ICT Indicators in Higher Education: Towards an E-readiness Assessment Model

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Abstract

The potential for information and communications technology (ICT) to transform teaching, learning, research and management in higher education has been the subject of many articles and reports [1]. Higher education institutions in developing economies are at different stages of adoption ICTs for education and management. For institutions that are in the early stages of the ICT adoption, there are no appropriate models or frameworks that are being used to assess their state of readiness to use ICTs in education and to develop appropriate institutional ICT strategies aligned to the institutional strategies. In addition, the few existing models can only be used for qualitative assessment without explicit and measurable indicators and targets. In other words, the indicators they use do not have quantitative targets that could be used for benchmarking and quantitative assessment of ICT strategies. This paper describes a model that overcomes this limitation by developing indicators with quantifiable targets. The proposed e-readiness assessment model contains 17 indicators grouped into five categories of network access, networked campus, networked learning, networked society and institutional ICT strategy. The model defines over 88 sub-indicators of the 17 indicators based on both hard facts and perception data. The model has also developed a staging framework with quantifiable targets for staging each of the 17 indicators and sub-indicators on scale of 1 to 4, where 1 is the lowest stage of preparedness and the 4 the highest stage of preparedness. Since collecting perception data based statistically significant is expensive, the researchers propose that institutions could integrate a sub-set of six sub-indicators into their strategic ICT plans in order to improve the integration of ICT in education. This framework has been tested in two separate e-readiness assessments of universities in Eastern Africa [2, 3]. This paper argues that the model is a good starting point for empirical studies on the assessment of the integration of ICT in higher education institutions and invites practitioners to adopt the indicators, modifying where necessary, to guide integration of ICT into higher education and to develop roadmaps for accession to higher stages of e-readiness for higher education institutions. Finally, the paper recommends further research to establish relationships between the indicators and sub-indicators and quality of higher education and to derive an ICT readiness index for higher education institutions.

1. Introduction

The potential for ICT to transform teaching, learning, research and management in higher education has been the subject of many articles and reports [1]. In the developed economies, Higher Education (HE) institutions in the developed world have automated most of their processes and there is a high degree of adoption of ICT in teaching and learning. This has not been the case in most higher education institutions in Sub-Saharan Africa [1]. Studies show that there is a wide variation in the adoption of ICT in higher education institutions (HEIs) in a given country like Kenya [2]. Moreover, there is also an apparent digital-divide even within the institutions that have adopted ICT in education.

Information and communication technologies (ICT) could be used in education to improve administrative efficiency and to enhance teaching and learning. ICTs also allow both students and lecturers to participate in global research and education networks that support access to knowledge and collaborative projects. Thus, the use of ICTs in higher education institutions has the potential to enhance the quality of teaching and learning, increase the research productivity of the faculty and students, and improve the management and effectiveness of institutions. Additionally, ICT usage by students in higher education institutions develops the future workforce to effectively participate in the increasingly networked world and the emerging knowledge economy [4,5]. Graduates of higher education institutions will also occupy leadership positions in government, business, and society in the future and therefore will play a critical role in the transformation of a country like Kenya to an information society.

In order to achieve this goal of transforming the teaching, learning, research and management of higher education institutions using ICT, the institutions must achieve a minimum level of e-readiness. E-readiness of the institutions is a measure of the potential for the institutions to participate in the networked world of higher education and research. However, most of the higher education institutions have not yet assessed their level of e-readiness due to both lack of contextually appropriate assessment frameworks and the fact that leadership of higher education institutions are not yet convinced that ICT is strategically important or even essential in higher education [2].

This paper develops a simple model of assessing e-readiness of higher education institutions in countries with low levels of ICT diffusion [2,3]. The model uses indicators that are understandable by leadership of higher education institutions and that could be integrated into the institutional ICT strategies to measure the degree of adoption of ICT. The model defines 17 indicators and over 88 sub-indicators that could be used to measure e-readiness of higher education institutions. The model has been used successfully for e-readiness assessment of higher education institutions in Kenya [2] and in the five East African countries of Burundi, Kenya, Rwanda, Tanzania and Uganda [3]. It has also been used to develop accession roadmaps for ten universities in the five East African countries. The authors' experience in using the tool has demonstrated that the tool is valuable for communicating with policy makers and leadership in the higher education and has resulted in higher stages of readiness for universities that have adopted the strategic indicators and sub-indicators in monitoring their ICT strategy implementation.

This paper first reviews e-readiness assessment frameworks and indicators for ICTs in higher education. It then describes the proposed e-readiness assessment model. The paper ends by providing conclusions on the model developed and making recommendations for adoption of the model and for the use of the indicators to guide integration of ICT into higher education and increase e-readiness of HEIs. It also recommends further research in refining the model.

2. E-readiness assessment frameworks and ICT in HE indicators

2.1 Concept of e-readiness

In general, e-readiness can be defined as the preparedness of a nation or community to participate in the information and knowledge society [6, 7]. It is often measured by judging the relative advancement of the most important areas for the adoption of the ICTs and their applications [8]. Researchers at the Center for International Development at Harvard University [6] described 'e-ready' society as:

> "One that has the necessary physical infrastructure (high bandwidth, reliability, and affordable prices) has integrated current ICTs throughout businesses (commerce, local ICT sector), communities (local content, organizations online, ICTs used in everyday life, ICTs taught in schools), and the government (e-government)".

The World Bank Information for Development Program [9] defined e-readiness for a state as:

> "The preparedness of states to provide governance equitably and cost effectively and the capacity to reflect in the degree of integration the deprived segments of society attain application of ICT as an e-governance tool. Apart from this the ability of the state to provide business, the capacity to participate in the provincial level digital economy and further networking with national level digital economy".

