

# Emerging Trends in Information and Communications Technology Education in Kenyan Universities

By  
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## **Abstract**

*Information and Communication Technology (ICT) degree programs in private and public universities remain very popular and attract very good students. In recent past, there has been an increase in the enrolment in ICT degree programs in the traditional areas of computer science, electronic engineering, computer engineering and in the newer areas of information systems and software engineering. This paper identifies some of the local and global drivers of this demand. It then uses the open networking model to analyze the future demand for ICT graduates. Using the model, the paper concludes that the focus of Kenyan universities should be in the academic areas of computer science, information systems and electronic engineering. In order to have an impact on the Kenyan economy and the ICT industry, there is an urgent need for universities to seek professional accreditation of the different ICT degree programs and therefore achieve international standards of quality. The paper recommends adopting the E-campus concept to develop a world-class learning environment for students and faculty that overcomes the low penetration of ICT in Kenya. Although ICT profession will remain popular because of the increasing use of ICT applications in businesses and governments in the region, the challenge for the universities is to attract, retain and develop doctoral-level ICT faculty.*

## **1. Introduction**

In the past 5 years, there has been an increase in the number of Information and Communication Technology (ICT) degree programs offered by Kenyan universities. For example, all of the 13 private universities in Kenya that have been chartered or given interim letters of authority by the Commission for Higher Education (CHE) offer ICT degree programs. The existing public universities continue to introduce new ICT degree programs and to expand the existing ones. The increase in total enrolment means that there is a strong demand for degree-level ICT education in Kenya. However, the author is not aware of any labour market analysis data that the universities have used to start or expand the ICT degree programs.

Apart from the ICT degree programs, most universities now offer some general information technology (IT) courses to all of their students (graduate and undergraduate). This means that there has been a deliberate effort to ensure that

all university graduates are “computer literate” or “IT literate”. Some universities also offer diploma level ICT programs and other non-degree IT programs. Such IT course offerings are outside the scope of this paper.

In this paper, we use the term ICT (or IT) degree program to describe programs in computer science, computer engineering, electronic engineering (includes telecommunications), software engineering and information systems. This is consistent with the “big IT” umbrella term adopted by American Accreditation Board for Engineering and Technology (see <http://www.abet.org>) which accredits ICT degree programs [1]. These ICT professional degree programs have very clearly defined global model curricula developed by the academic and professional communities. For example, the Joint Task Force on Computing Curricula established in 1991 by the Association of Computing Machinery (<http://www.acm.org>), the Association for Information Systems (<http://www.aisnet.org>), and the Computer Society of the Institution of Electrical and Electronic Engineers (<http://www.computer.org>) has developed guidelines for computer science and information among other degree programs [2, 3]. The model curricula define the learning outcomes and content of the ICT professional degree programs and universities and there is an expectation that universities would minimally comply with the guidelines.

The convergence of computing and telecommunications has also resulted in the convergence ICT degree programs, referred to as the “small IT” degree programs by ABET. These are often called B.Sc. in IT degree programs and contain content from the different degree programs (e.g., information systems and computer science). The author is not aware of any country or accreditation body that has developed professional accreditation criteria for such new programs. This is a work in progress among many professional bodies and even at ABET [1]. This paper will therefore address emerging undergraduate ICT education issues of the “big IT” degree programs that have well defined professional standards and accreditation criteria.

We note that all of these IT programs (big IT or small IT) are being offered because there is a strong global demand for IT professionals. For example, some developed countries, notably, the US, UK, and Germany, have introduced special Visa terms for IT professionals who wish to migrate from developing to the developed countries. This paper will highlight the global knowledge economy drivers for the strong demand for ICT education and the development of ICT education standards. Other local drivers of the demand for ICT education include the rapid growth of the telecommunications and Internet infrastructure, increasing use of computer-based information systems in large medium, and small-sized enterprises in Kenya and in the region.

