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Internet of Things (IoT) and quality of higher education in Kenya; A literature review

Nicholas Letting and James Mwikya
Management University of Africa. P. O. Box 29677 – 00100, Nairobi.

Abstract

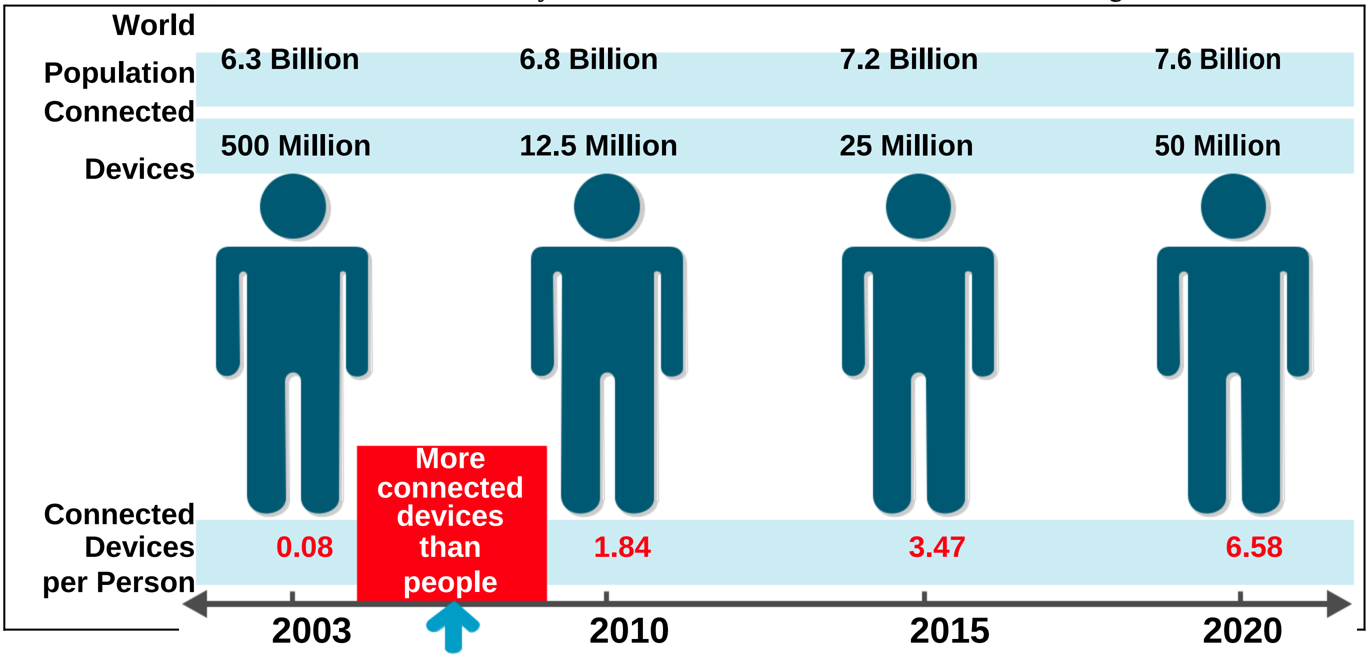
African governments have declared the twenty-first century 'as a knowledge era'. Kenya in particular, education more so university education is expected to play an increasingly greater role in socio-economic development by training skilled manpower and producing and disseminating the knowledge required for a knowledge-driven economy. As such, this education—technology relationship has been spotlighted as part of education policy and practice. Complaints about falling education standards, unemployable students, redundant curricula and backward institutional organisation, have therefore been punctuated by the debates about the role and place of technologies in the classrooms. Internet of Things (IoT) is a rapidly growing network of a variety of different 'connected things.' Use of IoT in academics is a new wave of change that has brought new opportunities and possibilities for the improvement of both teaching/learning process and educational institutions' infrastructure. The study recommends that the enterprise architecture in the institutions of higher learning need to reduce latency time because of the demand for content in instructional technologies. There is need to develop new strategies that consider an individual's privacy, choices and expectations, whilst still promote innovation in new technologies and services. Higher education must come up with new ideas to finance an information technology infrastructure and services.

Key Words: Internet of Things (IoT), Technology, Education, Infrastructure

Introduction

In 19th Century Spanish, Antoni Gaudí "God's Architect" pioneered a fluid buildings' style that seamlessly integrated visual and structural design, creating them as a three-dimensional scale models and molding the details as he conceived them (Brown and Eric, 2016). The expressive curves of his buildings were not just ornamental disguises but also integral parts of the load-bearing structure. Regrettably, similar fusion has yet to happen for the electronic infrastructure. It can simply be stated that the Internet of Things (IoT) also known as the" Internet of Objects", is the network of physical devices, vehicles, home appliances and other items embedded with electronics, software, sensors, actuators, and connectivity which enables these objects to connect and exchange of data (Brown and Eric, 2016). Each thing is uniquely identifiable through its embedded computing system but is able to inter-operate within the existing Internet infrastructure (Brown and Eric, 2016). According to Wigmore, (June 2014), as of 2016, the vision of the Internet of things has evolved due to a convergence of multiple technologies, including ubiquitous wireless communication, real-time analytics, machine learning, commodity sensors, and embedded systems. This means that the traditional fields of embedded systems, wireless sensor networks, control systems, automation (including home and building automation), and others all contribute to enabling the Internet of things. In 1999, seven research universities located across four continents were chosen by the Auto-ID Center to design the architecture for IoT (Marquez, 2016). The research universities were to explore more on networked radio frequency identification (RFID) and emerging sensing as researched by the Massachusetts Institute of Technology (MIT) from work at the Auto-ID Center (Marquez, 2016).