In the realm of higher education, Machado [10] conceptualizes e-readiness as

> "the ability of HEIs and the capacity of institutional stakeholders (managers, key ICT persons, teachers and students) to generate (e-) learning opportunities by facilitating computer-based technologies – in short, how e-ready a HEI is to benefit from educational technology (or e-learning)"

This paper adopted the CID definition of e-readiness which has also been successfully used to develop the World Economic Forum's Networked Readiness Index [11].

A higher education e-readiness model should therefore enable HE institutions to gauge their readiness to take advantage of the opportunities afforded ICTs. There are two main purposes for e-readiness assessment:

a. Diagnostic assessment as part of ICT strategic planning for a country, community or institution. This is the purpose of the AAU or CID assessment methodologies [1, 6]

b. Assessment for the purposes of ranking e-readiness and therefore comparing countries , communities or institutions. For example, the World Economic Forum networked readiness index is used to compare countries [11]

The model described in this paper has been derived from the CID and AAU assessment models and is therefore diagnostic. Its purpose was to be used in ICT strategic planning and evaluation of the effectiveness of institutional ICT strategies. In the following section, we briefly review the three main e-readiness assessment models that motivated the development of our framework, namely, the CID assessment tool [6], the Networked Readiness Index methodology [11], and the Association of African Universities (AAU) assessment tools [1].

2.2 E-readiness diagnostic assessment frameworks

CID e-readiness tool

The CID e-readiness tool was titled, "Readiness for the Networked World – A Guide for developing countries"[1] [6]. It was developed by the Information Technology Group at the Center for International Development (CID), Harvard University. This paper describes how the tool was modified and extended for use by the higher education community.

The CID e-readiness tool defined 19 indicators of the degree of e-readiness of a community or country. The 19 indicators were split into five main categories as follows:

(i) **Network access** category that measures readiness of the ICT infrastructure. It defined six indicators, namely – information infrastructure, Internet availability, Internet affordability, network speed and quality, hardware and software, and service and support. These indicators therefore measured the availability, cost, and quality of ICT networks and services

(ii) **Networked economy** category that measures the use of ICT by businesses and the government for commerce (B2C or B2B) and the availability of the human capital used to support the services. It has four indicators, namely, ICT employment opportunities, B2C electronic commerce, B2B electronic commerce and e-government. These indicators therefore measure how businesses and governments using ICTs to interact with the public and with each other.

(iii)**Networked learning** category of indicators measure the level of access to ICT by educational institutions, and the utilization of ICT in teaching and learning, and availability of ICT training programs. It has three indicators, namely, schools

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[1] http://www.readinessguide.org

access to ICTs, enhancing education with ICTs, and developing the ICT workforce. These address the questions of how educational systems integrate ICTs into their processes to improve learning and how the educational institutions are preparing the ICT workforce.

(iv) **Networked society** category measures the degree to which people and organizations are using ICT. It has four indicators, namely, people and organizations online, locally relevant content, ICT in everyday life, and ICTs in the workplace. The indicators here address the questions: of the extent individuals in the community are using ICT at work and in their personal lives and the availability of significant employment opportunities for those with ICT skills.

(v) **Network policy** category of indicators are used to assess the ICT policies and/or legislation and the success or failure of the regulatory environment in a particular community. It has two indicators, namely, telecommunications regulation, and ICT trade policy. These indicators therefore here address the question of the extent to which the policy environment promotes or hinders the growth of ICT adaptation and use.

In e-readiness assessment of using the CID tool, each of the 19 indicators would be staged on a scale of 1 to 4, where 1 represents unprepared and 4 represents the highest state of readiness in that particular indicator. The final results could then be presented as a radar diagram for the 19 indicators.

Networked Readiness Index

The Networked Readiness Index (NRI) is defined as "the degree of preparedness of a nation or community to participate in and benefit from ICT developments" [11]. The Index is a composite of three sub-indexes, namely, the *environment* for ICT offered by a given country or community; the *readiness* of the community's key stakeholders (individuals, businesses, and governments) to use ICT; and finally, the *usage* of ICT amongst these stakeholders. Figure 1 shows how the sub-indexes are used to derive the NRI.

Figure 1: Network readiness index framework
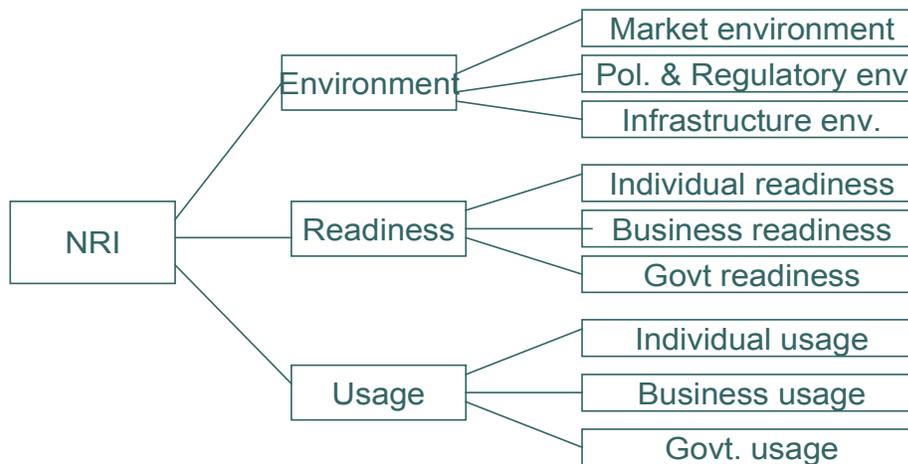
Source: WEF Global IT Report 2003-2004

The NRI has been designed as a macro-level tool for policymakers and global leaders. The index signals broad trends, flags opportunities and deficits, and makes a unique contribution to the understanding of how nations are performing relative to one another with regard to their participation in the Networked World [12]. It influences decisions such as investors' choice of a destination, effective Internet regulation or stimulation, as well as identification of investment opportunities.