We introduce a layered method of analysing the relative demands of the different ICT degree programs and recommend some possible areas of focus for universities in Kenya. Although assessment of ICT degree programs offered in Kenya is outside the scope of this paper, anecdotal evidence suggests that most of the ICT degree programs do not meet global professional accreditation standards. This is troubling because of the global nature of ICT professionals. There is therefore an urgent need to conduct detailed assessment of all ICT degree programs offered in Kenya to identify areas of weakness and suggest some remedies.

This paper is organized in the following way. Section 2 identifies the key drivers of the high demand for ICT education in Kenya and in other parts of the world. In Section 3, we use the open networking model to analyse the local and global ICT education opportunities and the implication for ICT students, graduates and universities in Kenya. Section 4 highlights the key indicators of the quality of ICT degree program (faculty, students, and learning environments) and the urgent need for professional accreditation. In Section 5, we describe the E-campus innovation that could provide a world-class learning environment for ICT students in a country with low Internet and ICT penetration levels such as Kenya. Section 6 contains our conclusions.

## **2. Drivers of the Strong Demand for Professional ICT Programs in Kenya.**

### **2.1 Current demand for ICT degree programs**

As we mentioned in the introduction, all of the universities in Kenya have either expanded their ICT degree programs or introduced new ICT degree programs in the past 10 years. The Joint Admission Board (JAB) admits government-sponsored students into public universities. The 10,000 students admitted into public universities by JAB last year represent only 14.7% of the total student population who were admissible into university that year based on the national university entrance examination. The JAB admission data of 1999 presented on Table 1 shows that demand for B.Sc. in Computer Science and in Electronic Engineering, measured using the first choice applicants against available spaces, was very high in the 1999/2000 and only "A" students could get admission into the programs. We note that in 1999, only computer science and electronic engineering degree programs could be classified as ICT degree program in 1999 in the public university system. The 2006 JAB data shows that new ICT degree programs in computer engineering, software engineering, telecommunications and information technology, and computer technology are being offered in the public universities. At present, only the private universities offer degrees in information systems at the undergraduate level.

Table 1: JAB popularity of degree programs by first choice in public universities

ACADEMIC PROGRAM	Univ #1		Univ #2		Univ #3		Univ #4		Univ #5		Univ#6	
	CAP	Cho-I	CAP	Cho-I	CAP	Cho-I	CAP	Cho-I	CAP	Cho-I	CAP	Cho-I
BA	500	204	400	053	-	-	25	002	300	03	080	002
B.Sc							0			9		
B.Ed (Arts)	290	129	150	031	210	051	12	014	200	03	060	002
							0			3		
	340	166	400	242	-	-	16	020	300	07	160	006
							0			2		
B.Ed (Sci)	-	-	180	168	-	-	16	030	060	07	050	009
B.Sc (CS)							0			0		
B.Sc (Agric)	030	180	-	-	020	029	02	012	-	-	030	071
Law							5					
	120	016	-	-	-	-	05	004	120	01	-	-
							0			6		
	120	495	-	-	-	-	-	-	040	13	-	-
										9		
Medicine	120	666	-	-	-	-	-	-	040	16	-	-
Nursing										6		
B.Ed (Music)	030	236	-	-	-	-	-	-	020	12	-	-
										4		
B.Ed (French)	-	-	025	016	-	-	-	-	-	-	010	000
B. Com	-	-	040	018	-	-	-	-	-	-	040	001
	200	679	-	-	-	-	03	030	070	26	120	068
							0			3		
B. Arch	030	095	-	-	020	048	-	-	-	-	-	-
BSc (Elect.)												
University #2ect.)	060	143	-	-	030	175	-	-	030	04	-	-
										2		
B. Pharm	040	249	-	-	-	-	-	-	-	-	-	-

Source: 1999/2000 JAB data

In general, students base their career decisions on the potential job market as reflected in job advertisements in the local media, the career paths of the alumni or others in the same profession as well as general perceptions of the future career prospects of some professions. The perceptions are not always based on concrete market analysis data. The high demand for ICT programs recorded by all universities in Kenya suggests a positive perception of ICT careers.

