

Concordia University College of Alberta
Master of Information Systems Security Management (MISSM) Program
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Information Security Implication of E-Learning Implementation in Kenya

by

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A research paper submitted in partial fulfillment of the requirements for the degree of

Master of Information Systems Security Management

Date: April 2008

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ABSTRACT

E-learning is one of the main ways of overcoming some of the key challenges in accessing education by the people living in rural and remote Arid and Semi-Arid Lands (ASAL) in Kenya. Different types of Information and Communication Technologies (ICT) can be used in innovative ways to resolve some of these limitations. However, the same technology brings about other challenges such as risk, costs implications and security issues that need management. With enormous and varied challenges in accessing at least the elementary schooling, there is need for a relevant and customized information security management model that is specific to the needs and challenges of these stakeholders. In this paper, Information System Security Management Maturity Model (ISM3 – pronounced ISM cubed) is proposed as one of the main ways of overcoming some of the key challenges in effective implementing of quality e-learning in Kenya.

ISM3 is sensitive to security objectives that mitigate risks, the level of maturity in Information security management, and to the availability of information security process metrics in E-learning. The exploratory study draws on literature reviews, E-learning policies and strategies, which have been developed by the Ministry of Education (MoE) in conjunction with Kenya Education Network (KENET) in E-learning implementation. Examples were drawn from case studies in primary, secondary schools and University where E-learning has been implemented. Resulting information acquired from the study were evaluated for the purpose of testing applicability of Information security management maturity model on the e-learning implemented in Kenyan primary, secondary, and tertiary levels of education. Results showed that the information security management maturity of E-learning can be tested.

1 Introduction

E-learning is one of the main ways of overcoming some of the key challenges in accessing education by the least privileged living in rural and remote Arid and Semi-Arid Lands (ASAL) in Kenya. With enormous and varied challenges in accessing at least the elementary schooling, there is need for relevant and customized information security management model content that is specific to needs and challenges of the respective stakeholders. Most of the models that exist to address the information security challenges in e-learning implementation have their limitations in terms of flexibility, time, and cost constraints and hence the need to address all risk mitigating factors. Application of E-learning in many education institutions – primary and secondary schools, universities and other tertiary institutions- must accompany an adequate information security management, since software for E-learning as well as any other information system is often subjected to information security risks, such as unauthorized access , integrity and availability of information issues. The implication of information system security and issues of E-learning have impacted the E-learning implementation.

1.1 Objectives

The objectives of this research are both to test the applicability of information security management maturity model (ISM3) to E-learning implementation in Kenya and possibly extend some suggestions to the ISM3 in the context of Kenya from information system security management point of view. In this paper, Information System Security Management Maturity Model (ISM3 – pronounced ISM cubed) is proposed as one of the main ways of overcoming some of the key challenges in effective implementation of E-learning in Kenya. ISM3 is a process focus-by-levels maturity model. On moving from one hierarchy of E-learning implementation, each level has a process focus based on five maturity levels. The reason why we prefer ISM3 over other maturity models is its direct response to information security objectives which are simple and easy to understand and implement in a project-based E-learning implementation in education sector. But then what is the Information Security implication of E-learning implementation in Kenya?

1.2 Research Methodology

Information security management System can be defined as part of the overall management system, based on a business risk approach, to establish, implement, operate, monitor, review, maintain and improve information security; whereas Information System (IS) can be defined as a

processes needed to deliver the client's business and its client's requirements in relation to the business plan. Hence, the IS objectives of any organization are to rationalize data pools and information repositories to make that organization work efficiently. By exploring the information security management strategies and process deployed for the sustainable development of e-learning in primary, secondary schools and tertiary institutions in Kenya, this research explores the applicability of information system security management maturity in e-learning implementation in Kenya.

1. 2.1 Understanding the Initial Research Question within a Simple Evaluation Framework

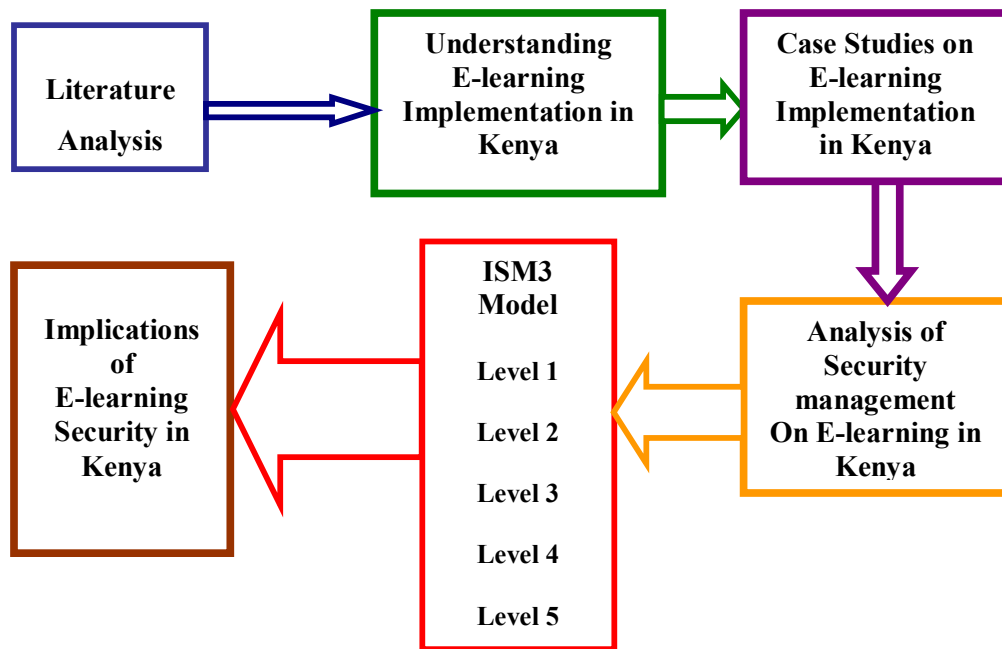


Figure 1: Model of the Research

This research aims to examine the implications of information security in E-learning implementation in Kenyan education. It will endeavour to examine the information security management strategies and process deployed in E-learning schools and tertiary institutions in Kenya. Underpinning this overall aim, the particular objectives of this research are based on the five maturity levels of ISM3:

ISM3 Level 1

Can we identify the range of information security planning and management strategies adopted by primary, secondary, and tertiary institutions in making the transition to embed E-learning? This level should result in a significant risk reduction from technical threats, for a minimum investment in essential Information Security Management (ISM) processes. This level is recommended for organizations with low Information Security (IS) Targets in low risk environments that have very limited resources. (Why we chose the ISM3)

ISM3 Level 2

Investigate the factors which affect key security-related decisions concerning the acquisition, deployment, support and development of ICT in E-learning implementation strategies: This level should result in further risk reduction from technical threats, for a moderate investment in ISM processes. It is recommended for organizations with normal IS Targets in normal risk environments that need to demonstrate good practice to partners and are keen to avoid security incidents.

ISM3 Level 3

Indicate how particular ISM approaches and planning strategies employed within institutions impact on the costs involved in integrating ICT into e-learning activities within schools and tertiary institutions. This level should result in the highest risk reduction from technical threats, for a significant investment in IS processes. This level is recommended for organizations with high IS Targets in normal or high-risk environments, for example organizations dependent on information services and e-commerce.

ISM3 Level 4

Establish current levels of ISM maturity by determining present levels of ability and willingness in these institutions for planning security and managing resources for the ongoing development of E-learning. This level should result in the highest risk reduction from technical and internal threats, for a high investment in IS processes. This level is recommended for mature organizations affected by specific requirements for example highly regulated organizations, such as stock exchange listed corporations, government bodies and financial institution

ISM3 Level 5

Determine what assistance that institutional leader requires in order to improve security management capability in this area and establish the principal implications of the integration and

implementation of ICT into mainstream activities within a range of education institutions, and link these to the ways in which E-learning has been implemented in Kenya: The difference between this level and ISM3 Level 4 is the compulsory use of process metrics.