The NRI was derived from the CID tool but uses a modified set of 48 indicators to measure the nine categories of indicators shown in Figure 1. The indicators are derived from both hard facts data and perceptions data obtained by surveying senior government and business executives. The values of the indicators were then mapped into a scale of 1 to 7 and then statistically used to derive the index. Although the framework proposed in this paper does not calculate an index, it defines quantitative values or ranges of values for each of the sub-indicators used to measure e-readiness.

The Association of African Universities (AAU) Institutional Self-assessment Guidelines

The Association of African Universities (AAU) developed a framework to assess ICT maturity of the member African universities in the year 2000 [1]. This framework was aimed at assessing the situation with regard to a university's capacity to use ICT in education and for internal administrative efficiency [1]. The Association identified nine assessment areas and relevant sets of variables for each area, as outlined below.

   a) **Planning and monitoring tools** - measured using the availability of university strategic plan, derived information policy plan, derived information master plan, and derived information project plans indicators.
   b) **Application of ICT in teaching and learning** - measured using the indicators of teaching objective for using ICT, professional development of academic staff,

technology access and usage patterns of academic staff, and technology access and usage patterns of students.

c) **Application of ICT in research** - measures the research objective of academic staff and students for using ICT.

d) **Application of ICT in academic information services (library)** – measures the extent of access to online public access catalogue, services in academic information management, and training in academic information management.

e) **Application of ICT in administration and management** – measures the extent of ICT application for administration and management functions.

f) **ICT infrastructure** – measures the type of infrastructure as well as accessibility and usage patterns.

g) **ICT organizational (support) infrastructure** – measures staff responsibilities in technical as well as functional areas.

h) **ICT financing** – measures the funding for ICT internally and via fundraising; with distinction within budget votes or budget line items.

i) **Training, research and development in ICT** – measures the training for ICT human resources development (workforce and leaders).

The above e-readiness frameworks suffer from three key limitations. Both CID assessment tool and the NRI methodology have often been used to measure the readiness of countries or states as the smallest community. That is, they have not been used for institutional assessment of e-readiness and therefore do not render themselves readily useable for higher education community and institutions. The model proposed in this paper focuses exclusively on higher education institutions. The NRI methodology assumes that hard facts data are available from credible sources like the World Bank, UNESCO, and ITU. This is not the case for most higher education institutions in sub-Sahara Africa in general and in Kenya in particular. In addition, the indicators used to derive the index are irrelevant for institutions and communities that are in early stages of ICT adoption. For example, institutional ICT strategy indicators are often missing from all the frameworks yet they are critical for institutional adoption of ICT [3]. .

Moreover, the values or range of values for the indicators appropriate for a developing country like Kenya are very different from those in a developed country like Finland. For example, stage 4 for the sub-indicator Internet bandwidth per 1000 students used in Kenya was only 5 Mb/s and above (high) for Kenya while it would be 1 Gb/s in developed countries.

The AAU model that was specifically developed for institutional assessment defines only a qualitative staging framework. The researchers were not aware of the use of the model in any university in Kenya or East Africa. The model proposed in this paper has a staging framework with quantifiable targets for each indicator, which is useful for developing roadmaps for accession to higher stages of readiness. Thus, the framework proposed in this paper, and described in the next section has borrowed from the CID, NRI, and AAU assessment methodologies but has different variables and indicators

3. Proposed e-readiness assessment model and ICT in HE indicators

The AAU assessment model has not been used to assess the e-readiness of Kenyan universities and the authors are not aware of any African university in Africa that has adopted the model for self-assessment as envisaged by the AAU. The NRI on the other hand has been published annually since the year 2002 World Economic Forum for an increasing number of countries where data is available (see http://www.weforum.org). It works best for developed or developing countries where all of the data is available and collected by credible institutions such as the World Bank, National Statistical bodies or the regulators. Most of the data required to assess readiness in East African universities is actually not available from any public sources. Huang [13] acknowledges there are differences between developed and developing economies with respect to e-readiness assessment models for e-business implementation

Although the 19 indicators by the CID [6] could have been adopted for use in the model proposed in this paper, many of the indicators were not relevant for a higher education institution. We therefore modified the CID tool by eliminating indicators that were not relevant and developed quantitatively measurable sub-indicators that could be staged on a linear scale of 1 to 4. For example, ICT Trade Policy, Telecommunications Regulation and Networked Economy indicators defined in the CID tool were not relevant e-readiness assessment of higher education institutions. Apart from eliminating some of the 19 indicators, we introduced six new indicators and defined two new categories. The two new Networked Learning indicators (i.e., ICT Research and Innovation and ICTs in Libraries) were motivated by the guidelines for institutional self-assessment guidelines developed by the Association for African Universities [1]

The final model contained 17 indicators classified into five categories, namely:

i.   *Network access* (information infrastructure, Internet availability, Internet affordability, network speed and quality)
ii. *Networked campus* (network environment, e-campus)
iii. *Networked learning* (enhancing education with ICTs, ICTs in libraries, ICT research and innovation, developing ICT workforce)
iv. *Networked society* (people and organizations online, locally relevant content, ICTs in everyday life, ICT in workplace)
v.   *Institutional ICT strategy* (ICT strategy alignment, ICT financing, ICT human capacity)

Each of the indicators was derived from sub-indicators. About 88 sub-indicators have been defined in this model. Similar to the CID assessment model, each of the indicators was to be staged on a scale of 1 to 4, with 1 being unprepared and 4 the highest state of ICT readiness for a typical higher education (HE) institution. The institutional ICT strategy category and the networked campus categories were not defined in the original CID assessment framework. In addition, the indicators and sub-indicators are now specific to higher education institutions in a typical developing country.