Universities on the other hand should base their decisions on the type of degree programs they offer, labour market analysis data, and global industry trends. At this time, we do not have data to show how universities are making decisions to introduce or expand ICT degree programs. It is even possible that universities are using the perceptions of the student body or their faculty without any underlying data analysis. This will not be acceptable in the future.

Although labour market analysis data are currently not available (the last study done by CHE was in 1994 and is now outdated and was not widely disseminated), it is still possible to forecast demand based on certain industry indicators as well as global trends. We suggest that forecasts based on such industry and global trends are necessary for reviewing ICT curricula and also in making decisions to start new ICT degree programs. We identify four factors that will influence the decisions on ICT education in the future, namely:

1. The rapid growth of the telecommunications and Internet infrastructure in Kenya and in the East African region
2. The increasing automation of businesses and government processes in Kenya (i.e., implementation of E-business and E-government strategies).
3. Globalisation and the global knowledge economy that forces all countries to achieve a high degree of networked readiness in order to be competitive.
4. Convergence of computing and telecommunications

In the following sub-sections, we briefly describe how each of the above factors will influence the demand and the curricula of future ICT degree programs.

## **2.2 Growth of the telecommunications and Internet infrastructure**

The Kenya Communications Act of 1998 liberalized the telecommunications sectors in Kenya. In 1999, Kenya had only 17,000 mobile subscribers. In July 2006, there were close to 6.5 million mobile subscribers according to the Communications Commission of Kenya (CCK), the national communications regulator (<http://www.cck.go.ke>). This has required huge investments in the telecommunications infrastructure by the mobile network operators.

Apart from the mobile network infrastructure, there has been an increase in the number of wireless voice and data access networks offered by the fixed operators. There are now over 70 licensed Internet Service Providers in Kenya and at least two operational local loop operators (<http://www.cck.go.ke>). The public data network service infrastructure continues to expand and by August

2006, there were 3 optical fibre links from Nairobi to Mombasa operated by three different companies.

The broadcasting sector has also grown dramatically since 1998. There are many FM radio stations and many TV stations. Each of these TV or FM stations needs ICT graduates to operate. This is an area that will continue to grow especially as electronic media houses start developing locally relevant content (<http://www.cck.go.ke>).

It is thus clear that the growth and expansion of the telecommunications infrastructure in Kenya and in the neighbouring countries will only be sustained by a large supply of ICT graduates from local universities. In the future, we expect all the telecommunications operators and broadcasters to provide value added services based on networked applications as a way of increasing their revenues. Such networked applications will be developed by specialized ICT graduates. This will further increase the demand for information systems and computer science graduates. The ICT graduates will be required to design, install, and maintain the telecommunications infrastructure and to develop new innovative networked applications for businesses and government.

### **2.3 Implementation of E-business and E-government strategies**

Most of the 50 companies listed on the Nairobi Stock Exchange (NSE) (<http://www.nse.co.ke>) have created fully networked organizations and have automated their mission-critical business applications. For example, companies in the financial sector have high degree of ICT readiness and have well-established ICT departments. Many state corporations also continue to automate their business processes and will need skilled ICT graduates to maintain the ICT infrastructure, develop applications and maintain the mission-critical applications.

All the companies are currently developing applications to support interactions with their customers and suppliers. This will mean they will need more computer science and information systems graduates. Electronic engineers will also be required to maintain the networked infrastructure of the companies.

Although the small and medium enterprises (SMEs) have not embraced ICT as much as the large companies, this is expected to be the area of growth in the future. SMEs require relatively cheap software solutions and will depend on local innovative software developers to automate their processes. Again, information systems and computer science graduates with software development skills as well as business skills will continue to be in high demand in this sector. As

always, SMEs that export products or import their inputs have a greater need to automate their operations [4].