In 2003, there were approximately 6.3 billion people living on the planet and 500 million devices connected to the Internet (Cisco IBSG, 2010). According to Cisco IBSG (2010), by dividing the number of connected devices by the world population, it is found that there is less than one (0.08) device for every person. IoT didn't yet exist in 2003 because the number of connected things was relatively small given that ubiquitous devices such as smart phones were just being introduced. For example, Steve Jobs, Apple's CEO, didn't unveil the iPhone until January 9, 2007 at the Macworld conference. Explosive growth of smart phones and tablet PCs brought the number of devices connected to the Internet to 12.5 billion in 2010, while the world's human population increased to 6.8 billion, making the number of connected devices per person more than 1 (1.84 to be exact) for the first time in history (Cisco IBSG, 2010). It is estimated that IoT was "born" sometime between 2008 and 2009. The Internet doubles in size every 5.32 years (Evans, 2011). CISCO (2015) indicate that "it has been predicted that by 2015 there will be 25 billion devices, 50 to 100 billion devices by 2020 connected to the Internet" As shown in figure 1.



Source: *Cisco IBSG, April 2011*

Figure 1: *The internet of Things Was "Born" Between 2008 and 2009, expected penetration of connected objects by the year 2020.*

In Kenya, the ground is well equipped for IoT, according to sector statistics released in third quarter of financial year 2017/18 by the Communications Authority, the data shows (figure 2) that the mobile penetration in Kenya was over 90% of the total population (Communications Authority of Kenya, 2017).The number of active mobile subscriptions rose from 41.0 million recorded in the first quarter to 42.8 million subscriptions, which marked a growth of 4.4 per cent over the period (Communications Authority of Kenya, 2017). Subsequently, the mobile penetration level increased to 94.3 per cent from 90.4 per cent recorded in the preceding quarter (Communications Authority of Kenya, 2017). Smartphone penetration in Kenya as of April 2017 had grown to more than 60 per cent of the population (White Paper, 2017).

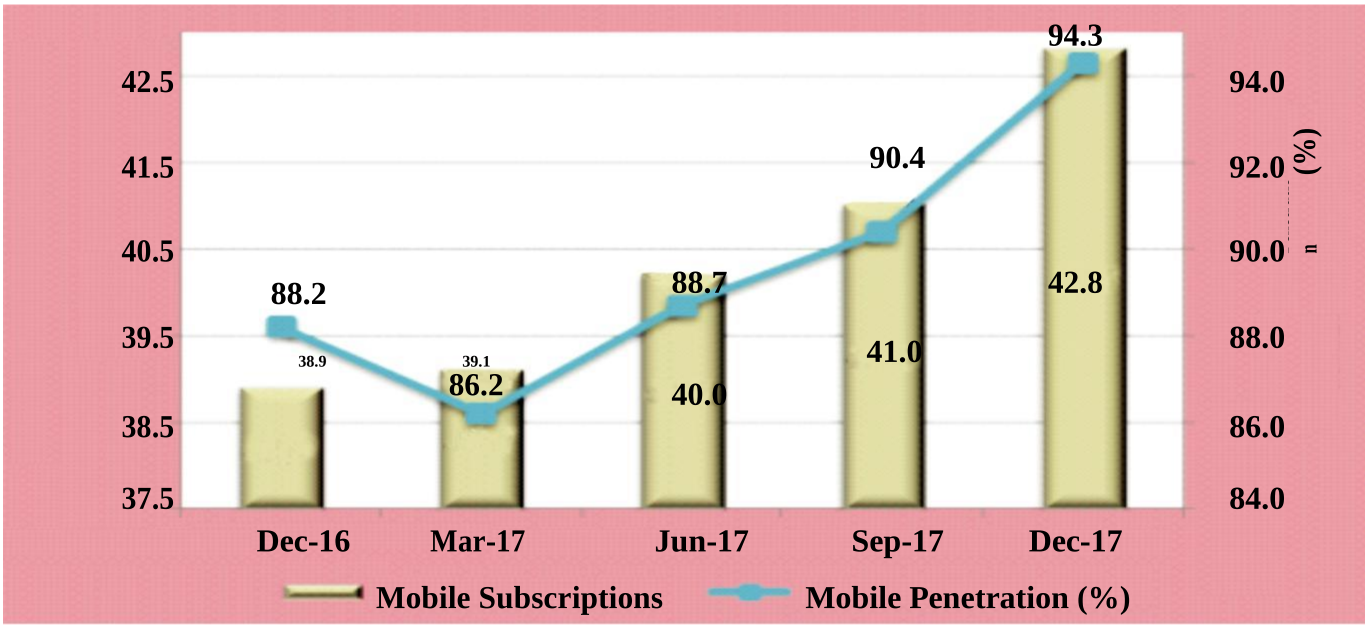


Figure 2: *Mobile Subscriptions in Kenya*

Source: *Communications Authority of Kenya, 2017*

The internet subscriptions grew to 33.3 million during the quarter under review up from 30.8 million subscriptions recorded (figure 3) on the previous quarter marking an 8.0 per cent growth.