To set the context, we firstly start with a brief description of the experiment environment, which is Kenya, a fast developing nation in East Africa. We then state the problem by asserting that although the current e-learning implementation in Kenya models have had a fair share of successful implementation, it has equally failed in meeting the demand for information security management maturity in its e-learning systems. This has resulted in a weak implementation, monitoring and evaluation framework. As noted in the e-readiness assessment by the Information Communication Technology Commission (ICCT) of Kenya, “successful implementation of ICTs in education strategy requires concrete indicators and a sound institutional framework for implementation, with the requisite capacity for monitoring and evaluation of information security in e-learning implementation in Kenya.”^[1]

2 Literature review

In 2003 a newly elected government of Kenya made good on its election pledge to provide free primary education for all. And late 2007 the government integrated into this free kitty the four year secondary education. So, Kenya became the only African country to offer a 12 year free primary and secondary education. However, this good initiative set in a problem of maintaining quality in education after access was drastically increased. Implication of this has been, in the last five years, a raised primary school enrolment from 5.9 million to 8 million while secondary school enrolment increased from 774,154 to over 1 million, and pre-primary enrolment from 1.25 million in 2000 to 1.67 million [1].

Also, despite these impressive gains, Kenyan schools were left scrambling to deal with the influx of students, which severely taxed their infrastructure and supplies. Another serious implication of these problems in terms of the impact on the quality of education was the shortage of textbooks. To counter these problems challenges, and attain universal access to public schools, retention, and improved quality of education, they need to implement E-learning was a great option. The Kenyan MoE is discovering that technology that seems so out of reach to so much of Kenya may in fact be able to help meet education needs - from primary through higher education. E-learning, which can involve both teaching computer skills and using those skills to undertake distance learning, is set to become a critical educational tool in the education system of Kenya

2.1 E-learning

E-learning can be defined as delivery of content and interaction through electronic media including Internet, intranet, extranet, audio/video tapes, interactive radio and T.V, and CD-Rom. It is typically an online delivery of information, communication, education, and training providing a new set of tools that can add value to all the traditional learning modes – classroom experiences, textbook study, CD-ROM, and traditional radio-based training. The Kenya Educational Network (KENET) defines E-learning as “the effective teaching and learning process created by combining e-digital content with local community and tutor support along with global community engagement”¹. From these definitions, one key points is clear about E-learning that it is obviously more than putting together course contents on the web; it is about using right technology and the web in particular way that securely supports the learning process.

Anyhow, either of these definitions requires an environment, which typically covers a set of application and process such as web-based and computer learning, mobile classroom or any digital collaboration including mobile phones for the purpose of enhancing learning by improving educational quality, increasing access, and reducing costs. The Kenyan Ministry of Education (MoE) in conjunction with KENET has adopted the above goals for the purpose of enhancing accessibility, relevance and quality enhancement of education. However, to realize effectiveness, access and efficiency gains requires excellent management of the information systems, co-ordination of development and changes in systems in a way that will reflect an educational institutional desire to achieve the security objectives.

One key objective of any organization would be of course to reduce cost. Mayfield, a mathematics professor at University of Southern California on his mathematical proof study came up with a paradox, which shows that as security posture improves, the marginal cost of further improvement also increases ^[2] To be able to measure cost, one need to manage something including defining the achievable goals, while optimizing the use of resources of that something. Management activities normally include the requirements to plan, direct, control and coordinate. ISMS is an organizational approach to IS, which involves process management as its core discipline. It is through well-defined processes that IS is improved, risk is reduced and maturity measured. So, an ISM typically involves ways to manage information based on a systematic

institution (risk) process approach management to establish, implement, operate, monitor, review, maintain, and improve information security.

2.1.2 E-Learning Security Issues

In E-learning it is not the information itself that has to be protected but the way it is presented. The obvious practical implication for effective implementation is a need to have a process of continual adaptation and alignment of information security in E-learning to reflect changing demands while meeting the priorities of the learning needs at the respective education institutions. Information is the central asset for education institutions without which there can never be learning. Information security is thus critical. Information security has been successfully incorporated by all Internet Service Providers (ISPs) as one of information security management top priorities. Information Security is enforced through the implementation of strong password encryption in critical areas; access lists to control areas of access; and firewalls where necessary. This means that ISP's Kenya databases consist of a variety of flat file systems as well as high-end, relational databases. The ISP's Kenya operates a Cisco routing and switching network as well. Consequently, any education institutions may choose to implement information security in their E-learning at any of the defined processes at any stage of maturity.

E-learning involves application of different technologies such as interactive white board, video conferencing; virtual classrooms among others. Some of these learning technologies will involve discussion between teachers and students who are far from each other. Kenyan E-learning implementation is unique because of both the technological shortcomings. Again, implementation of E-learning is challenging given the lack of resources, electrical supply – particularly in the rural areas, and even national ICT infrastructure. However, there has been, instead a more strategic approach to implementing E-learning to accommodate individual differences and actively engage learners in developing their ability to acquire knowledge. For instance, the New Partnership for Africa's Development (NEPAD), a not for profit organization designed to address the current challenges facing the E-learning in Kenya [2], has successfully grasped E-learning's potential provided by a high mobile use in Kenya to strategically and innovatively introduce E-learning in the rural and ASAL where the nomads-with least access to education - live.

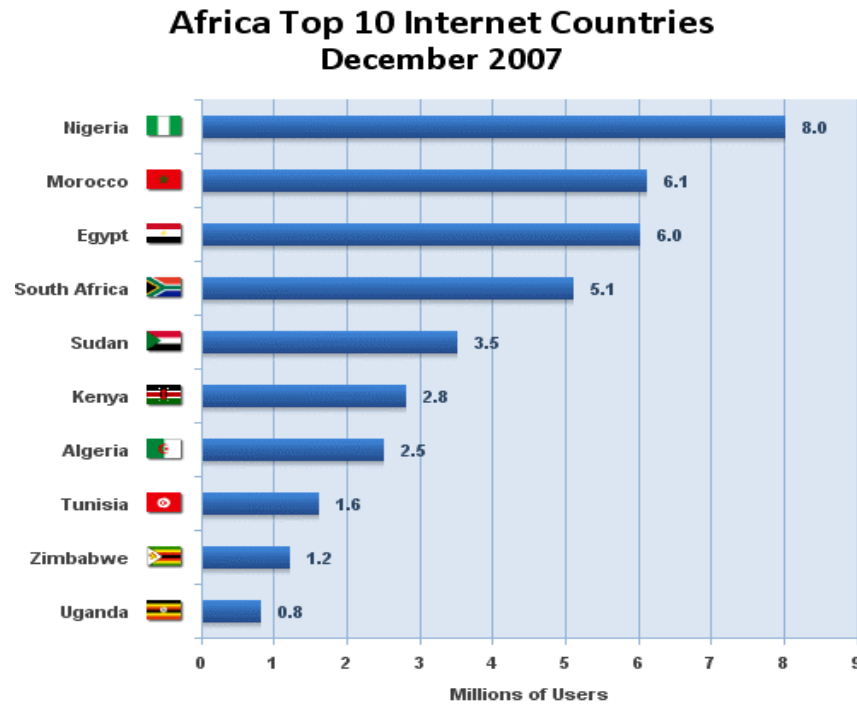
Although all E-learning systems are expected to provide mechanisms of access control that limit access to content, unauthorized users can as well gain access through the underlying layers such as the operating system or the database system on which the e-learning system is installed. It is therefore necessary to ensure that access control is enforced on all layers including physical access to the servers. Trust in E-learning is a necessity. In these cases the security requirements of students, teachers, and all stakeholders must be able to rely on the accuracy of the content and protection of the content of the E-learning platform deployed against unauthorized modifications. Other forums that definitely require students to confide in both the E-learning system are arts subjects and the social sciences discussions where an essential component of courses is the open chat rooms/discussions.

To avoid all these security glitches, implementation of security mechanisms and a policy that clearly states what will be stored, and for how long can reduce this risk for students. However, young learners across the three levels of learning (primary, secondary and tertiary) tend to trust all sources of information and accept whatever they read as true. It is thus very important that the integrity of content, including the author's identity, is managed, and not just controlled. But what is E-learning?