Apart from the E-business strategies of the private sector, the government of Kenya released an ambitious E-government strategy in 2004 [5]. Although implementation has been slow because the networked infrastructure was not in place, it is expected that there will be a huge demand for E-government applications and for ICT professionals to maintain the mission-critical E-government applications in the period 2006-2010. The ICT industry in Kenya is also expected to expand once full implementation of E-government strategy starts. Again, we expect a large demand of ICT graduates in all areas but especially in electronic engineering, computer science and information systems.

## **2.4 Convergence of computing and telecommunications**

Digital technology allows convergence of media (print, radio and television) with telecommunications and computing (hardware and software). The digital convergence leads to the following:

- a. The convergence of the telecommunications, broadcasting and Information Technology industries (now referred to as ICT industry or sector)
- b. The convergence of services and markets (e.g., Internet service providers can also create content for broadcasting)
- c. Increasing overlap of telecommunications and content and/or broadcasting regulation.
- d. Increasing overlap of exit requirements of ICT degree programs

The increasing overlap of the ICT degree programs means that universities must continue to review ICT curricula and to engage the industry in such curriculum reviews. It also means that some innovative universities will continue to create new hybrid degree programs that will serve the emerging needs of the industry.

One major challenge of the changes in the industry and convergence is the need to develop post-graduate lifelong learning and graduate degree programs in ICT. At present, only three universities in Kenya offer postgraduate degree programs in ICT and this is expected to be an area of growth in the future.

## 2.4. Globalization and the knowledge economy

Although it appears that it is the local conditions that will determine the type of ICT degree programs offered in local universities, it is also a fact that ICT profession is global and is “portable”. ICT is also one of the pillars of the emerging global knowledge economy. That means that the E-readiness or ICT readiness of countries will determine their competitiveness in goods and services. There will also be competition for ICT graduates and programs. ICT skills will be in demand in other parts of the world. ICT graduates could also develop products for other parts of the world because of globalization as happens in India.

Universities therefore need to understand the global trends driven by the knowledge economy because that will affect their ICT faculty and the quality benchmarks of their ICT graduates. The World Bank Institute has identified the four main pillars of a knowledge economy [6], namely:

- a. **Economic and institutional** pillar, which provides incentives for the efficient creation, dissemination and use of existing knowledge
- b. **Education pillar** that develops an educated workforce that can use knowledge effectively
- c. **Innovation pillar** that ensures that global knowledge diffuses into the nations and adapts it for local use and creates new local knowledge.
- d. **Information and communication technology infrastructure (ICT)** pillar that facilitates the effective communication, dissemination and processing of information.

We note that the ICT pillar is required to support all of the other pillars, especially the innovation pillar.

The World Bank now measures and ranks the competitiveness of nations using the knowledge economy index (KEI) and the knowledge assessment methodology (<http://www.worldbank.org/kam>). In a knowledge economy, the development and competitiveness of countries will depend on their ability to leverage local and global knowledge. It has been shown that the KEI is directly proportional to the Gross Domestic Product (GDP) of a country. Developed countries have a relatively high KEI as shown in Figure 1. Thus, emerging economies will have to develop their ICT human capital and infrastructure in addition to other pillars of the knowledge economy in order to remain competitive.