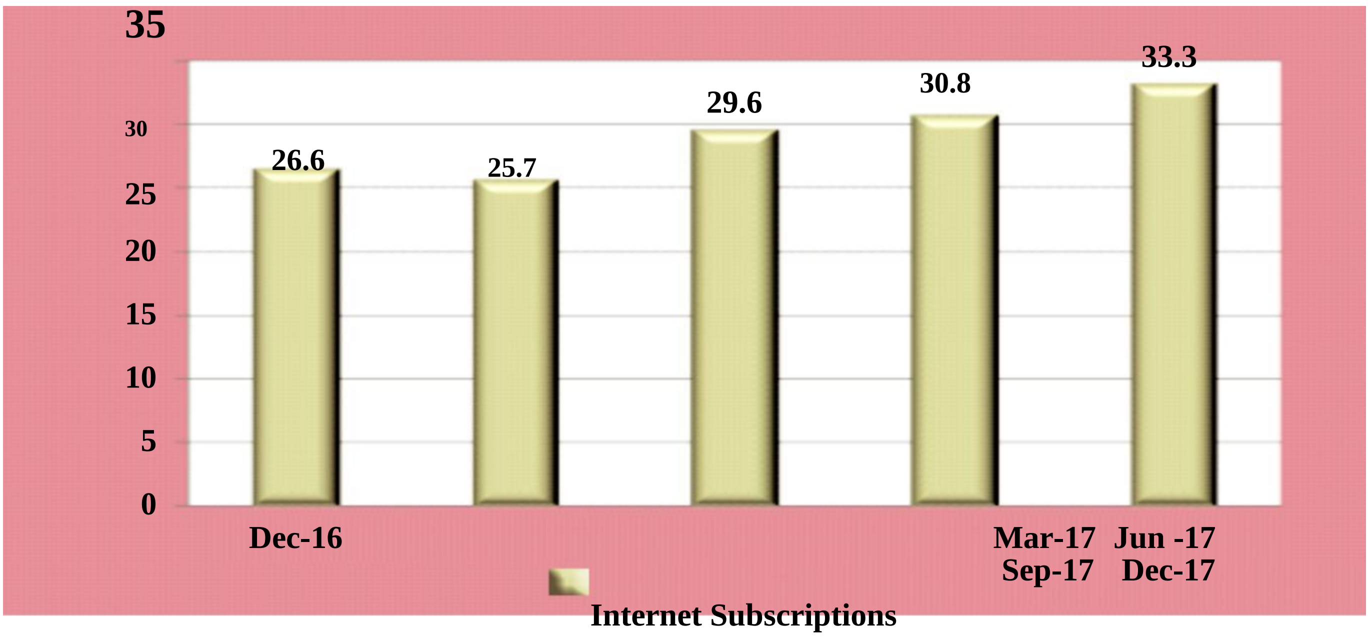


Figure 3: *Internet Subscriptions in Kenya*

Source: *Communications Authority of Kenya, 2017*

The total number of broadband subscriptions stood at 18.0 million up from 17.6 million subscriptions (Figure 4) registered in the previous quarter. This translated to broadband penetration level of 39.7 per cent during the period under review (Communications Authority, 2017).

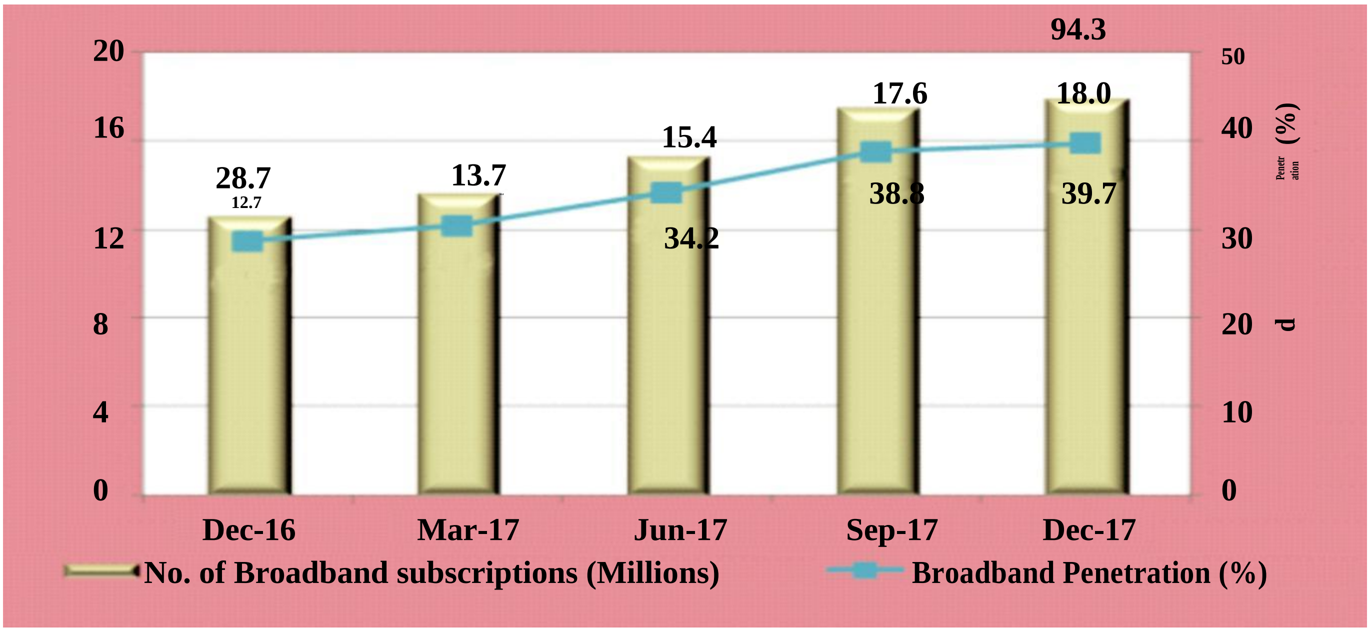


Figure 4: *Broadband Subscriptions in Kenya*
Source: *Communications Authority of Kenya, 2017*

Cloud computing is an information technology (IT) paradigm that enables ubiquitous access to shared pools of configurable system resources and higher-level services that can be rapidly provisioned with minimal management effort, often over the Internet (Oestreich and Ken,2010). Cloud computing relies on sharing of resources to achieve coherence and economies of scale, similar to a public utility (Rao *et al.*, 2012). Xiaohui (2013) argue that Cloud computing is the most important part of IoT, which not only converges the servers but also processes on an increased processing power and analyzes the useful information obtained from the sensors and even provide good storage capacity as shown in the Figure 5.