2. 1. 3 E-learning Implementation in Kenya

E-learning and the use of ICT is playing key role in shaping teaching and learning in Kenyan. Its implementation is providing innovative and creative ways for learning and technology transfer to the least skilled community across Kenya. Since the Internet came to Kenya in 1994, the country has experienced phenomenal growth in its use. There are now numerous Internet hosts, close to 100 licensed Internet Service Providers and over quarter million internet users in the country [3].

Figure 1: Kenya position among the top 10 African Internet Countries



Source: www.internetworldstats.com
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2. 1. 4 E-learning Infrastructure in Kenya

a) Electricity and phone lines in Kenya

Although there is limited access to electricity and phone lines in Kenya, and few people in Kenya have computers at home, the latest trend of Internet usage shows that usage of Internet almost tripled (1,054,900 in 2005 to 2,770,300 in 2007) [2] in a span of last two years due to the number of Internet access centers increased availability, particularly in urban areas. Radio and television access is much better compared to five years ago. On the other hand, mobile phones are routine and widely used in Kenya. Mobile phone usage has tremendously increased as well over the last two years². As a matter of fact, today, mobile phones outnumber fixed lines by approximately 20:1 with mobile penetration at around 15%. And because of mobile phone portability and the permission for mobile networks to operate their own international gateways from since 2006 there has been an impetus to the market.

b) Telephone systems

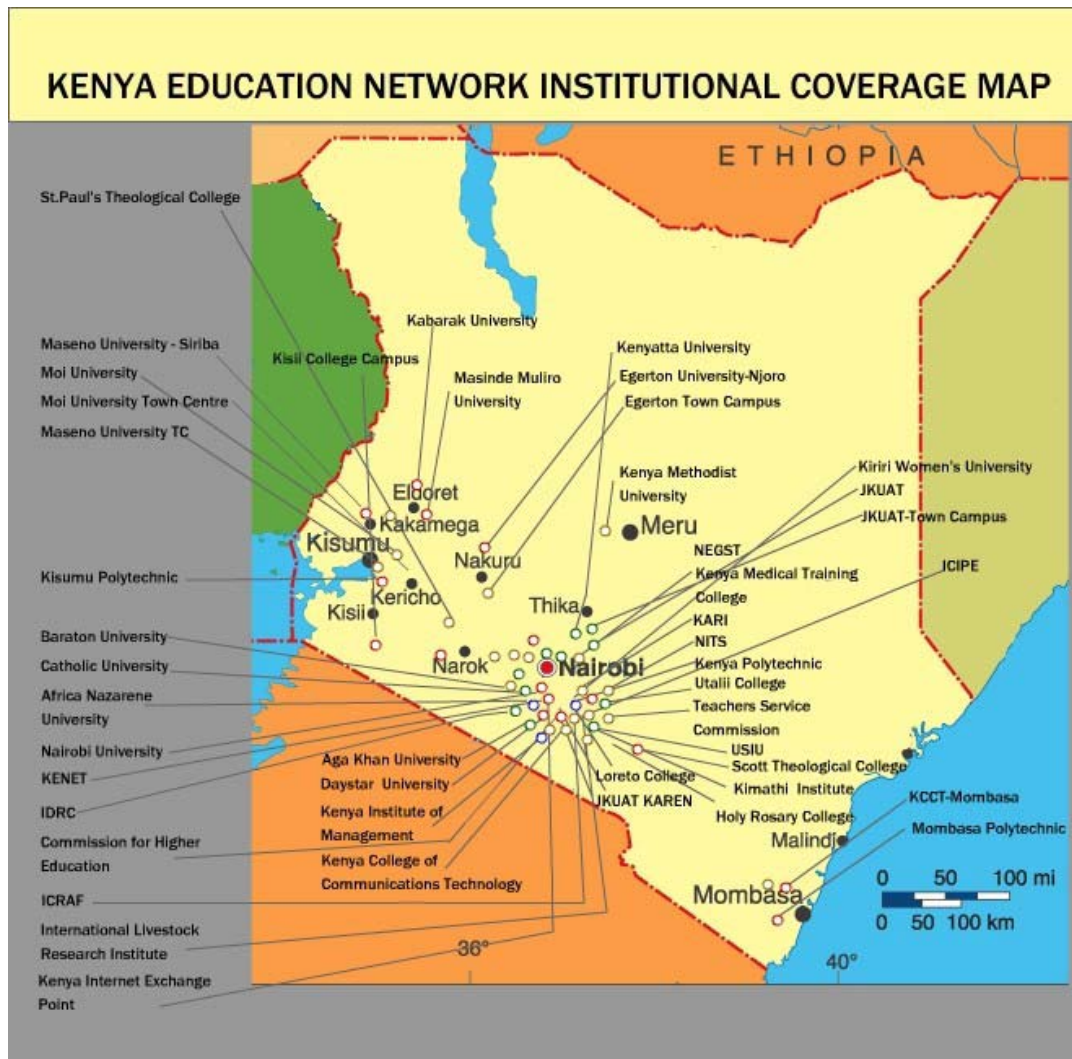
There is inadequate fixed-line telephone system with trunks, which are primarily microwave radio relay. Serious business data is commonly transferred by a very small aperture terminal (VSAT) system. The sole fixed-line infrastructure provider is Telkom Kenya, which was recently privatized to enhance competitiveness. Thus, most people rely on the mobile-cellular segment of the market (with multiple providers) fostering a boom in mobile.

Table 1.0 Statistical Overview Of The ICT Infrastructure As of September 2007

ICT Infrastructure	Total Number		
	2002	2005	2006/07
Telephone lines		281,800	293,400
Mobile telephones		4,612,000	6.485 million
Television broadcast stations	8		
Internet users	200,000	1,054,900	2,770,300
Internet hosts		13,274 (2006)	21,120 (2007)
Radio stations	24 AM; 18 FM		

The process of implementing E-learning in Kenya is nationally managed by both KENET and MoE officials and partners who offer strong leadership. KENET, created in 1999 to establish sustainable communication and networking among educational institutions in Kenya, facilitates wide use of ICTs in E-learning implementation and sharing of other information resources to the general populace at affordable cost. KENET's key objective is to develop a comprehensive national education portal with an appropriate E-learning process that train sufficient faculty and ICT support staff, establish a high-speed national IP-based network interconnecting all learning and educational institutions, and more so provide sustainable and permanent Internet access to all institutions, and create at least one learning center in each institution to support E-learning.