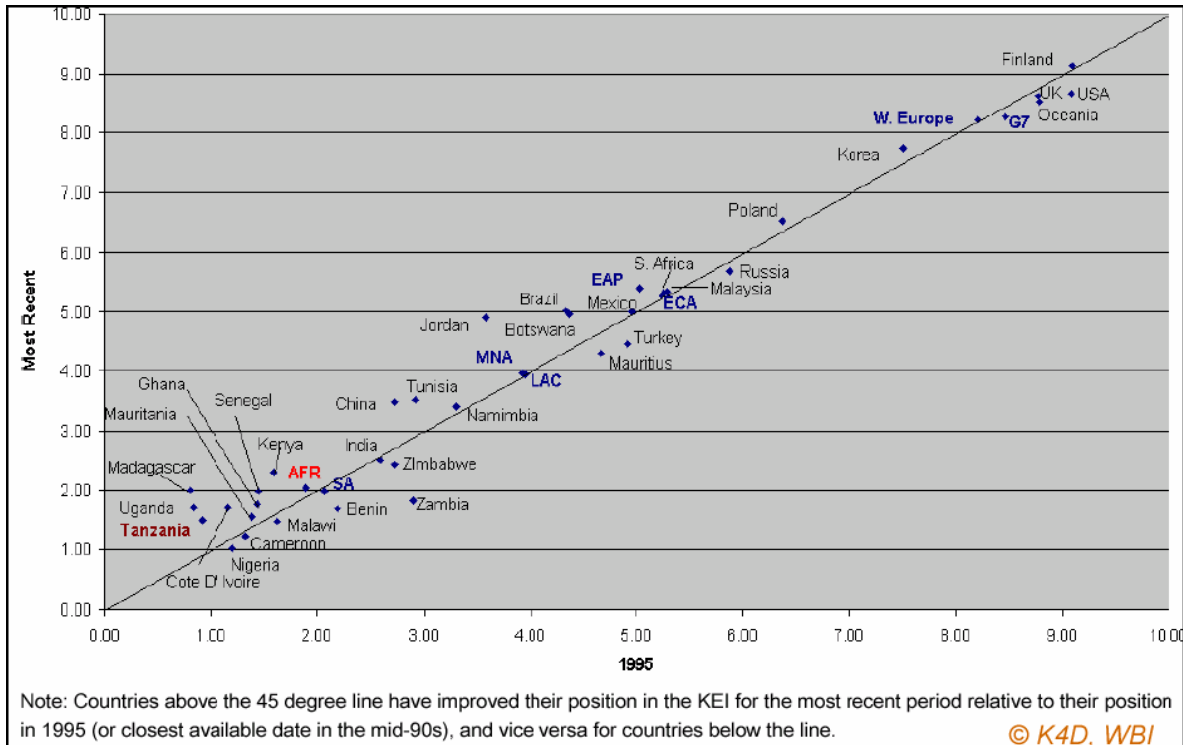


Figure 1: Global Map - Knowledge Economy Index

Note that Kenya had a KEI of only 2.2 while Finland has a KEI of nearly 9.00. The KEI tracks the GDPs.

Thus, the need to increase investments into the firm-level and national-level ICT infrastructures and applications will continue to increase demand for ICT graduates. However, there is still a need for a university in an emerging economy to determine the relative importance of the different ICT degree programs. For example, should a university offer both computer engineering and computer science degree programs and what should be the relative enrolments? Students entering universities also need to make decisions about the demand for specific degree programs without the benefit of market analysis data.

In the next section, we show how a layered model of the ICT industry could be used to determine the relative sizes of different ICT degree programs (e.g., electronic engineering or information systems). A layered model requires a detailed understanding of industry trends and country-level opportunities in the ICT sector. We note that any errors in determination of sizes of degree programs will mean wasted resources for both the university and the students.

### 3. Analysing Emerging ICT Education Opportunities Using the Open Networking Model

Table 2 shows the open networking (ON) model [7]. We have adopted the model to estimate the relative sizes of the different ICT degree programs using emerging ICT industry structures.

Table 2: Open networking model

<b>Networked Applications</b> E-mail, fax, telephony, videoconferencing, TV. E-games, Web browsing, Web casting. Interactive education, interactive TV, Image server.
<b>Interoperability (Middleware)</b> Name servers, security, Privacy, Directories ... Intelligent agents, distributed processing environments ...
<b>Internetworking – Internet Layer 3 &amp; 4</b> TCP/UDP end-to-end transport, IP/RSVP flows Operating systems
<b>Digital pipes and hardware (TCP/IP Layer 1 &amp; 2)</b> Computing services: Computing hardware and devices Telecom services: POTS, ISDN, ATM, Wireless ... TV services: CATV, DSB, VOD, Data pipes (LANS, Leased lines, Modems)

#### 3.1 Data pipes and hardware layer

The bottom layer of the ON model provides the foundational computing and telecommunications services. This includes the computer hardware and associated memory, the data pipes used to carry digital data, and the local and wide area network infrastructures. The skill set required in this layer is provided by electronic engineers, computer engineers, and telecommunications engineers. However, some computer science graduates also work in this area because of the pervasive and embedded computer systems that are software driven.

