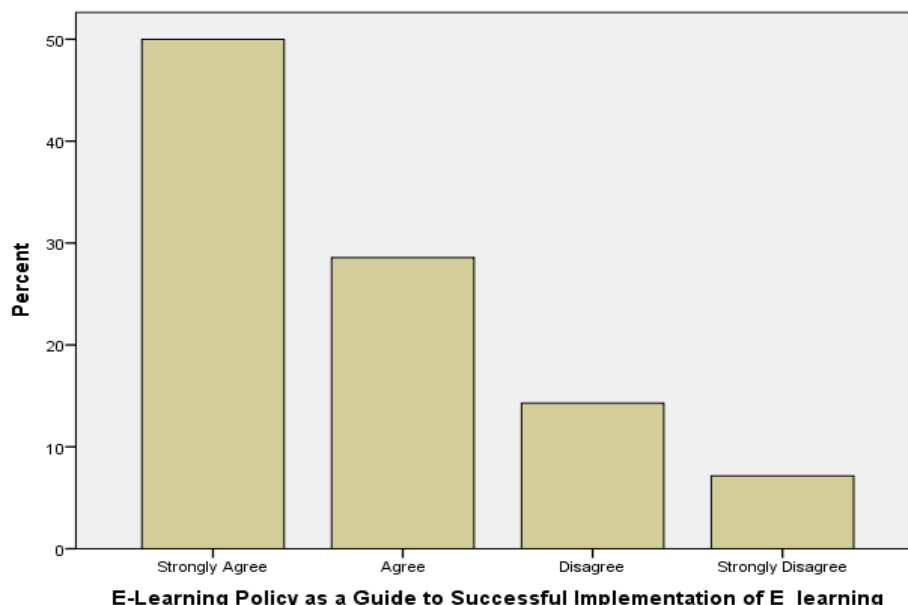


**Figure 4.4:** Adequacy of Communication Tools

#### 4.3.11 E-learning Policy Guide on successful Implementation of E-learning

The study sought responses on whether E-learning policy can guide successful implementation of E-learning at the universities. From the figure 4.5 below, Majority of the respondents (76.8%) who either strongly agreed or agreed

were of the opinion that existence of E-learning policy can successfully guide E-learning implementation in their universities. Only 21.4% of the respondents were of the contrary opinion. All the respondents interviewed were of the opinion that E-learning policy is a vital tool in E-learning implementation.

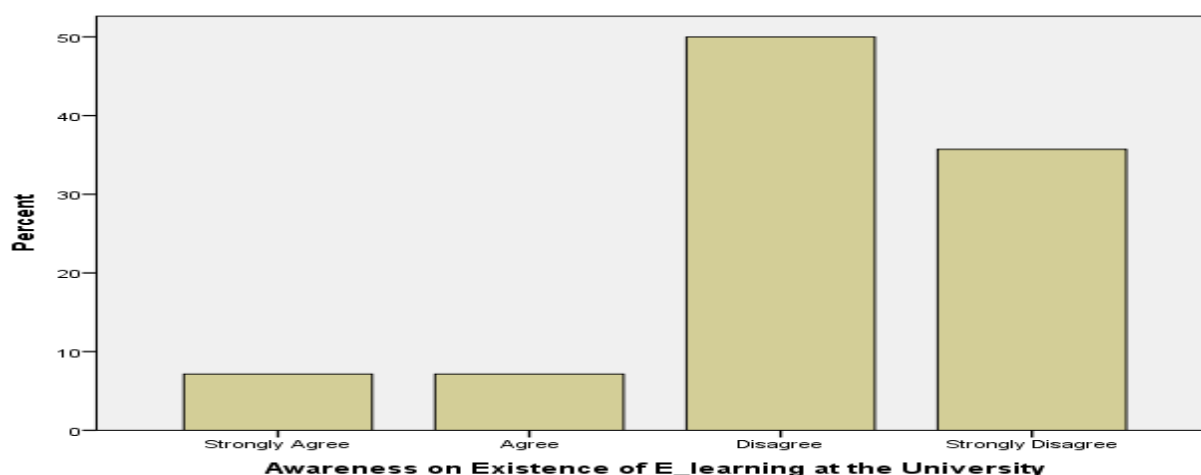


**Figure 4.5:** E-learning Policy Guide successful Implementation of E-learning

#### 4.3.12 Existence of E-learning Policy at the universities

The study sought to establish the existence of E-learning policy in Kenyan universities. Figure 4.6 below shows that 85.7% of the respondents (who either disagreed or strongly disagreed) were not aware of the existence an E-learning

policy at the university. Further, three of the respondents interviewed stated that they had no information about existence of an E-learning policy in their universities. This is an indicator that most universities implement e-learning without any policy in place.