Figure 2.0 KENET National Institutional Coverage Map

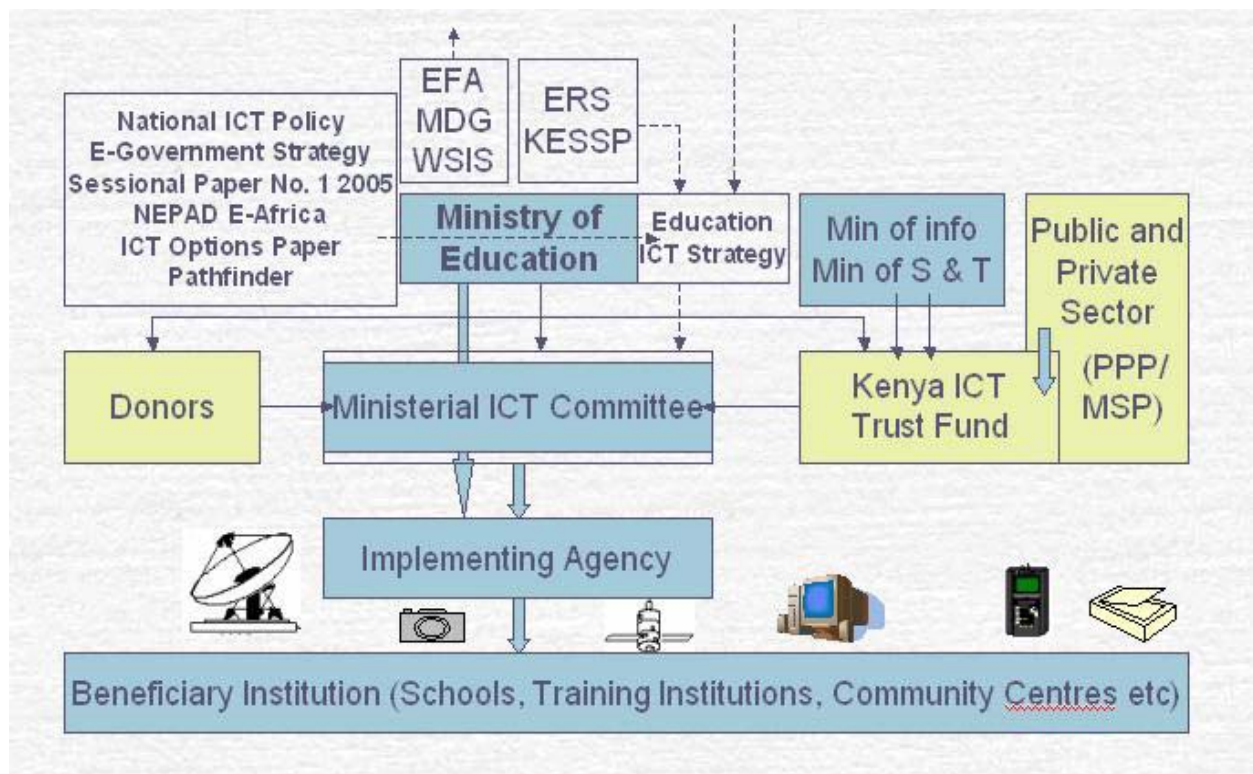


*= Arid and Semi-Arid Lands (ASAL)

Source: KENET: http://www.kenet.or.ke/services/index.php?yah=policies&yeh=foss_policy

To implement E-learning in observance of the KENET’s key mission of providing quality and cost-effective network services through a sustainable, high-speed and reliable national educational and research network, information security management must be in place. After laborious research and work KENET and donors/partners have successfully put in place a high – speed national IP-based network interconnecting several learning and educational institutions. As a result there has been a tremendous improvement in the ICT infrastructure. The Kenya National ICT Strategy for Education and Training Implementation Framework is illustrated in this diagram to enable us understands the E-learning implemented at each level.

Figure 3: ICT Training Implementation Framework



Source: http://www.education.go.ke/ICTStrategy_Implementation.htm

To evaluate the different E-learning infrastructure employed in Kenyan education system its imperative to understand the E-learning design already implemented in the education system and how it is delivered. From the above KCT E-learning framework it is clear that there is lack of explicit ICT policy targets and strategic indicators in primary school E-learning implementation. Before suggesting and recommending an extension of information system security management maturity model that need to be an integral part of the MoE's and ICT strategic indicators of maturity, let us critically evaluate the diverse E-learning strategies and methods deployed at the Kenyan primary school, secondary school, and university level through case studies. To help explore the E-learning implementation in Kenya, the following key questions were used 1) How do we uncover success in information security implementation? 2) How do we reduce one security risk without creating or increasing others? 3) How do the information system measure or determine the success of the E-learning implementation at each institution? And how do we devise effective and appropriate information security evaluation and monitoring procedures?

3 Boundaries within Which E-learning is Conducted In Kenya

3.1 Case Study 1: NEPAD e-School Satellite Network in ASAL in Kenya³

In Kenya, mobile learning is partly a way of dealing with the challenges of poor connectivity, mains electricity, and computer availability on the one hand. With the stimulation by the enormous spread of mobile phones and by the vigour and talent of the mobile phone networks in Kenya, - the “Kenya Way” can, perhaps, give unique solutions into the problems of supporting remote, nomadic, or rural communities or work with innovative blends of technologies and modalities. NEPAD provides a great opportunity to create a more permanent network to the nomadic people of North East Kenya by using this uniquely Kenyan dimension to mobile learning. Implementation of E-learning is challenging given the lack of resources, electrical supply – particularly in the rural areas, and even national ICT infrastructure.

Because of the successful Mobile phone use in Kenya, as reported in the table 1.0, there is no doubt that the Internet represents an area of immense opportunity with a growth of almost 300% in a span of 6 years with 7.5% population mobile users (approx. 2.78 Million) [5]. This infusion of wireless technology, primarily mobile phones, has had a huge E-learning impact in the remote parts of Kenya. These trends underscore the need for Kenya to grasp E-learning’s potential in teacher development and education and to begin planning to exploit these new resources for educational development in the ASAL where the nomads-with least access to education -live.

This necessitated the NEPAD and government to initialize and implement an E-learning project at the core of enabling the Internet-based connectivity for the NEPAD e-Schools initiative at the remote areas of the country with an aim to establish an national-wide satellite network that will connect the schools (mobile schools) to the Internet as well as to points within which educational content will be fed to the schools on a continuous basis. NEPAD target both children and adults from nomadic communities (target group) living in the four North Eastern districts namely: Mandera, Garissa, Wajir and Ijaara. The mobile schools were commissioned in 2005 by the Kenyan President and are already active [4]. This has impacted positively on enrolments in these ASAL districts. NEPAD project used a Very Small Aperture Terminal (VSAT) networks to access Internet and then connect from a hub to facilitate direct connection to a corporate data center or application provider such as a credit card authorization provider. The VSAT networks may have anywhere from one to tens of thousands of remote VSATs communicating with a

single hub. So, instead of relying on the scarce presence of telephone/cable infrastructure for the local connection, VSAT networks use wireless links to satellites in the stationary orbit over the equator⁴. VSAT provide broadband access from essentially anywhere.

Figure 4.0: A VSAT Sandwiched Between Two Classes in Northern Kenyan Schools



These VSAT networks are designed in a hub-and-spoke design with the E-learning centres connecting directly over the air to a central connecting facility. The VSAT terminals are the satellite modem/router and small (generally between .75 meter and 1.2 meters) dishes that operate at these E-learning centres. And the VSAT hubs are the equipment used at a learning centres as a receiver/router (similar to a DSL or cable modem) attached to a small dish mounted on top of or outside the building. And the large dish acts as the sophisticated hub RF components receiver, which then transmit to the remote sites, and route information to and from the Internet or private networks via the linked lines.

Usually, the target group is assembled in these learning centres where they get formal introduction on how to use their mobile phones to access learning materials in local languages. The target group is both male and females who have no previous access to education facilities. E-learning implementation via the VSAT networks is providing innovative and creative ways for knowledge in these rural and ASAL. Associated with the positive changes and opportunities of the technological capabilities are some challenges and risks, some of which

involve reaction of individuals and organizations to changes and dealing with the problem of increasing digital divide.

Security Benefits of VSAT.

VSAT has a centralized network management capability –VSAT has hub-and-spoke architecture networks that can control the entire network from one of its redundant earth station locations. This feature enables firewalling, virus scanning, intrusion detection, network management and more for an entire customer network in a completely centralized fashion. Another reason that VSAT services are perfect for backup/failover connectivity is their capability to rely on a single phone conduit as a point of failure for their primary and backup connections. So, this fault tolerance feature of VSAT is a critical additional level of redundancy. But how do you measure the success of e-learning implementation in this NEPAD e-school project?

Results

By end of 2006, the project achieved the target net end of year result for North Eastern Kenya at 24.5 percent comprising of 29.7 percent males and 19.4 percent females access education through e-learning method enhanced by the help of VSAT. Other reported benefits in NEPAD ASAL E-learning projects included improvements in science subjects with students finding it easier to understand digital diagrams as opposed to those drawn manually by teachers.