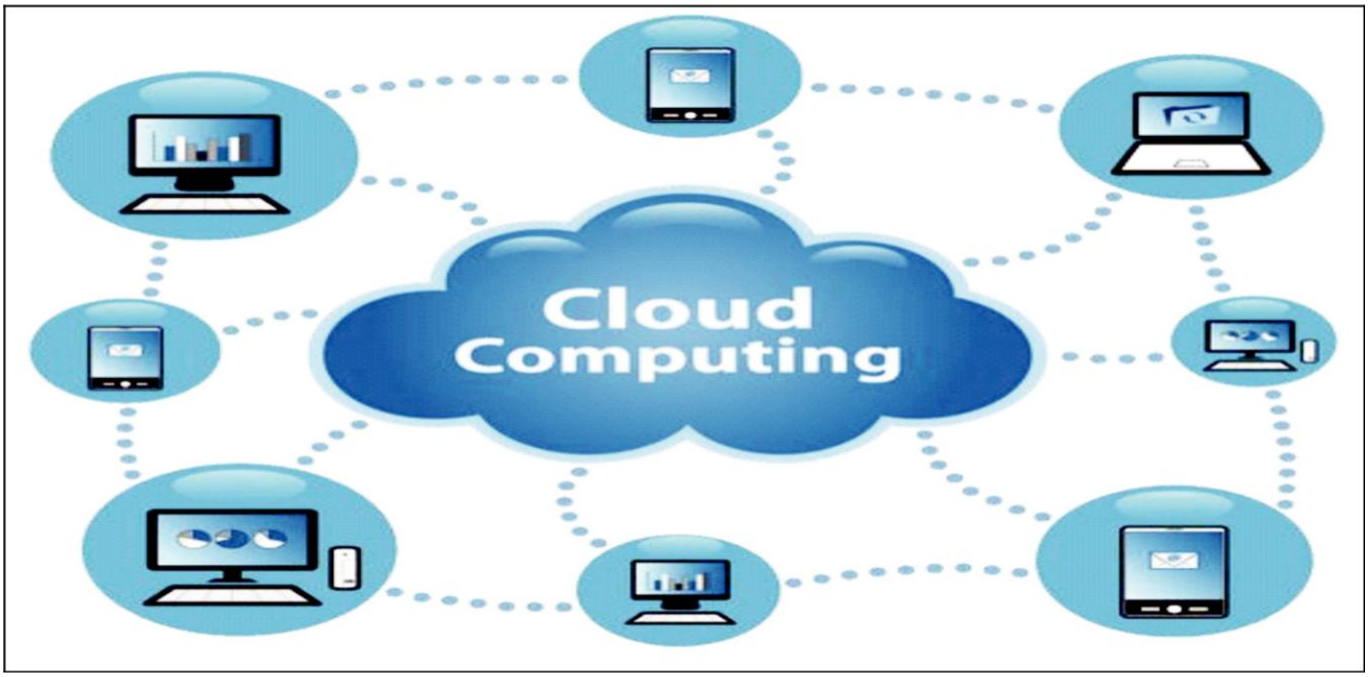


Figure 5: *Cloud Computing Scenario*
Source: *justscience.in/cloud-computing*

Rao *et. al.* (2012) argues that these technologies are responsible for the connection between the objects, so it calls for a fast and an effective network to handle a large number of potential devices. For wide range transmission network 3G, 4G etc are commonly used. Similarly for a short-range communication network we use technologies like Bluetooth, WiFi etc. Osborne (2015) posited that the Internet of things is the next stage of the information revolution and referenced the inter-connectivity of everything from urban transport to medical devices to household appliances. The ability to network embedded devices with limited CPU, memory and power resources means that IoT finds applications in nearly every field (Vongsingthong & Smanchat, 2014).

Internet of things would allow intercommunication and interoperability of myriad devices in a home building setup. Pill bottles can order refills from the pharmacy; light switches and thermostats can talk to light bulbs and heaters; people can check on their homes from their offices as shown in figure 6. Existing technologies already allow many of these functions, but IoT provides a single consistent integration. It can handle information sent through the main power supply line, over a wireless connection or even engraved on a metal key, and it seamlessly integrates with the local and global computer networks.