The researchers developed new quantitative criteria for staging that was considered appropriate for typical HE institutions at early stages of adoption of ICT in education. For example, one of the sub-indicators defined in the framework was the number of networked computers per 100 students. The framework defined stage 1 to be range less than five PCs per 100 students while stage 4 was 50 PCs per 100 students. The stages therefore represent a value judgment based on the experience of researchers in the Kenyan higher education ICT environment, situational data collected from higher education institutions and trends in learning environments at institutions in middle-income countries [10]. These criteria were set as minimalist standards for increasing the ICT readiness and usage in the different institutions. It is therefore possible for different institutions to set higher standards in their corporate and ICT strategic plans.

Figure 2 below shows what we refer to as the ICT in Higher Education E-readiness Assessment Model (HEAM).

Figure 2: Proposed ICT in Higher Education E-readiness Assessment Model (HEAM)
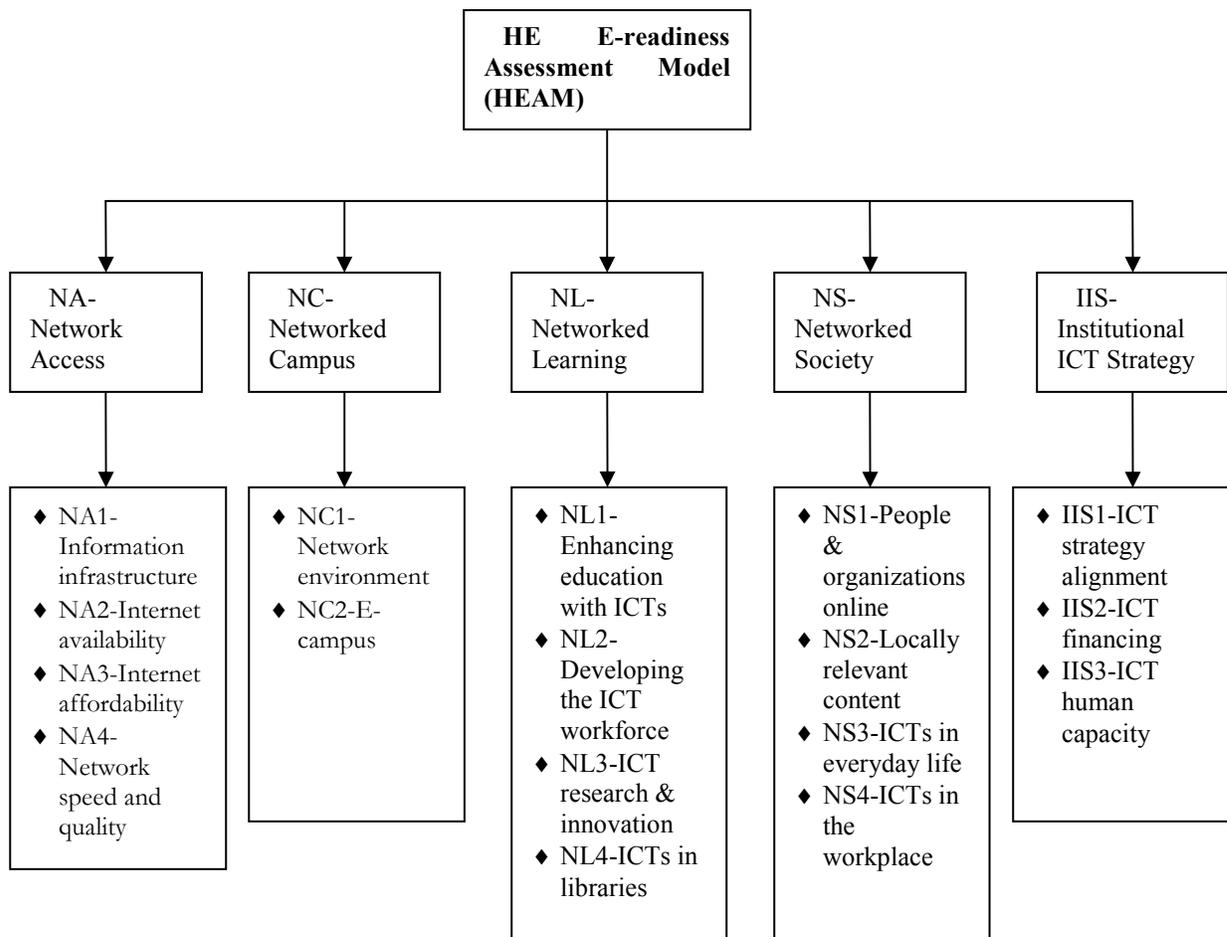
The individual elements of the model are described below. The staging framework was used in the November 2007 to assess 25 Higher Education (HE) institutions in Kenya [2] and in November 2008 to assess 50 East African Universities [3]. The framework was also used for assessment of 10 EA universities in November 2010 but the networked society indicators that are based on perception data. Thus, the tool has been tested at least three times and in each case used to communicate strategic ICT issues with the senior institutional leadership. The researchers have observed that accession to higher stages of readiness in all indicators is heavily dependent on a Chief Executive Officer (e.g., Vice Chancellor) becoming the champion for ICT adoption and usage. This is consistent with leadership requirements for any organizational change management effort, including ICT adoption and usage. We note that the staging framework is largely a moving target as it is context sensitive and the context is constantly changing. For example, the actual relationship between an ICT variable (e.g., bandwidth per 1000 students) and the staging depends on the sophistication and availability of Internet bandwidth in a particular region or country.