3.2 Case Study 2: E-learning Implementation Process at Secondary School

In January 2008 Kenya become the third African Country to launch E-Learning facilities in secondary schools [5]. E-learning was launched at Kamiti Secondary School in the outskirts of Nairobi. The program enables students to be taught through information communication technology (ICT) and is a collaboration effort between the MoE and several local and multinational ICT companies⁵. The project involves the use of computers and wireless connectivity for all types of class work. The teacher uses a laptop to which the students connect from their low-cost laptops known as classmates. The classmate laptop is equipped with a Celeron M processor, 2GB of NAND Flash memory, which acts as a more robust hard disk drive running Microsoft Windows XP operating system. The cost of US\$300 (Ksh 18,000) is met by the Intel and Microsoft corporations of America.

In the new Classroom®, the blackboard® has been replaced with a touch screen and students send their work to the teacher through wireless connectivity. This e-learning

environment allows students to access a system from remote access points. Teachers load course material onto course web sites for students to retrieve. Students retrieve course material and lectures from a course web site, and even submit assignments to the same course web site from where lecturers retrieve and mark such assignments. The programme is aimed at providing schools with affordable ICT tools that will enable teachers and students to use the Internet, among other range of digital resources. However, there are hurdles that need to be overcome before the programme can be implemented nationally. For instance, teachers need to improve their information technology skills [6].

3.2.3 Case 3: E-Learning Implementation at Tertiary Level - Maseno University

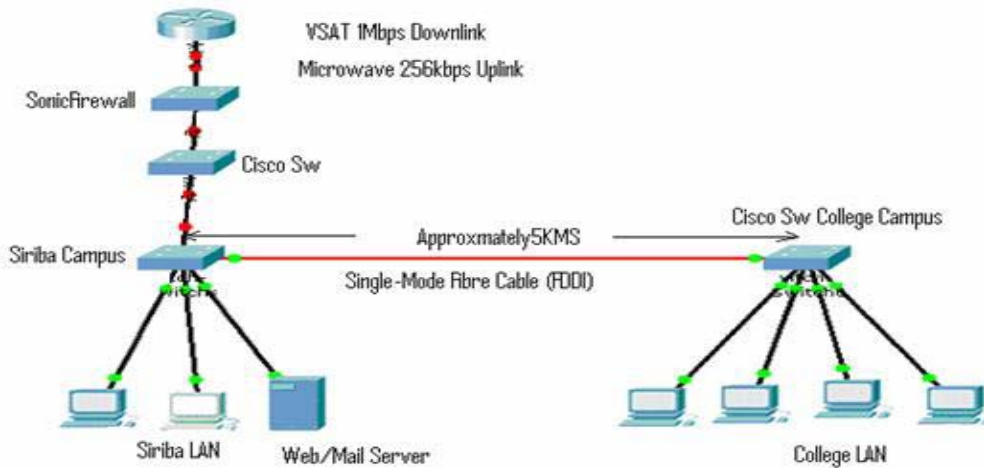
E-learning in Kenyan college has been implemented as pilot projects in order to offer access to university education to a number of students who qualify but fail to be admitted to public universities. Maseno University is one public university that has successfully implemented E-learning as a pilot centres. Maseno University is a full-fledged university located 25 km from Kisumu city. It has a good KENET services with integrated internetworking Cisco devices. Security and IT Centre and evening academic programs unit were established to overcome the challenges the university faces to increase access to university education. By using the ICT and related emergent technologies to pilot this expansion this case study surveys Maseno University e-readiness status, and evaluates the current infrastructure that has successfully enabled the E-learning implementation. By determining the E-learning devices and numbers of computer hardware available; manpower ability to handle the E-learning infrastructure and the academic resource to develop the requisite content, this case study offers a big picture of how e-learning in Kenya has been implemented at tertiary level

The KENET Infrastructure at Maseno

Through KENET, the University has installed a fiber optic backbone network between two key affiliate campus Siriba and College campuses. Internet access is provided at the main campus by a wireless link of 256kbps microwave radio for the *uplink* and a 1Mbps satellite *downlink*. A link between the main campus and the Kisumu Town Campus is at an advanced stage. The current student population is over 500 students, with a total of 200 Computers of which 80% are being used in academic programs and training the surrounding community on Computer Literacy and Industry Certification programs; while the remaining 20% are used in offices for administration.

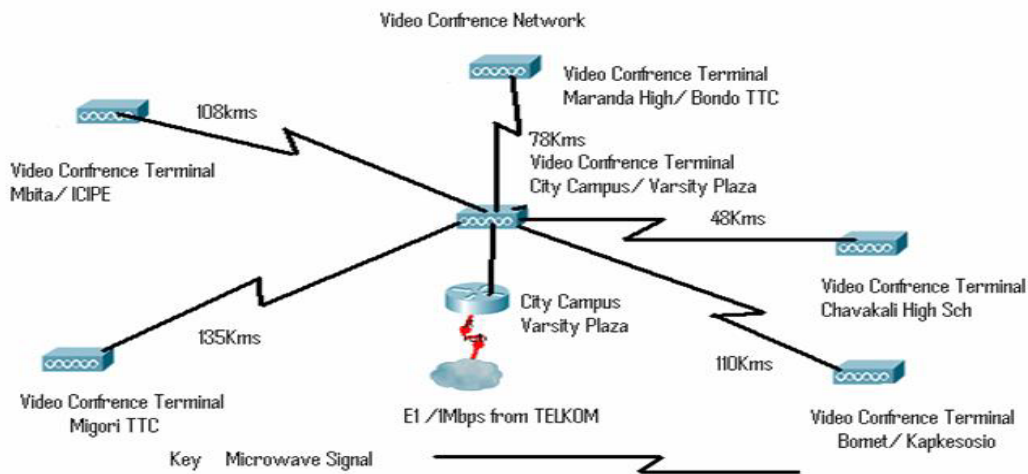
A large number of switches are distributed across the network as illustrated in diagrams below.

Figure 5: Diagrammatic Overview of Maseno E-learning Network Infrastructure



Source: <http://www.maseno.ac.ke/updates/e-learning-status.htm>

Figure 6: Video Conferencing Structure at Maseno University



All the education institution within a radius of approximately 200 km is well covered with the video conference internetworking infrastructure.

3.3 E-learning Implementation Difficulties

In spite of all these convenient communication infrastructure, the MoE policy framework indicates that there are a number of challenges concerning access to and use of ICT in Kenya, including high levels of poverty, limited rural electrification, and frequent power disruptions that affect e-learning implementation in rural areas especially in primary schools. Most secondary

schools have some computer equipment. However, very few secondary schools have sufficient ICT tools for teachers and students [6].

The country does not have adequately trained personnel to make this dream a reality across the educational spectrum. At the primary level, the problem is even bigger: there is inadequate emphasis on practical skills altogether in the curriculum. Besides, there are no resources available to in-service teachers in order for them to cope with these new demands. Matters are worsened by the fact that Kenya still has high levels of illiteracy. And even in schools that have computers, the student-computer ratio is 150:1, making it rather hard for effective E-learning implementation.⁶ Generally there is limited physical telecommunication infrastructure into rural and low-income areas. So, direct access to high-speed connectivity in small number of Kenyan schools through an Internet service provider, or donor funded VSAT has been a great contributor to the successful E-learning implementation in Kenya. Thus, most of the schools with ICT infrastructure have acquired it through initiatives supported by parents, the government, NGOs, or donor agencies /partner and the private sector, including the NEPAD e-Schools program

Setting up basic ICT infrastructure in primary schools has been a daunting task due to lack of adequate connectivity and network infrastructure. Consequently, there is limited access to dedicated phone lines and high-speed connectivity for e-mail and the Internet. Even where access to high-speed connectivity is possible, high costs remain a barrier to access. As well, very few schools can afford to use VSAT technology. Roughly 10% of secondary schools with computers are able to share teaching resources via a Local Area Network (LAN). As a solution to these access problems, the ministry has leveraged the E-government initiative of networking public institutions countrywide to facilitate connectivity for the educational sector through KENET.

There are three organizations of critical importance in the context of ICT development in Kenyan schools. One of these, the Kenya ICT Trust Fund, which has positioned itself to facilitate mobilization of resources to provide ICT to schools and communities and acts with its members as a co-ordinating body for sharing information about priorities and developments. Government initiatives have impacted on the future direction of ICT in the Kenya school curriculum, while private institution of learning offers diverse approach to E-learning implementation. Notably, successful implementation of E-learning brings forth implications such

as financial expenditure to ensure adequate infrastructure of technology and professional development for teachers, are considered.