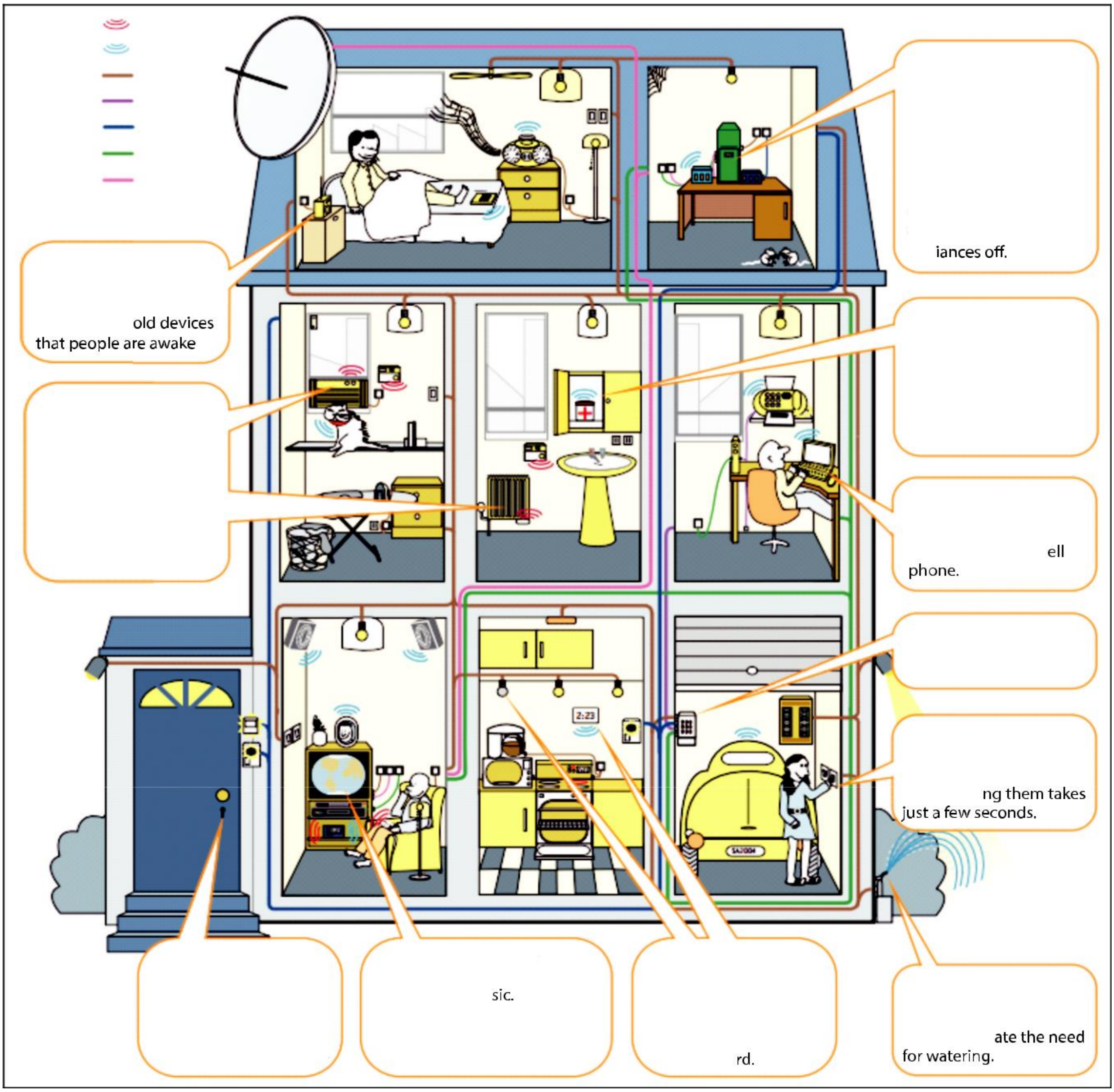


Figure 6. *Smart building*
Source: *Siemens (2018)*

IoT architecture

The Internet of Things is the environment where gadgets equipped with smart sensors collect data and exchange it over a network (see figure 7).

Thus, the system operates on three levels:

- Hardware (various objects enhanced with firmware/embedded systems and smart sensors).
- Infrastructure (a piece of software that receives, analyzes and stores sensor data; it runs in the cloud or on a corporate server).
- Apps (applications for smartphones, tablets and PCs that connect hardware to the infrastructure and enable users to manage smart gadgets).

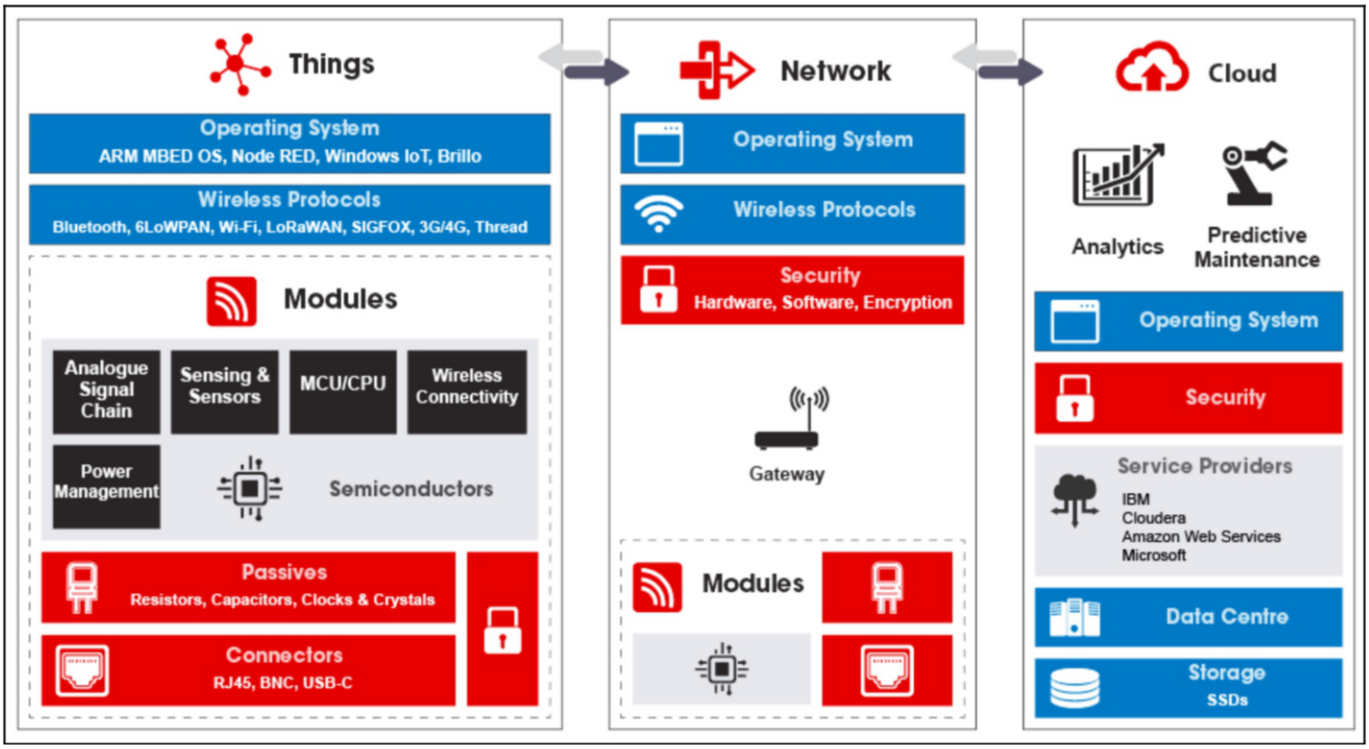


Figure 7: *IoT high level Architecture*
Source: *ie.rs-online.com*

Tools that assist students in activating and deploying information, that mediate the methods and modes of transforming that information into knowledge, have been at the heart of sound pedagogic praxis (Leanne *et.al*,2018) . Having the right equipment – that helps open up pathways for student activity, assists in the processing and mobilisation of ideas, and connects those ideas with the contexts that surround them – forms the basis of the teaching and learning environment (Roediger & Pyc, 2012). The education—technology relationship has been spotlighted as part of education policy and practice critique. The ubiquity of computers, the internet and digital forms of communication have now made their integration into the classroom mandatory. From smartboards to learning management systems such as Blackboard, to PowerPoint and Facebook groups, technology has often been championed – with limited criticism – as the saving grace of (perceived) old and redundant modes of didactic education that apparently disempower students (Leanne *et.al*,2018). These technologies are seen to be transformative for students, inclusive, interactive and valuable, therefore making teaching easier and learning simpler. They are coded to centralise the student in the learning process instead of the teacher, therefore enabling greater flexibility in learning styles and engaging student attention through multimedia delivery of materials (Leanne *et.al*,2018).