Although the model proposed in this paper was developed specifically for assessment of higher education institutions in Kenya, it has been used effectively in other EA universities. We therefore believe that it could be applicable in other institutions in sub-Sahara African countries. This is because it has been shown that there is a strong correlation between the ICT Opportunity Index introduced by ITU and the economic classification of countries introduced by the World Bank [18]. For example, countries classified as high average income countries by the World Bank are also ranked among the top 29 in the ITU ICT Opportunity index (14), Similarly, the bottom low average (< US$ 800 GDP per capita) were also ranked among the bottom 121-183 countries in the ICT opportunity index. Kenya and most of the countries in sub-Sahara Africa are in the low average category and we expect the state of readiness of the higher education institutions to be in the same category. However, it is possible for a university to be an ICT early adopter island with the right leadership. The researchers have observed that rural universities are able to achieve the same level of e-readiness comparable urban universities.

In the following sections, we describe the indicators and sub-indicators defined for each of the five categories of indicators.

3.1 Network Access

We adopted the first four indicators of the Network Access category of the CID tool, namely:

    (a)   Information infrastructure (in the campus)
    (b)   Internet availability (by the higher education institutions)
    (c)   Internet affordability (by the institutions)
    (d)   Network speed and quality (as perceived by users on campus)

We then developed a set of sub-indicators for each indicator guided by our experience and knowledge of what is relevant in the local context. Table 1 shows the indicators and the sub-indicators in this category of indicators and the main purpose for the indicators.

Table 1 – Network access indicators and sub-indicators

Indicator	Key Sub-indicators	Purpose
NA1 - Information infrastructure	♦ NA1.1 - Telephone internal teledensity ♦ NA1.2 - Telephone external teledensity	The sub-indicators measure access to telephone services by staff of an institution
NA2 - Internet availability	♦ NA2.1 - Uplink bandwidth per 1,000 students ♦ NA2.2 - Download bandwidth per 1,000 students ♦ NA2.3 – Networked PCs per 100 users	The sub-indicators measure the extent of availability of Internet in an institution
NA3 - Internet affordability	♦ NA3.1 - Internet bandwidth costs as a percentage to the total expenditure of the institution or campus ♦ NA3.2 - Cost of Internet per 1,000 students	The sub-indicators measure the extent to which Internet is affordable
NA4 - Network speed and quality	♦ NA4.1 - % of students who think on-campus e-mail always works ♦ NA4.2 - % of faculty who think on-campus e-mail always works ♦ NA4.3 - % of students who think Internet speeds are better than those for Cyber Cafés ♦ NA4.4 - % of faculty who think Internet speeds are better than those of Cyber Cafés	The sub-indicators measure the quality of e-mail and Internet services in an institution

In order to stage the indicators and sub-indicators on a scale of 1 to 4, it was necessary map actual range of values to a stage for each of the variables shown in Table 1. For example, the Internet availability indicator NA2 had three sub-indicators, NA2.1 (the uplink bandwidth per 1000), NA2.2 (downlink bandwidth per 1000 students) and NA2.3 (PCs per 100 students). Table 2 shows how the values were assigned in the E-readiness survey of 25 Kenyan HE institutions in 2007 [2]. Targets used for each of the 17 ICT indicators for are available at http://eready.kenet.or.ke.

Table 2: Example mapping range of values for sub-indicators of Internet availability

Stage	NA2.1 range of values (uplink bandwidth per 1000 students)	NA2.2 range of values (downlink bandwidth per 1000 students)	NA2.3 range of values (PCs per 100 students)
Stage 1	< 128 kb/s	<512 kb/s	NA2.3 < 5

Stage 2	$128 \leq NA2.1 \leq 512$ kb/s	$512 \leq NA.2.2 \leq 2048$ kb/s	$5 \leq NA2.3 \leq 20$
Stage 3	$512 \leq NA2.1 \leq 1024$ kb/s	$2048 \leq NA.2.2 \leq 4096$ kb/s	$20 \leq NA2.3 \leq 50$
Stage 4	$\leq NA2.1 \geq 1024$ kb/s	$NA.2.2 \geq 4096$ kb/s	$NA2.3 \geq 50$

The range of values shown in Table 2 were selected based on actual data collected from the 25 higher education institutions assessed in Kenya. That is, they represented the range of values achieved by the HE institutions in Kenya. For example, the highest Internet bandwidth offered by one of the HE institutions surveyed was considered the minimum in the stage 4 range. Similarly, the worst Internet bandwidth offered was the highest range in stage 1. We note that most of the institutions were mapped into stage 2 or 3 of the framework. This tool therefore allows institutions in a given region or country to select appropriate values for staging.

Another factor that was considered in assigning the values for the NA2 sub-indicator range of values was the fact that only satellite Internet bandwidth was available to the Kenyan (and East African) institutions. In general, an asymmetrical ratio of uplink to downlink bandwidth ratio of 1:4 has been used at most of the institutions. Thus, NA2.2 values were four times NA2.1 values.

Table 2 shows that the minimum total satellite bandwidth for stage 4 institutions would be 5 Mb/s per 1000 students while stage 4 PC ratio would be a minimum of one PC for every two students. This was only achieved in some of the ICT departments in some of the institutions.

3.2 Networked Campus

The networked campus category contains only two indicators, namely, network environment and the e-campus indicators. This category of indicators is closely related to the network access indicators. For example, the network environment indicator measures both the ICT power supply environment and the security for ICT equipment and software. ICT power supply and security are big challenges for most of the campus networks and systems and determine availability of ICT on campus. Table 2 shows the indicators and the sub-indicators in this category of indicators and the main purpose for the indicators.