Kenya lies low in international Networked Readiness Index (NRI) rankings. Table 2.0 shows the NRI for Kenya in the past three years in comparison to South Africa, Mauritius and the USA. This is a good measure of the countries e-readiness and the regulatory and national infrastructure. A low ranking for Kenya suggests low level of readiness and usage by businesses, government and individuals.

Table 2: Networked Readiness Index

Period	USA	Kenya	South Africa	Mauritius
2004-05 (Rank out of 102 countries)	4	75	34	47
2005-06 (115 countries)	1	91	37	45
2006-07 (122 countries)	7	95	47	51

Source:http://www.kenet.or.ke/Ereadiness_surveyof_Kenyan_highereducation_institutions2007.pdf

Table 3: ICT Opportunity Index Scores and 2005 Rank for Comparator Countries

Year	USA	Kenya	South Africa	Mauritius
2003 (score)	276.46	39.60	85.16	110.03
2004 (score)	305.67	41.18	88.26	118.88
2005 (score)	323.87	42.26	96.78	150.27
2005 (Rank out of 183 countries)	13	145	90	56

Source:http://www.kenet.or.ke/Ereadiness_surveyof_Kenyan_highereducation_institutions2007.pdf

3.3.1.1 Electricity and Phone Lines in Kenya

The sole fixed-line infrastructure provider is Telkom Kenya. Thus, most people rely on the mobile cellular segment of the market fostering a boom in mobile-cellular telephone usage. Because of the successful Mobile phone use in Kenya, as reported in the table 1.0, there is no doubt that the Internet represents an area of immense opportunity with a growth of almost 300% in a span of 6 years with 7.5% population mobile users (approx. 2.78 Million). This infusion of wireless technology, primarily mobile phones, has had a huge e-learning impact in the remote parts of Kenya. These trends underscore the need for Kenya to grasp E-learning’s potential in teacher development and education and to begin planning to exploit these new resources for educational development in

the ASAL, where the nomads-with least access to education live.

Also, with readily availability of at least 72 licensed ISPs the CCK ensures that Internet Services provision by the respective ISPs is efficiently delivered to the users. Since many people in Kenya do not have fixed phone lines, computers, or electricity, Internet shops, known as cyber cafes, provide access to Internet and email, mainly in the major towns. A major factor that may have influenced the use of ICT positively in Kenya is the use of the English language. English is the official language in Kenya, and Information Technology (IT) services are largely based in English, so this has been an advantage. Successful implementation of E-learning is a process that requires understanding of learning strategy, design and technology. It is obviously more than simply putting learning content online and expecting that people will learn without effort.

Table 4: The Cost of Providing Mobile and Internet Services to the General Public in Kenya

Operator	Service	Costs (USD)
Telkom Kenya Ltd (fixed)	Access to network	39.00
	Monthly fixed charge	3.28
	Local call/3 minutes	0.06
	National inter-urban calls (150 km)/minute	0.21
	International calls to USA/minute	2.20
	International link at 64 kbps/month	8200.00
Safaricom Kenya Ltd (Pre-paid phone card)	Access to network	32.00
	From a cellular phone to another (within Safaricom Network)/minute	0.19
	Cellular phone (from Safaricom Network to another) /minute	0.31
	From a cellular phone to a fixed phone/minute	0.31
Kencell Commun. Ltd (Pre-paid phone card)	Access to network	37.00
	From a cellular phone to another (within Kencell Network)/minute	0.19
	Cellular phone (from Kencell Network to another)/minute	0.51
	From a cellular phone to a fixed phone/minute	0.32

Source: http://brunoleonimedia.servingfreedom.net/Varie/IBL_Arunge_Kenya.pdf

3. 3.1.2 Kenya Education Network Challenges [7]

Kenya ranks very low in international Networked Readiness Index (NRI). Table 1.0 shows the NRI for Kenya in the past three years in comparison to South Africa, Mauritius and the US The NRI measures not only the regulatory and national infrastructure but also most importantly, usage by government, businesses, and individuals. This ranking shows low level of e-readiness and usage by businesses, government and individuals.⁷

Table 5: Kenya NRI

Period	USA	Kenya	South Africa	Mauritius
2004-05 (Rank out of 102 countries)	4	75	34	47
2005-06 (115 countries)	1	91	37	45
2006-07 (122 countries)	7	95	47	51

Table 6: ICT Opportunity Index Scores and 2005 Rank for Comparator Countries⁸

Year	USA	Kenya	South Africa	Mauritius
2003 (score)	276.46	39.60	85.16	110.03
2004 (score)	305.67	41.18	88.26	118.88
2005 (score)	323.87	42.26	96.78	150.27
2005 (Rank out of 183 countries)	13	145	90	56

Kenya has successfully put in place an ICT policy framework and implementation strategy, but with no measurable outcomes. To be able to implement E-learning successfully the KENET need to have a process metric system. The latest addition to KENET's assets has been the installation of a fiber optic backbone network, dial-up links, Internet access, computer hardware, E-learning devices available, manpower ability to handle the E-learning infrastructure and the academic resource to develop the requisite content. It also offers recommendations to tertiary institutions though not all are connected due to high cost of bandwidth. At secondary and primary schools levels – they are very keen to join as KENET members because cost of bandwidth is still high. Bandwidth is expensive in Kenya. For instance, \$800/month for a 64 kb/s permanent connection, cost of a non-branded PC about \$900, software license costs are also relatively high.

Table 7: Cost of Bandwidth in Kenya

Type of access	Total cost/ 10 week term (US\$)
Analog dial-up access (28.8 kb/s modem)	\$475
Digital dial-up access(64 kb/s ISDN line)	\$ 2450
Maseno university computer lab access (128/512 kb/s)	\$31.25

Currently pilot dial-up links are in place to encourage email communication at Maseno's Siriba and College campuses. Internet access is provided at the main campus by a wireless link of

256kbps microwave radio for the *uplink* and a 1Mbps satellite *downlink*. A link between the main campus and the Kisumu Town Campus is at an advanced stage. Given the above statistics it's clear that a well-developed Intranet is crucial for success in training and developing on-line materials.

4 Evaluating Information Security in E-learning Implementation Kenya

E-learning systems in Kenya present a unique challenge to IS engineers because of their nature and inherently complex architecture. IS is not just a technical issue that can be addressed by the Chief Information Officer (CIO), but it is a corporate governance issue that must be addressed by top management including Board of Directors, middle managers and all process implementers before implementation is enforced across all levels of the organization. So, in any project, it is people in the end that determine the success or otherwise of the project and not technology and its associated issues. In nutshell a typical E-learning infrastructure would have I) Learning Services that includes activity authoring and management, course/curriculum management and validation; assessment, marking, and grading; sequencing/flow, tracking and reporting; and II) common services including wide range of functions: administrative, collaboration, information management, and some core middleware functions.

Kenyan E-learning implementation is unique because of both the technological shortcomings highlighted earlier and intended E-learning users. Consequently, E-learning implemented in Kenya involves application of different technologies such as interactive Classmate®, video conferencing; virtual classrooms among others. Some of these learning technologies will involve discussion between teachers and students who are far from each other. There has been, instead a more strategic approach to implementing E-learning to accommodate individual differences and actively engage learners in developing their ability to acquire knowledge.

Whatever the design, IS is a critical issues in E-learning. It is the responsibility of everyone who has the opportunity to control or report the institution's data to support throughout the institution its IS program. Each role has different responsibilities for IS and each individual should be accountable for his or her actions. Accountability requires clear lines of reporting, clear communication of expectations, and the delegation and judicious use of appropriate authority to bring about appropriate compliance with the institution's policies, standards, and procedures.⁹ Thus, every E-learning model should be sensitive to the security of the information systems to the

level of availability of infrastructure, technical support, and clear policy on implementation, evaluation and curriculum re-orientation.