Challenges facing higher education in Kenya

African governments have declared the twenty-first century 'as a knowledge era', having recognized the importance of education in general and of higher education in the socio-economic development of the continent (Damtew & Altbach

2004; Okioga, Onsongo & Nyaboga 2012; Nyangau 2014) in particular. Education, more so university education, is expected to play an increasingly greater role in socio-economic development by training skilled manpower and producing and disseminating the knowledge required for a knowledge-driven economy. It should enable individuals to develop their capabilities to the highest potential; serve the needs of an adaptive, sustainable and knowledge-based economy and play a major role in the shaping of a democratic, civilized and inclusive society (Okioga *et al.* 2012). It is on basis of these convictions about and anticipations on University education that many governments have laboured over the years to improve access, quality and relevance of university education. This has culminated in the 'massification' of higher education (Jowi 2003; Kaburu & Embeywa, 2014) across many countries, including those of Africa in general and Kenya in particular. Out of this 'massification' of University educations are multiple challenges facing the sector that affect the functioning of the sector, thereby severely undermining its capacity to deliver a quality and relevant education accessible to all (Kaburu & Embeywa 2014; Munene, 2016). The many challenges that the sector must contend with have implications for its ability to deliver the envisioned quality and relevant education required for socio-economic and other forms of development in the country.

Private higher education is the fastest growing sector worldwide; it is estimated that about 30 per cent of higher education enrolments are in private institutions (Duderstadt, 2002). The growth in private universities has been particularly strong in former Soviet bloc countries, East Asia and Latin America, while many English speaking African countries have experienced growth in the sector (Kihara 2005; Sharma 2009). Kenya's private higher education though has a longer history, compared to most of Africa, and antedates the public privatization movement. Conditions for the development of private education in Kenya evolved in the late 1970s and in the 1980s (Kihara 2005; Sharma 2009). In particular, limited government funding for university education meant restricted supply of university education against a rising demand for the same, a gap that required the entry of other non-governmental players to fill (UNESCO, 2005a). In lieu of this, private universities emerged as a viable option of acquiring higher education in Kenya (Mutula 2002) and have continued to flourish and coexist with public universities in the country. These offer market-driven courses and provide a conducive environment for academic excellence (Okioga *et al.*, 2012). Today, the private universities boasts about 20 per cent of all students currently enrolled in Kenya's universities. There are 37 private institutions of higher education in the country, comprising eighteen (18) fully-fledged chartered universities, five (5) university constituent colleges, fourteen (14) institutions with Letter of Interim Authority (LIA) and one registered institution (Accredited Universities in Kenya, 2017).

Unlike public universities, private universities offer comparatively fewer programmes, with a bias toward business studies, information communication and technology and the social sciences. In addition, unlike their public counterparts which are mainly dependent on direct funding from the state (and are highly subsidized by the state), private universities depend on endowments, tuition fees and direct funding from founders and sponsors. They have to recover most of their costs from instruction and other services such as hostel accommodation. As a result, private universities are notably expensive compared to the public institutions. The only form of public funding for these universities comes in the form of student loans; but this is notably small compared to the amounts received by public universities, A portion of students sponsorship by government has now been introduced following allocation of government students to private Universities by KUCCPS.

Today Kenya's higher (university) education sector comprises a total of seventy one (71) institutions, making it one of the largest higher education systems in Africa. The growth in the number of public and private universities in Kenya has been accompanied by an impressive growth in student enrolments (Nganga 2010; Ministry of Education 2012; Munene, 2016). In 2013, the number had grown to 361,379 students, reaching 443.783 and 470,152 students in 2014 and 2015 respectively (ICEF Monitor, 2016). The dramatic growth in student numbers has been propped by government policy of absorbing as many students as possible that meet the minimum admissions qualification (Chacha, 2004; Boit & Kipkoech 2012; Wangenge-Ouma, 2012). The exponential growth in enrolments in 2013 resulted from the admission of record numbers of students by public universities, beating their fast-growing private sector rivals and defying infrastructure constraints. On the other hand, the contribution of the private sector remains minimal, mainly because the majority of private institutions have limited capacity with annual admissions ranging from 500 to 2,000 students (Ngome, 2013).

In African continent just like her counterparts, Kenya recognizes that the education and training of all Kenyans is fundamental to development. As such, the country has always placed education as a priority at all levels, promoting it not just as a basis for social mobility but also as a factor of national cohesion and socio-economic development (Kinuthia 2009; Ministry of Education 2012; Nyangau, 2014). In particular, the government sees the country's future as a prosperous and internationally competitive nation to be dependent on the university education system. According to the Ministry of Education (2012), the country's university education system is expected to create sustainable pools of highly trained human resources equipped with the skills required for the country to experience socio-economic development and to remain globally competitive in a rapidly changing and more diverse economy. This will enable the country to actualize the national ambition of being a knowledge-based economy. Given the centrality of (university) education in Kenya's development, the government has, since independence, invested heavily in all sectors of education with the goal to widen access at all levels. Such investments resulted in the country experiencing exponential growth in primary, secondary, tertiary and university education.