Table 2: Networked campus indicators and sub-indicators

Indicator	Key Sub-indicators	Purpose
NC1 – Network environment	♦ NC1.1 - Existence of UPS in computer laboratories ♦ NC1.2 - Existence of UPS in offices ♦ NC1.3 - Existence of licensed anti-virus software ♦ NC1.4 - Existence of institutional firewall ♦ NC1.5 - Existence of physical security in laboratories ♦ NC1.6 - Existence of off-site back-up ♦ NC1.7 - Number of years of administrative experience of the Head of ICT ♦ NC1.8 - % of ICT staff who have worked with users for more than 3 years ♦ NC1.9 - Frequency with which ICT staff upgrade their skills	The sub-indicators measure the ICT power supply availability and security of ICT equipment and software, which includes disaster recovery, plans
NC2 – E-campus	♦ NC2.1 - % of units with websites ♦ NC2.2 - Frequency of updating website information ♦ NC2.3 - Level of integration of computerized systems ♦ NC2.4 - Extent of online interaction	The sub-indicators measure the degree of automation of internal processes and electronic interactions of the campus with students, staff, suppliers and other key stakeholders

To be in stage 4 in network environment indicator means that an institution is in stage 4 in the ICT power supply sub-indicators and the ICT security sub-indicators. It also means that majority of ICT staff have many years of experience working with users (more than three quarters of the ICT staff have worked with users for over three years) and that ICT staff upgrade their skills at least every year.

The electronic campus or E-campus indicator measures ICT usage for internal as well as external operations. A stage 4, a campus would have fully automated internal operations and would also be using ICT to interact with suppliers, students, staff and other key stakeholders. This means that the campus and associated departments would have interactive and transactional websites that are regularly updated.

3.3 Networked Learning

The networked learning category contains four indicators as outlined earlier. We borrowed aspects of application of ICT to teaching and learning, application of ICT in research, and application of ICT in libraries from the AAU self-assessment guide. We added an additional indicator on developing the ICT workforce. The four indicators are:

(a)   Enhancing education with ICT
(b)   Developing the ICT workforce
(c)   ICTs in the libraries

(d)   ICT research and innovation

Although "enhancing research with ICTs" was considered as a separate indicator, data collected was incomplete to inform the staging framework. This indicator was therefore not analyzed. We intend to pick it up in our next iteration of the model. Table 3 shows the indicators and the sub-indicators in this category and the main purpose for the indicators.

Table 3 – Networked learning indicators and sub-indicators

Indicator	Key Sub-indicators	Purpose
NL1 - Enhancing Education with ICT	♦ NL1.1 - Educational software usage ♦ NL1.2 - Usage of course management system (Moodle, WebCT) ♦ NL1.3 - % of integration of ICT in curricula ♦ NL1.4 - Use of ICT in the classroom ♦ NL1.5 - Use of ICT in student projects	This indicator measures the integration of ICT in curricula and the readiness of institution to offer e-learning courses and use ICT in the classrooms. Stage 4 institutions have integrated the ICT in curricula and ICT used in all stages of learning and projects (even non-ICT projects)
NL2 - Developing ICT Workforce	♦ NL2.1 - % of ICT staff with professional certification ♦ NL2.2 - % of employees trained on productivity tools ♦ NL2.3 - % of ICT staff who have received network administration training	Sub-indicators measure the extent to which an institution is preparing and training its ICT workforce. In stage 4, institution has proficient users of ICT who are regularly trained.
NL3 – ICT Research and Innovation	♦ NL3.1 - ICT undergraduate degree program ♦ NL3.2 - ICT Master's degree program ♦ NL3.3 - ICT PhD degree program ♦ NL3.4 - Participation by students in international design projects and exhibitions (e.g., IEEE exhibitions)	This indicator measures ICT research and innovations. The sub-indicators selected as indirect measures of ICT research and innovations. For example, Master's and doctoral ICT programs offered increase the research output of institutions. Stage 4 institutions have ICT doctoral degree programs and students participate in ICT exhibitions and competitions.
NL4 – ICT in Libraries	♦ NL4.1 - On-campus OPAC ♦ NL4.2 - Off-campus OPAC ♦ NL4.3 - Availability of Internet databases ♦ NL4.4 - Information literacy training ♦ NL4.5 - Local digital content (digital library) ♦ NL4.6 - Use of E-mail updates to library holdings	Sub-indicators measure the degree of automation of library and usage of ICT for back-end library operations. In stage 4, library is fully automated (front-end and bank-end operations) with support and training of users

3.4 Networked Society

The networked society category of indicators measures the readiness of the community to use ICT for teaching, learning, research, and management (or administration). It consists of the following group of indicators:

    a. People and organizations online
    b. Locally relevant content
    c. ICTs in everyday life
    d. ICTs in workplace

Table 4 summarizes the indicators and the associated sub-indicators used for staging.