The supply of digital pipes and hardware is dominated by a few very large companies. For example, Intel dominates the electronic device market for processors, memory, and digital signal processing chips. Manufacturing of the electronic devices and hardware is mostly in the Far East countries of China, Taiwan, and South Korea. It is unlikely a country like Kenya could compete in

this area. It is therefore unlikely that the demand for the electronic engineer will be very high and also there would be a big difference in the areas of specializations in Kenyan universities.

Apart from the computing and telecommunications devices, the ICT industry in bottom layer is also dominated by system integrators who develop the telecommunications and computing systems. Although there are more players at the system level, the ICT industry is again dominated by a few very large corporations. Examples include Siemens, Philips, Nortel, Cisco, Ericson, and Nokia that supply the radio and optical fibre links, telephone exchanges, routers, base stations, and mobile devices. Although manufacturing opportunities are possible for developing countries with low labour costs, China and other Far East countries are already ahead of African countries in this market.

The ICT professionals trained in these areas in Kenya would therefore be employed to install, configure, and maintain the complex telecommunications networks and systems. The skill sets for supporting such complex ICT infrastructures is provided by electronic engineers, computer engineers, and computer scientists in smaller numbers. These are the same ICT professionals required to maintain the firm-level ICT infrastructures. We therefore expect that there will be a high demand for ICT professionals in these area but the areas of specialization would have to be appropriate to the industry needs in Kenya and the region. For example, no need to train the engineers for VLSI design and manufacturing when job opportunities in those areas do not exist. However, the foundational components of the curricula would still be similar to that offered in developed countries.

### **3.2 Internetworking layer**

The Internetworking layer is similar to the Internet Protocol (IP) and Transport layers in the TCP/IP protocol suite. The internetworking layer is now dominated by Internet protocols for voice, data, and video services. The skill set in this area is again provided by electronic engineers (includes telecommunications engineers), computer science, computer engineering, and information systems degree programs. Since these ICT skills are required by both the infrastructure providers (e.g., Safaricom and Kenya Data Networks) as well by individual firms that need to be networked, we expect a strong demand for these types of ICT graduates.

We note that it is relatively less expensive to develop ICT graduates to work in this layer. The main investments for universities are in hiring and retaining quality faculty and in specialized laboratories.

### **3.2 Interoperability or middle-ware layer**

This is the layer that allows different networked applications to interoperate. There are only a few dominant middleware products (e.g., CORBA-based middle-ware products). This is a software intensive area. The skills set required to work effectively in this area are acquired in computer science, software engineering, and some specializations of electronic engineering. Our considered view is that in Kenya, it would be better to train broader-based electronic engineers rather than computer engineers. That means it would be unnecessary to invest in specialized computer engineering facilities.

### **3.3. Networked applications layer**

This is the area that needs the largest number of ICT professionals because of the large number of customized networked applications that need to be developed. Although a few software companies still dominate some of the mission-critical software applications (e.g., Enterprise Resource Planning dominated by SAP), specialized ICT professionals are required to set up and support the complex systems. The relevant ICT degree programs for working in this area include information systems, computer science, and software engineering. We estimate that a much larger number of information systems professionals are required in this layer because of their deeper understanding of business processes and strategies. Although the ICT infrastructure required to support an information systems degree programs is much cheaper than that for electronic engineering or computer science, it is much harder to recruit and develop ICT faculty in the information systems area.

In order to train ICT professionals for each of the layers of the ON model, it is necessary to establish world-class training facilities. This is a challenge because Kenya has a relatively low level of E-readiness when measured using the Networked Readiness Index as Table 3 illustrates. NRI measure the readiness of individuals, businesses and governments to benefit from ICT developments.