For the university education sector to deliver its mandate, quality of education is of essence. This means that the education delivered by universities must not only be accessible, equitable and relevant to the needs of the economy and society, but must also meet high quality standards. For private universities in particular, quality education is also a major factor for survival. To compete effectively with their private counterparts and to justify the high fees charged to clients, private universities can only rely on the quality factor; they must offer quality education (Kalai, 2010). It is the quality aspect of university education that is the subject of the debate ensuing hereafter.

Although the construct of quality in higher education is subjective and its meaning contested, with different stakeholders contextualizing it differently relative to their contexts (Nyangau, 2014), in their view, a quality university education should be one that produces graduates who are fit for (having the requisite skills to discharge) their roles and responsibilities in the labour market. Harvey and Green (1993) stated that the quality of an education system can be evaluated in terms of the fitness for purpose or the extent to which it is able to facilitate the attainment of the stated goals and objectives, in this case by producing graduates who have the knowledge and skills to drive the country's socio-economic growth and development. Cheng and Tam (1997) indicated, that quality is, by and large, a function of input, process and output of the system.

The quality of the university education in Kenya is anchored by the sector's vision of providing a globally competitive quality education, training and research for sustainable development (Ministry of Education, 2012). The mission is to produce graduates who respond to the needs of the society, whilst upgrading the skills of the existing workforce, developing the community and business leaders of tomorrow, as well as the ability to start new businesses to employ Kenyans thereby contributing to the country's economic well-being (Munene 2016). To realize its mission, university education in Kenya has to promote socio-economic development in line with the country's development agenda; achieve manpower development and skills acquisition; promote the discovery, storage and dissemination of knowledge; encourage research, innovation and application of innovation to development; and, contribute to community service (Ministry of Education, 2012). Research suggests that in Kenya, like in most other African countries, the 'massification' of university education raises questions about the quality of higher education. The fast growth of the sector has occurred without effective strategies for ensuring the maintenance of a healthy balance between quality and quantity. Specifically, the rapid expansion in university education in the country has not been accompanied with the provision of resources necessary for the maintenance of high standards, quality and relevance (Okioga et al. 2012; Munene, 2016). This has undermined considerably the quality of the education offered by the sector as well as that of the final product, i.e. the graduates themselves (Odhiambo 2011; Nganga 2014; Nyangau 2014; Kaburu & Embeywa 2014; Munene 2016).

Possible applications of internet of things by Kenyan universities

Technology will always have a place in all educational disciplines . IoT also has many opportunities for Science, Technology, Engineering, and Mathematics (STEM) disciplines, such as computer programming and physical computing. Internet of things interconnects billions of physical devices, all over the world, that have digital sensors and are interrelated by leveraging any network. The high education institutions can apply this technology to improve on the quality of education offered and using IoT as a tool to improve education and make educational life easier.

IoT-based smart campus (one to many)

The term Internet of Things in Education is considered two faceted because of its use as a technological tool to enhance academic infrastructure and as a subject or course to teach fundamental concepts of computer science. Universities face various challenges which affect the quality of education as highlighted. IoT offers “one -to many” solution, that it is one solution solving number problems. IoT is being used as a teaching and research medium in education. According to Marquez, (2016), integrating IoT as a new actor in educational environments can facilitate the interaction of people (students and teachers) and (physical and virtual) objects in the academic environment. In general, almost all university campuses are connected to the Internet, and on each campus, there are multiple objects like windows, doors, projectors, printers, classrooms, labs, parking, and building, etc. Using sensors, Radio-frequency identification (RFID), Near-field communication (NFC), Quick Response (QR) tags and such other IoT technologies, these objects can be converted to Smart objects (Cata, 2015).

A Smart Campus can be a collection of multiple smart things in a single system. An intelligent campus may include the following; Smart E-learning Application with IoT, Smart IoT-based Classroom, Smart IoT-based LAB Room, IoT Sensors for Notes Sharing, IoT Sensors for Mobiles Devices, IoT-enabled Hotspot for Campus. Using IoT as a tool to improve education and make educational life easier, some of the related works in this regard are presented here. A real attempt was made to use and implement IoT technology in University of Padova (Cheng & Liao, 2012). The primary focus of their study was to develop a Web Service Model for Wireless Sensor Network and to provide a framework that had been validated through a case study. These services were then implemented in the Information Engineering Department at the University of Padova. The work examines the use of Cloud Computing and IoT in incorporating the structure of education resources and provides an integration model. Another study discusses the impact of four different technologies including IoT, Cloud Computing, Data Mining and Triple-Play on new distance education (Castellani, 2010). The research work describes the application of IoT and Cloud Computing in Education and also differentiates smart campus with the digital campus.

Smart IoT-based classroom

Smart classrooms concept means an intellectual environment equipped with advanced learning aids based on latest technology or smart things. These smart things can be cameras, microphones and many other sensors, which can be used to measure student satisfaction regarding learning or many other related things. The use of smart object may provide ease and comfort for class management and better learning and teaching environment (Leanne *et.al*, 2018).

Smart classroom management

The term “classroom management” means a way or approach a teacher uses to control/manage his/her classroom. Smart devices have made it possible for a teacher to decide when he should speak louder when students are losing interest, or their concentration level is decreasing (Rytivaara, 2012). The use of IoT devices for teaching and learning purposes is a hot trend among institutions across the world which provides a new and innovative approach to education and classroom management. Such tools are already being utilized. Smart classrooms allow teachers to know what students want to learn and the way they want to learn which is beneficial both for faculty and students. Moreover, smart classrooms help students to understand the real purpose of using technology which also makes the learning process easier, the advancement in the field of technology in education has facilitated educators to design classrooms which are productive, useful, and collaborative and managed through IoT (Chang, 2011).