Table 4: Networked society category of indicators

Indicator	Key Sub-indicator	Purpose
NS1 - People and Organizations Online	♦ NS1.1 - % of respondents who have never used the Internet ♦ NS1.2 - % of respondents who consider Internet most important for e-mail ♦ NS1.3 - % of students who consider Internet most important for academic work ♦ NS1.4 - % of faculty using Internet daily ♦ NS1.5 - % of students using Internet daily ♦ NS1.6 - % of students who think that the institution's website is interactive ♦ NS1.7 - % of students who do not know about their institutional website ♦ NS1.8 - % of students with e-mail accounts	Indicator measures the intensity of use of on-line resources and what they need the Internet for. Stage 4 means less than 1% have never used the Internet, over 75% of students and faculty use the Internet daily and all students and faculty have e-mail addresses.
NS2 - Locally Relevant Content	♦ NS2.1 - % of faculty visiting 1-2 local websites ♦ NS2.2 - % of students and faculty looking for academic information from the Internet ♦ NS2.3 - % students looking for news/entertainment ♦ NS2.4 % of students and faculty visiting Web portals with local (national) information	Indicator measures availability of websites with local content. It could be academic, news or entertainment. It also measures the degree to which users are attracted to the locally relevant websites. In Stage 4, students, faculty and staff have access to relevant local content
NS3 - ICTs in Everyday Life	♦ NS3.1 - % of students with campus access to computers ♦ NS3.2 - % of faculty with campus access to computers ♦ NS3.3 - % of students whose main access to computers/Internet is cyber café ♦ NS3.4 - % of students with home access to computers ♦ NS3.5 - % of faculty with home access to computers ♦ NS3.6 - % of students and faculty using computers for e-mail/Internet ♦ NS3.7 - % of students and faculty using PCs for word processing	This indicator measures access and usage of ICT on- and off-campus.

NS4 - ICTs in the Workplace	♦ NS4.1 - % of faculty using Internet for academic work ♦ NS4.2 - % of faculty using e-mail for internal communications ♦ NS4.3 - % of faculty who access Internet from office ♦ NS4.4 - % of faculty staying on-line for more than 1 hour	Data obtained from staff (academic and non-academic staff). Measures readiness and usage of ICTs at work (e-mail, ERPs, e-learning platform, Productivity tools)

Each of these indicators was sub-divided into sub-indicators that were then staged. The people and organizations online indicator measures the use of Internet resources for learning, research, news and entertainment. It assumes that users have access to e-mail as well as informational, interactive and transactional websites. E-mail accounts could be provided either by the institutions or other ISPs.

The locally relevant content indicator measures the degree to which local on-line resources are available in Kenyan higher education institutions websites or other websites hosted in Kenya. Such local websites could contain local news and entertainment or locally developed learning resources like databases or e-learning courses. The indicator measures the extent to which Kenyan Internet content has been locally developed and its relevance to the higher education academic community.

ICT in everyday life indicator measures the readiness and use of a variety of ICT services and equipment by the higher education community. For the purpose of this indicator, ICTs are defined broadly to mean computers, PDAs, mobile phones or fixed line phones, televisions, and radios. Such ICTs equipment or services need not be provided by the institutions but could be available at cyber cafés or even at home. Data for this indicator was collected using the field-based perceptions survey.

ICT in the workplace indicator was specific for academic and non-academic staff of HE institutions. It measures the readiness and usage of ICT at work. For an academic staff member, this means using ICT for classroom presentations, preparation of notes and e-learning content, and for Web-based research. It is also used to measure the use of ICTs for internal and external communication. Non-academic (administrative) staff, for example those in an accounts department could use institutional information systems for their daily work. Administrative staff could also use ICTs to interact with suppliers, government, off-campus students and staff.

3.5 Institutional ICT Strategy

The Institutional ICT Policy category of indicators is composed of three indicators, namely:

(a) ICT strategy
(b) ICT financing
(c) ICT human capacity

ICT strategy is measured using several sub-indicators, including the alignment of ICT strategy to the corporate strategy, the extent of ICT strategy implementation, and the reporting levels of the Head of ICT. ICT financing was borrowed from the AAU self-assessment guide and is measured using the sub-indicator of percent of annual institutional expenditure used to purchase Internet bandwidth. Although a sub-indicator that measures the percent of budget allocated to ICT was specified, most of the institutions could not provide the required data to calculate the percentage. The ICT human capacity indicator is measured using several sub-indicators that included the business and technical experience of the Head of ICT, the frequency of upgrading the skills of the ICT staff, and the retention of ICT staff.

Table 5 summarizes the indicators and the associated sub-indicators used for staging.

Table 5: Institutional ICT strategy category of indicators

Indicator	Key Sub-indicator	Purpose
IIS1 – ICT Strategy	♦ IIS1.1 - Status of ICT in the institution ♦ IIS1.2 - Reporting level of the head of ICT ♦ IIS1.3 - ICT leadership ♦ IIS1.4 - Extent to which ICT strategy is known or understood by students and staff ♦ IIS1.5 - Extent ICT strategic plan is aligned to the corporate strategic plan	The indicator assesses the extent to which strategic ICT planning takes place and is linked to corporate strategic planning, who provides leadership for ICT and the organizational structure of ICT
IIS2-ICT financing	♦ IIS2.1 - Percent of Internet or ICT costs to the total institutional expenditure ♦ IIS2.2 - Proportion of ICT capital budget from internal sources ♦ IIS2.3 - Total ICT hardware and software costs per 1,000 students	The indicator measures the degree to which an institution has sufficient budgetary allocation for ICT
IIS3 - ICT human capacity	♦ IIS3.1 - Highest qualification of the head of ICT ♦ IIS3.2 – No. of years of administrative experience of the head of ICT ♦ IIS3.3 - % staff who have worked with users for more than 3 years ♦ IIS3.4 – Frequency of upgrading skills for ICT staff	The indicator measures the degree to which an institution has competent and well trained ICT professional and support staff. The ICT staff must be especially well trained in networking technologies.

As an illustration, ICT strategy addresses strategic planning for ICT, the championship of ICT, and the organizational structure of ICT. To be in stage 4 in this indicator, an institution needs to have an ICT policy and strategic plan that is tightly linked to corporate strategic plan and known by most students and staff, have the head of ICT report to the CEO and a member of the top decision-making body of the institution and have the CEO provide the leadership for ICT.