4.1 Identifying Security Issues in E-learning Implementation in Kenya

Kenya has successfully implemented E-learning in primary, secondary, and tertiary institutions. However, the lack of explicit ICT (as noted in the table 6.0 above) in higher education policy targets and strategic indicators has resulted in weak implementation, monitoring and evaluation framework, which translate into a lack of IS management framework. Successful implementation of ICTs in education strategy requires concrete indicators and a sound institutional framework for implementation, with the requisite capacity for monitoring and evaluation. This research proposes an ISM model that can be used by educational institutions in e-learning implementation to their staff and students in Kenya. But what are the security issues in IS? Operational!

IS as the protection of information to ensure confidentiality (information accessibility to the intended users); Integrity (information intended accuracy and completeness is maintained); and Availability (ensuring that the information is accessible to authorized users when required). This can be achieved by applying a suitable set of controls namely: policies, processes, procedures, organizational structures, and software and hardware functions. The primary reason why IS is so important within the E-learning environment is that E-learning is mainly dependent on information as well as ICT. It is the use of ICT however, that can lead to many possible IS risks that can compromise information. For instance, an E-learning environment allows students to access a system from remote access points. This the environment that exists, where teachers or students either load course material onto course web sites for students to retrieve, or students retrieve course material and lectures from a course web site, or even submit assignments to a course web site from where lecturers retrieve and mark such assignments, etc. But the IS risks that can arise from the above mentioned examples without proper ISM include alteration of course materials, copying assignments from course websites by unauthorized users, or submitted assignments get deleted by unauthorized users.

The IS risks identified above should be addressed by ensuring that the E-learning IS countermeasures are implemented throughout out the E-learning environment [E. Kritzinger, etal, 2006]. This paper proposes five maturity model levels that E-learning could be used to help institutions in Kenya securing their information against harmful attacks.

4.2.2 IT Security Governance: IT Governance Maturity Model versus ISM3

IT governance is a regulatory compliance to an organization's financial and technological accountability, which ensures that companies achieve their strategies and goals. IT governance maturity model targets strategic IT planning and governance methodology. IT governance refers to formal high level processes and structures for IT strategic planning, basically put IT governance revolves around how an organization realigns the IT objective with business strategy to ensure that the organization stays on track to achieve their business missions and goals. So, an IT governance framework ensures that the IT department is functioning in a way management needs¹⁰. Whereas ISM3, a process model, incorporates three key governance issues: Firstly, it identifies key ISM processes at various levels of maturity; a responsibilities model - responsibilities-based view of an organization, and a security in context model - allows an organization to tailor its security objectives to its business needs. ISM3 intentionally refuses to define in terms some intrinsic or private essence of an organization, but instead terms like security, vulnerability, weakness, risk, threat, opportunity, incident, attack, error and accident are defined "operationally". The maturity spectrum relates cost, risk and threat reduction and enables incremental improvement, benchmarking and long term targets. The lesser the risk the more the process of an ISM progresses to maturity. ISM3 is the best model to evaluate the security implications of the e-learning implemented by educational institutions in e-learning implementation to their staff and students in Kenya [12].

The Kenyan Government has already established a significant legislative and regulatory regime around IT security, and is considering additional action. However, it has taken along time to pass this law because IS is often treated solely as a technology issue, when it should also be treated as a governance issue. Lack of progress in this issue is due in part to the absence of an ISM framework, which instructs personnel at different levels about how to implement E-learning solutions is crucial. Two common standards that are generally used to focus on an organization's ISMS are ISO/IEC 27002 (ISO/IEC 17799) and ISO/IEC 27001. The first standard is used as guidance for planning and implementing ISM and a great starting point for developing ISMS. ISO/IEC 27002 provides a program to protect information asset and controls used to implement ISMS. But, ISO 27002 is the standard, which provides management system standard. However, successful ISMS should be a process, which must ensure the continuous verification of all elements of the security system through continuous improvement of all elements of the information and management and security management system.

This process must adopt a plan-Do-Check-Procedure model as its ISMS. The only security management model, which is based on processes management, and compatible with ISO9001, ISO27001, ITIL, CobIT and ISO20000 is ISM3. It has five maturity levels and metrics for IS [12]. The key objective of this research is to evaluate and discuss the applicability of ISM3 in E-learning implementation at primary, tertiary, and secondary levels of education in Kenya based on security objectives. In all the case studies used in this research, the security objectives will be expressed in fairly general terms such as: 1) use of services, access to storage, and user's restrictions to authorized assets; 2) making sure that expired or end of life-cycle repositories are permanently destroyed or sanitized; 3) personal information of learners and teachers is accessible for a valid purpose to authorized users on a need-to-know basis; 4) Confidentials are accessible to authorized users only; 5) appropriately licensing and accessibility to authorized users (KENET members); 6) physical security to the information repositories and systems (servers), among others. To understand the security objectives in consideration it is imperative to understand the ISM3 clearly.

4. 2. 3 Information System Security Management Maturity Model (ISM3)

ISM3 is a presentation of a maturity matrix that is defined by a number of levels or stages that represent improved capability and performance in particular organizational processes. This enables the organization to proceed to the next level of maturity as they fulfill its requirement. The other best thing about ISM3 is that it is a creative-commons licensed with some rights reserved, which means that anyone can download and immediately use it. According to Vicente Aceituno Canal (p.22), ISM3 requires an organization to state its security objectives, which basically forms the basis for design, implementation and monitoring of the ISM system. The key premises in this research is that security objectives and security targets should balance E-learning implementation 'business' objective, compliance and technical needs and limitations, like cost, functionality, privacy, liability and risk. And risk in this case will be the failure to meet a security objective, hereby referred as an incident, which will normally threaten achievement of a business objective. The 'business' objective would be the overall E-learning implementation objective. Under ISM3, the common processes of IS are formally described, given performance targets and metrics, and used to build a quality assured process framework.

Altogether, the performance targets for security become the IS Policy. The emphasis on the practical and the measurable is what makes ISM3 unusual, and the approach ensures that ISM

systems adapt without re-engineering in the face of changes to technology. ISM3 describes five basic ISM system configurations, equivalent to maturity levels, and these are used to help institutions to choose the scale of ISM system most appropriate to their needs. The maturity model spectrum relates cost, risk and threat reduction and enables incremental improvement, benchmarking and long term targets. But how has the e-learning implemented in Kenya enabled the creation of ISM systems that are fully aligned with the business mission and compliance needs?

4.3 Application of ISM3 to E-learning Implementation in Kenya

The ISM3 definition of security is prevent and mitigates incidents that could jeopardize the organization's property and the output of products and services that rely on information systems. By modeling the information system according to the conceptual model of ISM3, we are able to grade the security requirement of each component, in order to choose the appropriate level of security measures application. Every process in ISM3 contributes to the goals of the overall objective of ISM, which are defined by the security objectives of the organization. Security is defined as the result of the continuous meeting or surpassing of a set of objectives. In KENET's case an incident is any loss of confidentiality, availability or integrity. Under security target in context, an incident is a failure to meet the KENET's overall business objectives. The security must aims to guarantee that business objectives are met.

5 Information Security Management Systems in Kenya

KENET mission is to establish sustainable communication and networking among all educational institutions in Kenya that will facilitate wide use of ICTs in teaching, learning, research and sharing of other information resources to the general populace at affordable cost. However, infrastructure delayed the connectivity of most of the strategic institutions due to exorbitant costs of hardware, software, & bandwidth. On governance, KENET Board of Trustees formed in 2001 to oversee and steer the initiatives, there is KENET Management committee made up of technical personnel/faculty of member institutions manages the affairs of KENET on behalf of the trustees. KENET Secretariat –formed in 2002 (full time staff) take care of the day to day operations of KENET.