Table 3: Networked readiness index (NRI) ranking for 2004 and 2005

	USA	Kenya	South Africa	Mauritius
2004 (out of 1024 countries)	4	75	37	47
2005 (out of 1151 countries)	1	91	34	45

Source: World Economic Forum

How is it then possible for universities in Kenya to provide ICT education at the same level of quality as countries with high NRI ranking such as the US (NRI ranking directly proportional to the GDP of countries)? The next section introduces the innovative E-campus concept that could be used to develop “islands” of world-class ICT infrastructures to overcome the limitations of a low NRI ranking. Some universities in Kenya and many universities in India have followed this model with very good results.

#### 4. The E-campus Innovation and Quality of ICT Education

In this paper, an E-campus is defined as an information system enabled campus [7]. The components of an information system include the networked infrastructure, the automated business procedures and processes, and the people who develop, maintain, and use the systems for their work. In a typical university campus, this would mean a fully-networked campus, with networked mission-critical applications teaching, learning, and managing a university, and qualified ICT workforce and professionals.

An E-campus ensures that a university as a community acquires a high degree of e-readiness even when the country has a low-level of readiness. Graduates of such a university would then be the change agents in the institutions they join after graduating (e.g., governments, educational institutions, or SMEs).

The networked infrastructure component of an E-campus is relatively cheap to set up because of the falling prices of ICT products. However, since an E-campus still requires a relatively high bandwidth connection to the global Internet, this increases the operational costs. For ICT education, it turns out a very high speed connection is not always required especially if most of learning resources are placed within the E-campus.

The networked application and the ICT professionals' components of the E-campus are also relatively expensive and increase the operational costs. However, it has been determined that 5% of the revenue of a university with 3,000 students would be sufficient to set-up and maintain a world-class E-campus. This is affordable by most universities in Kenya. An ongoing E-readiness survey of universities in Kenya will derive the appropriate level of funding for an E-campus.

## **5. Quality of ICT Degree Programs**

### **5.1 Professional accreditation of ICT degree programs**

As explained in the introduction, the "big IT" degree programs have global curricula guidelines that have been developed by the global academic community in collaboration with the umbrella of professional associations and accreditation boards. Thus, there is a universal understanding of what needs to be taught in a computer science or information systems degree programs. The key motivation for developing international model curricula is the fact that ICT professionals could work anywhere in the world and outsourcing of software development and ICT manufacturing is now a well established industry.

The danger is that a university in a developing country does not need to comply with the professional standards, especially because the ICT industry is not highly developed in such countries (nobody really will complain). For example, it is estimated that India produces 280,000 engineering graduates per year but only 25% meet international standards [Newsweek article). This is a great waste of resources. In Kenya, anecdotal evidence from local industry suggests that there is some dissatisfaction with depth of technical knowledge of the ICT graduates who wish to develop advanced networked applications or to operate the complex telecommunications infrastructure.

One way to ensure compliance with global standards is to seek professional accreditation of ICT degree programs. For example, the Institution of Engineering and Technology (IET) accredits universities offering ICT degrees. Accredited programs then attract high quality faculty and students. For example, Vellore Technical University in India is a private university that is now accredited by IET.

This makes it easier for ICT graduates to find jobs in India and in other countries. (see <http://www.iee.org/professionalregistration/accreditation/International>

Directory of Accredited Degrees -Issue9.pdf). ABET accredits ICT degree programs in the US but institutions outside could also apply for accreditation.

## 5.2 Assessing the quality of ICT degree programs

In general the quality of an ICT degree program could be expressed by the following formula shown on equation (1):

$$\text{Quality of ICT education} = QS * QF * QL * QC \text{ ----- (1)}$$

Where QS = Quality of the students

QF = Quality of the faculty

QL = Quality of learning environment (E-campus)

QC = Quality of the curriculum

Notice that the formula is multiplicative and all the variables must be of high quality. The author is not aware of any assessment studies that have been conducted in Kenya to rank or establish the quality of ICT degree programs. There is an urgent need to assess the status of ICT degree programs using the above framework.