Data for staging this category of indicators was obtained from hard facts questionnaires. We note that stage 3 or better readiness in this category of indicators is a pre-requisite for readiness in all the other indicators especially network access and networked learning.

4. Conclusions and recommendations

This paper has reviewed the existing e-readiness assessment models. It has proposed a new e-readiness assessment diagnostic model based on 17 ICT indicators. It was derived from the CID tool and AAU assessment guidelines. The main contribution of the model is the definition of ICT indicators and sub-indicators with quantifiable targets. These targets were considered meaningful to higher education institutions in countries classified in the Low Average in the ITU ICT Opportunity Index [18]. The model was used successfully in the assessment of 25 higher education institutions in Kenya in the year 2006 [2] and 50 universities in East Africa in 2008 [3]. It was also used in the year 2010 to assess 10 EA universities that developed roadmaps for accession to higher stages roadmaps (results to be published in 2012). Figure 1 shows the radar diagram for the 17 Kenyan universities that were assessed both in 2006 and 2008 for the 17 indicators. This is an example of how the framework has been used.
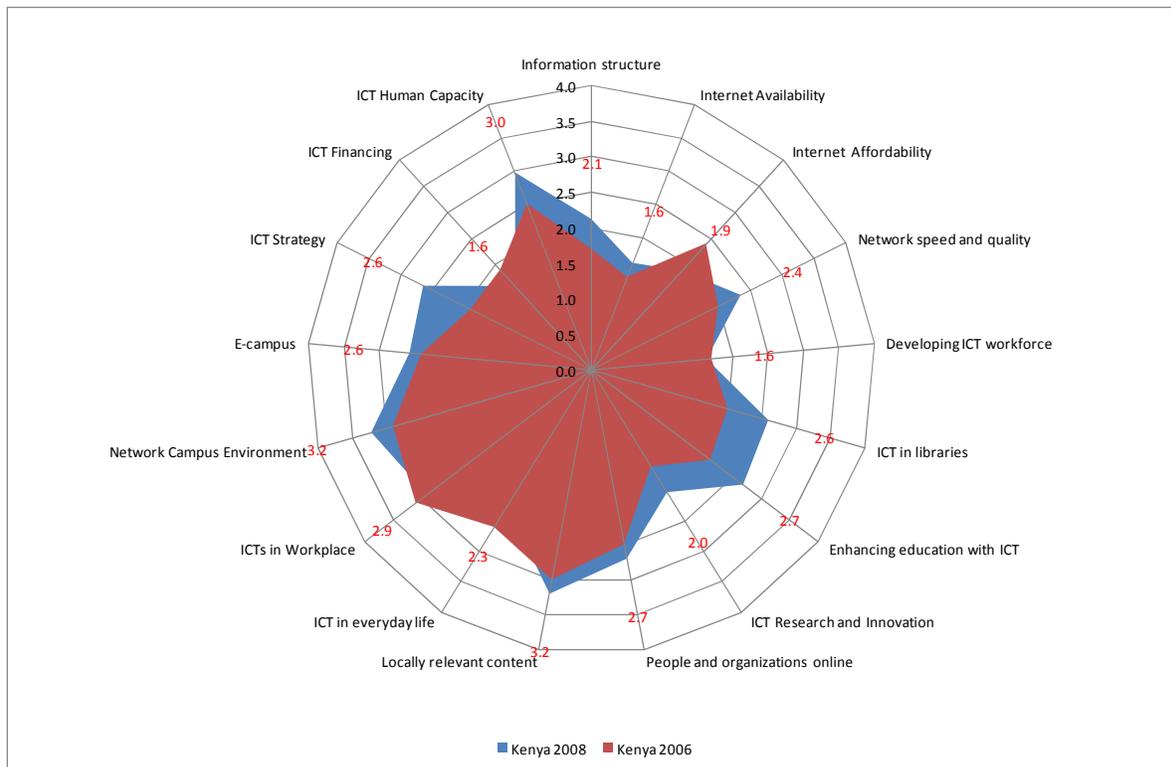

Figure 1 – 2006 and 2008 Comparison of assessment data for 17 Kenya Universities

The researchers found that the following six sub-indicators could be considered the most critical for accession to the networked learning category of indicators:

- Internet bandwidth cost per 1000 students
- Internet bandwidth per 1000 students
- Internet bandwidth or ICT budget as a percent of the total expenditure
- PCs per 100 students
- Extent of ICT strategy implementation
- Integration of ICT in curricula

The researchers have discovered that three of the above sub-indicators indicators are particularly effective in communication with the senior leadership of universities in EA about their e-readiness status:

a) Networked PCs or laptops per 100 students (Stage 2 target is 10 shared and networked PCs per 100 students.
b) Internet bandwidth per 1000 students (stage 2 target is 2 Mb/s per 1000 students)
c) Internet bandwidth or ICT budget as a percent of the total expenditure (stage 2 target is 1.5%)

The proposed higher education e-readiness assessment model will help higher education institutions in economically developing countries to adopt a set of indicators that will help them integrate ICT into teaching, learning, research and management. The proposed model constitutes a relatively sound framework to act as a good starting point for empirical studies on the assessment of the integration of ICT in higher education institutions. Although the model is still being tested and will require further development and refinement, we invite researchers to use and test it in order to build the required knowledge in this area. At the same time, we invite practitioners in institutions of higher learning to adopt the indicators, modifying where necessary, to guide integration of ICT into higher education and increase e-readiness of HEIs.

We recommend further research to establish relationships between the indicators and sub-indicators and to derive a University in developing country e-readiness index.

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