**Figure 4.6:** Existence of E-learning Policy at the universities

## 5. Discussion of Findings

The objective of the study was to evaluate the ICT infrastructure preparedness on E-learning systems in Kenyan universities. The study revealed that there is inadequate ICT infrastructure in Kenyan universities which is a major challenges hindering the implementation of E-learning as summarized in below. The range of computer laboratories in most of the universities is 4-6 as indicated in figure 4.1 which is not adequate to support successful implementation of E-learning. The study also established that students do not have enough time to interact with computer as most of them (64.3%) access computer laboratories twice a week. Findings presented in table 4.4 shows that universities have local area network although the coverage is limited. Reliability of internet connection is also a challenge as 42.9% of respondents indicated that it is usually slow or

down most of the time. It was also observed that internet bandwidth is not adequate in most of the universities as majority of ICT staff (77.8%) indicated that it is below 100Mbps. However table 4.6 shows that in most of the universities, there is fibre optic connectivity although its installation does not cover all the sections of the universities. ICT staff considered fibre optic connectivity as a key infrastructure that would boost E-learning implementation. The study also established that learning management systems (LMS) are not very popular in most universities and a lot of awareness and training needs to be done. This concurs with a survey done by Ssekakubo et al (2011) that pointed out that majority of LMS platforms implemented in Sub-Saharan countries tend to fail; partially or totally due to the fact that many learners and technical staff in developing countries are not exposed to many ICT solutions. As indicated in table 4.8 the popular LMS platforms in Kenyan

universities are Moodle, Wedusoft, Chisimba and Google classroom. From figure 4.3 majority of the respondents (78.6%) stated that email and whatsapp are the most common communication tools while 21.4% stated messaging and blog. The study also revealed that Kenyan universities do not have E-learning policies in place that can guide successful implementation of E-learning systems. Most universities implement E-learning projects without having a clear strategy on how to go about it. This shows that ICT infrastructure is not enough and poses a great challenge to any university in Kenya attempting to implement E-learning system. This concurs with a survey done by Kashorda & Waema (2014) on E-Readiness that stated that universities still experience difficulties of inadequate ICT infrastructure.

## 6. Conclusion

This study has raised a number of issues that needs to be addressed for successful implementation of E-learning in Kenyan universities.

It can be concluded that ICT infrastructure is not adequate to support successful implementation of E-learning. Computer laboratories are not enough in most universities and are in the range of 4-6 as indicated in figure 4.1. Further the number of times university students access computer laboratories is not enough to facilitate E-learning lessons. Limitation of local area network to certain areas of the university is a hindrance to success of an E-learning system. Additionally, there is no reliable of internet connection in most of the universities to support E-learning programmes most of the time. The study also indicated that internet bandwidth is not sufficient in most of the universities as it is below 100Mbps. However most universities are connected to fibre optic cable though not well distributed for effective usage in E-learning. Universities have not created enough awareness on available learning management systems hence underutilized. Further the study shows that there are a range of communication tools available for students, lecturers and other staff; however the common ones are email, whatsapp and messaging. From the study, it's clear that universities do not have E-learning policies to guide the implementation of E-learning systems.

## 7. Recommendations

### Enhancement of ICT Infrastructure in Kenyan Universities

There is need for enhancement of E-learning infrastructure to enable reliable access to E-learning system by students and lecturers. ICT resources such as computers, laptops, computer laboratories, local area networks (both wired and wireless), internet connection and internet bandwidth should be increased to ensure that they are adequate to cover the ever growing student population that access E-learning. This will only be possible if university management prioritizes E-learning by setting up budgetary allocations in every financial year. Additionally universities through the government should come up with a memorandum of understanding with internet service providers (ISP) (such as KENET and mobile service providers) of subsidizing internet cost hence providing adequate internet bandwidth to

universities that will ensure faster internet connectivity for easier access to E-learning. Further the government should make it a policy that all university students should have a computer when joining university programmes this will enhance their ICT literacy as well as improving accessibility to E-learning systems.

Finally, the government through the Ministry of Education Science and technology should formulate E-learning policies to guide successful implementation of E-learning the Kenyan universities.

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