It is also a fact that none of the ICT degree programs are now professionally accredited by the international professional associations and institutions. This could be the reason why certification courses offered by Microsoft (MCSE) or Cisco have become popular with ICT graduates and industry. The Computer Society of the Institution of Electrical and Electronics Engineers (IEEE) has introduced the Certified Software Development Professional Program for software developers but this is not yet popular in Kenya (<http://www.computer.org/portal/pages/ieeecs/education/certification>). This certification would be required by ICT professionals who intend to develop software for global markets or for mission-critical application where the engineering discipline is necessary (e.g., medical or financial applications). There is also no certification for the more complex telecommunications and networked applications infrastructure that will be needed in the future. It is our considered view that Kenyan universities and ICT departments should seek professional accreditation using global standards since the ICT profession is global in nature.

In order to develop accreditation standards in Kenya, it will be necessary first to assess the status of ICT education in Kenya in terms of learning facilities, qualifications of faculty, and the learning outcomes achieved by the ICT graduates. The author is currently involved in a research project to establish the status of ICT education in Kenya.

## 6. Conclusions

The demand for ICT graduates continues to grow because of the growth and expansion of ICT infrastructures and application in Kenya and in the region. Many businesses and the government are expected to continue automating their business processes. Advertisements in the local and international media show that there is a strong demand for ICT graduates in all areas and this is probably driving the demand for ICT degree programs.

Consequently, all Kenyan universities have introduced at least one “big IT” degree program in the areas of information systems, computer science, electronic engineering, software engineering, computer engineering, and other variations of ICT degree programs. Most of these programs are developed without explicit reference to the model curricula developed by professional ICT associations (e.g., ACM, AIS, and IEEE) in collaboration with the academic community. In many cases, the programs are structured in ways that are similar to similar programs in other countries especially UK, US or Japan. The author is not aware of any structured participation of the local professional associations and industry in the development of ICT degree programs.

In some cases, the curricula of some of the older ICT degree programs in electronic engineering or computer science have not been reviewed in response to global trends. Neither have the teaching labs been modernized nor the older ICT faculty trained in emerging technologies and teaching methods. Anecdotal data suggests that many ICT degree programs are not achieving the desired learning outcomes in general and this could affect the innovativeness of the graduates. There is therefore an urgent need to develop local accreditation standards using a participative process involving the Commission for Higher Education as the accreditation body, professional ICT associations, and local industry, and ICT departments in universities.

Apart from the local drivers for demand for the high demand for ICT graduates in Kenya, this paper has shown that the emerging knowledge economy will increase the demand for ICT graduates in the future. The convergence of telecommunications and computing is also driving changes in curricula and a proliferation of the converged “small IT” degree programs that do not yet have clear accreditation standards and criteria.

One of the problems for ICT students, graduates, and universities is to determine the relative needs of different ICT skills and knowledge elements. This paper has used the open networking model (a layered model) to show that Kenyan

universities will need many more computer science and information systems graduates than say computer engineering graduates. The problem is that there is a shortage of ICT faculty in all these areas who have the relevant academic qualifications as well as professional industry experience. At present, only the University of Nairobi has a doctoral program in computer science and information systems but it only graduates an average of 1 PhD per year. Universities in Kenya could adopt the consortium method to develop doctoral faculty in Kenya similar to model used by the African Economics Research Consortium (<http://www.aercafrica.org>) that pools educators and researchers in economics from all over Africa to train doctoral students.

Apart from developing ICT faculty, universities in Kenya will have to create world-class specialized labs for educating innovative ICT professionals. Industry-university links could support such facilities. We have shown that the E-campus model can be used to overcome the limitations of the low networked readiness index ranking of Kenya and the neighbouring countries. That is, the low NRI ranking is actually an opportunity for Kenyan universities because it means fast growth of the ICT sector in the foreseeable future.

The ICT profession is portable and global. It will continue to attract the best students. Universities need to offer the best ICT education to the bright students because of the impact on performance of businesses and government.

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