Smart classroom attendance system

Taking attendance of a class is a time-consuming task. Use of IoT can save time and effort both. A study proposed an efficient smart classroom roll caller system (SCRCS) using IoT architecture to collect or record student attendance after every period accurately and timely. RFID tags are attached to the Students' ID cards. The SCRCS can be installed in every classroom and read the students' identity card collectively. It shows not only the total attendance on Light Emitting Diode (LED) display at the beginning of any class but also shows the all identity card on multiple slots of SCRCS. The record of a student's attendance is also kept at the academic office (Chang, 2011).Another study proposed a web based attendance system using NFC technology in Android smart phones. The student taps the matric card towards the NFC Android Smartphone, and the attendance will be saved on the server automatically. Teachers and students both can check the presence from their smart phones (Alghamdi & Shetty, 2016).

Real-time feedback on lecture quality

Students' understanding directly relates to the lecture quality. Students' feedback plays an essential role to improve lecture quality. The study proposes a creative environment that can monitor and observe students' reactions to a lecture using sensing and monitoring technology. This IoT-based smart classroom provides real-time feedback on lecture quality which will help to improve the lecture quality (Chew, 2015).

IoT-based smart lab

It is said that the "The college building (or campus) is the lab." This thinking is part of a movement that began in the EU, called Living Labs. Research was conducted to combine several concepts together including IoT, the idea of living lab, i-campus, smart box design and Pervasive-interactive-Programming (PiP) (Chin & Callaghan, 2013). The primary purpose of the study was to teach the necessary programming skills to novices using IoT and PiP together. Total 18 participants including staff and students participated in the evaluation of PiP. The results of the assessment showed that PiP helped and supported members of different backgrounds and age groups to understand and practice the programming skills effectively (Chin & Callaghan, 2013). A study introduced a Lab development kit using a set of sensors with Zigbee, Raspberry Pi/Arduino boards which support to offer wireless communication in the lab. A module design method was adopted for the course labware. A survey was conducted to evaluate the Raspberry Pi based Lab kit and the results of the study showed positive feedback from students (Temkar *et al.*, 2016). In their study, authors state that online virtual laboratories can also contribute to providing a qualitative and competitive edge to any education system. They present a case study where they use IoT and Arduino Platform with Xively web service for reading and showing data collected from a temperature sensor.

Figure 8. *IoT Lab.*

Source: *Siemens/Youtube*

Challenges of IoT in higher education

IoT brings tremendous challenges and opportunities to higher education. IoT is a dramatic shift in the traditional instructional paradigm while integrating broader disciplines, including social science, to enrich the value of big data available from social media. Some of the IoT challenges in higher education sector include:

Cloud computing

Many universities are using hybrid cloud as their enterprise architecture for hosting IoT applications. The combination of millennials, the most tech-savvy students in the universities, as well as the rise of tablet and mobile technology, has opened new methods to increase the effectiveness of enterprise architecture, instructional technologies, research and learning environments. With universal computing, the cloud provides seamless connections and services to information technology services. According to Cheng and Liao (2012), presently, enterprise architecture in many higher education institutions depend on hybrid cloud infrastructures with computing platforms on private clouds, while enterprise and instructional applications gradually move to public clouds. Enterprise architecture in these institutions need to reduce latency time because of the demand for content in instructional technologies, the huge increase in audio and videos for instructions, and the need for active enterprise networks (Cheng and Liao 2012),.

Security and privacy

The implementations of IoT technologies present new and unique security and privacy challenges and issues. Addressing these challenges and issues to ensure security in IoT devices and services should be a fundamental priority. One of the fundamental criteria for IoT is the need to include effectual and trustworthy privacy and security mechanisms (Mineraud, *et al.*, 2016). Higher education is vulnerable to the security and privacy of the IoT ecosystem. Even though there has been further momentum to deal with the security of the IoT infrastructure, there is still no strategy to identify business risks associated with data breaches. Higher education sector need to develop standards to secure IoT applications. As higher education creates millions of future workers, it has to embrace IoT platforms and systems even with the challenges of IoT financing, evolving digital educational pedagogy, training, and interdisciplinary research. In addition, IoT applications must engage the future workforce morally and ethically to address cyber security issues as society depends more on IoT applications. Therefore, a collaborative method to safety and security will be required to develop solutions in effective and appropriate way to face IoT security challenges. Furthermore, the full potential of the IoT depends on strategies that consider people's privacy. Therefore, to fulfill these opportunities, there is need to develop new strategies that consider an individual's privacy choices and expectations, whilst still promote innovation in new technologies and services (Agarwal and Pati, 2016).

Reliable Wi-Fi connection

There is a continuous need for new technologies for education, like high-speed wireless networks which provide the bandwidth for audio and video streaming of lessons. The growing use of learning management systems LMS like Moodle and Blackboard is creating massive amount of structured and unstructured data such as audio and video content. Sophisticated electronic schoolrooms equipped with lecture capture systems and web streaming provide an opportunity for students to access instructional contents on demand at any time (Jin, 2012).

Financing

Although IoT potential economic impact will exceed $ 11 trillion by 2025, the Internet of Things development requires substantial upfront investments. The whole setup of an IoT-based educational institution can be expensive. Therefore the cost of devices and equipment is another challenge. The cost of information technologies continues to increase every year as content and application. These application stacks continue to grow both horizontally and vertically on instructional technologies, research computing and enterprise technologies. Alongside the information technology and laboratory fees, most universities do not have a strategy for sharing costs and identifying the total cost of ownership for an IoT infrastructure (Kumawat D. 2018). Higher education must come up with new ideas to finance an information technology infrastructure and services. To develop a simple IoT app will cost $ 1000-$4000, for a detailed costing of an IoT application (see figure 9).

Figure 9: *IoT application estimates.*
Source: *Kumawat D. (2018).*

Recommendations

The study recommends that the enterprise architecture in the institutions of higher learning need to reduce latency time because of the demand for content in instructional technologies. There is need to develop new strategies that consider an individual's privacy choices and expectations, whilst still promote innovation in new technologies and services. Higher education must come up with new ideas to finance an information technology infrastructure and services. Sophisticated electronic schoolrooms should be equipped with lecture capture systems and web streaming provide an opportunity for students to access instructional contents on demand at any time.

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