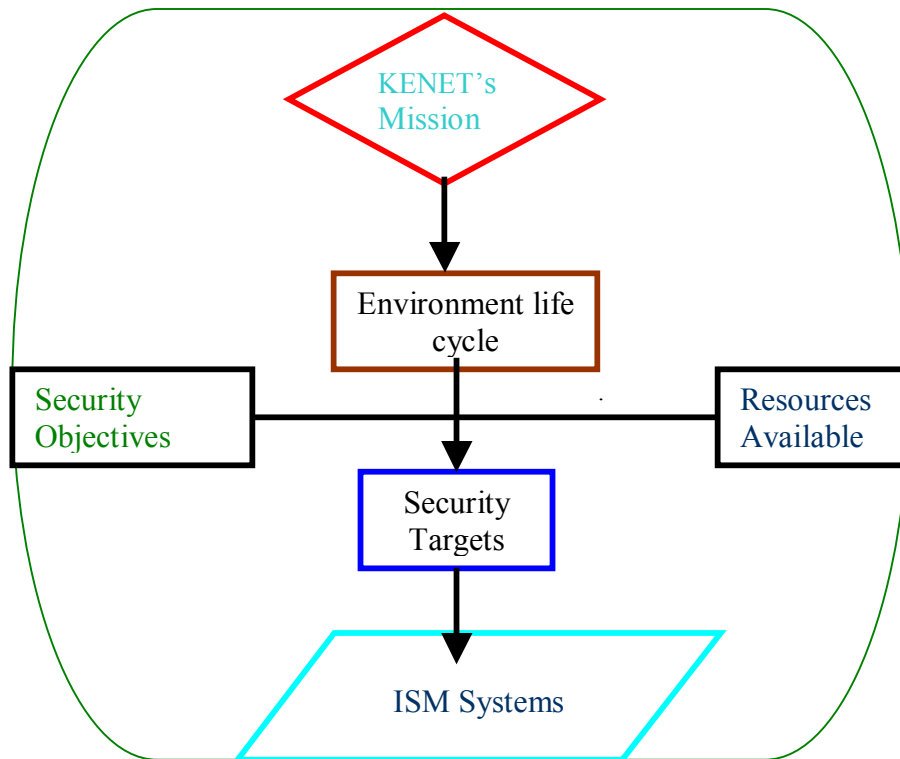


Figure 7: Evaluation Of KENET's Information Security Management Systems

With ISM3 institution may choose to implement any of the defined processes at any stage of maturity. However, this should be related to specific security objectives. Similarly, it is possible to choose not to implement some required processes based on the environment variables of each institution. And for accreditation, the decision each institution adopts must be consistent with its security objectives. The KENET's security targets in summary would be defined as ensuring: 1) reliability and performance of services and channels exceeds client (members) needs; 2) existence of repositories and services is assured for exactly as long as client requirements (availability of services); 3) all expired or end of life-cycle repositories are permanently sanitized; 4) assurance of precision, relevance and consistency of repositories; 5) users are accountable for the repositories and messages they create or modify; 6) users are accountable for their use of services and acceptance of contracts and agreements; and that 7) accurate time and date is reflected in all records. To test applicability of ISM3 to evaluate E-learning implementation at Kenya's primary school, secondary school, and tertiary levels (the three case scenarios), we expose the E-learning implementation process to ISM3.

5.1 Applying the ISM3 to Test Information Security in E-learning Implementation in Kenya

How has the E-learning implementation in Kenya enabled the creation of ISM systems that are fully aligned with the business mission and compliance needs? It is important to understand how ISM3 divides ISM responsibilities. ISM3 separates the responsibilities into strategic, tactical and operational levels. Each level corresponds to the respective management level in the organization - strategic management to people who authorize resources for IS; tactical management to those who oversee usage of resources; and operational to those who use the resources. It also provides an inventory of security processes that corresponds to each of these layers of management. So in the tables below KENET’s strategic, tactical and operational management’s processes are being evaluated based on ISM3’s five maturity levels as explained in section 4.

6 Results Analysis: Secondary Data Analysis

a) Strategic management

	Level 1	Level 2	Level 3	Level 4	Level 5
1 Report to Stakeholders	pass	pass	pass	pass	pass
2 Coordination	pass	pass	pass	pass	pass
3 Strategic vision	pass	pass	pass	n/a	n/a
6 Allocate resources for information security	n/a	n/a	n/a	n/a	n/a

Table 7: Evaluating the Applicability of ISM3 Using Strategic Management Capabilities

b) Tactical management

	Level 1	Level 2	Level 3	Level 4	Level 5
1 Report to strategic management	pass	pass	pass	n/a	n/a
2 Manage allocated resources	pass	pass	pass	n/a	n/a
3 Define Security Targets	pass	Pass	n/a	n/a	n/a
7 Security Awareness	n/a	n/a	n/a	n/a	n/a
8 Select Specific Processes	pass	pass	n/a	n/a	n/a

Table 7.1: Evaluating the Applicability of ISM3 Using Tactical Management Capabilities

C) Operational Management

	Level 1	Level 2	Level 3	Level 4	Level 5
1 Report to tactical management	pass	pass	pass	pass	n/a
2 Select tools for implementing security measures-CIA triad	pass	pass	pass	pass	n/a

3 Environment Patching	pass	pass	n/a	n/a	n/a
4 Environment Clearing	pass	n/a	n/a	n/a	n/a
5 User Registration and authentication process	pass	pass	pass	pass	pass
6 Physical Environment Protection Management	pass	pass	n/a	n/a	n/a
7 Malware Protection Management	n/a	pass	n/a	n/a	n/a
8 Information Quality Probing	pass	pass	n/a	n/a	n/a

Table 7.2: Evaluating the Applicability of ISM3 Using Operational Management Capabilities

6.1 Using ISM3 to Test Applicability at The Three E-learning Institutions’ Levels

Evaluating ISM3 applicability at Primary, Secondary and University E-learning Implementation

ISM3 Levels	Strategic	ISM3 Levels				
		1 ICT coordination level/Tactical management	2 ICT facilitation levels	3 Information Security Planning and Management Strategies in E-learning	4 Present levels of ability and willingness in planning security and managing resources for the ongoing implementation of e-learning	5 Assistance an institutional leader require in order to improve security management capability in this area
University Maseno	Tactical	pass	pass	pass	n/a	n/a
	Operational	pass	pass	pass	pass	n/a
Kamiti Secondary School	Tactical	pass	pass	n/a	n/a	n/a
	Operational	pass	n/a	n/a	n/a	n/a
NEPAD Project	Tactical	Pass	pass	pass	n/a	n/a
	Operational	pass	pass	n/a	n/a	n/a

Figure 8: Maturity Matrix Evaluating E-learning at Primary, Secondary, and University in Kenya

In Kenya, KENET is charged with the process of E-learning implementation. From the three case studies, it is clear that E-learning implementation in Kenya is deployed depending on availability of resources (funds), and relevant technological skills and awareness. For instance, at secondary and university levels E-learning implementation, there is an elaborate strategic, tactical, and little bit of operational management observance to ensure the network security, user accessibility, authentication, and accountability security targets are aligned with the overall KENET's objective. Every process in ISM3 contributes to the goals of the ISM, which are defined as to prevent and mitigate incidents that could jeopardize the institution's property and the output of products and services that rely on information systems, and to optimize the use of information, money, people, time and infrastructure.

Following considerations to apply ISM3 to the new E-learning implementation in Kenya, all we did to analyze maturity of ISM was based on the information corrected from the three case studies: primary, secondary, and tertiary. The following roles have special importance in ISM3: Client - is the person who provides resources and sets requirements for a process and a process owner; strategic management: - managers involved in the long-term alignment of IT with business needs; tactical management: - managers involved in the allocation of resources and the configuration and management of the ISM system; and operational management: - managers involved in setting up, operating and monitoring specific processes. We considered KENET as the sole process owner although each institution has their own processors. But to determine these key responsibilities we used the following questions:

I. Is there any co-ordination or strategic management deployed between leadership of KENET and leadership of the security function at the implementation level? If Yes, then is the security objective is met and risk, cost of mitigating risk is minimized? One key mission of KENET is to offer ICT Leadership in all the member institutions. This whole-school approach adopted by KENET is important in planning and implementing any E-learning environment. To implementing E-learning in Kenya under the ICT realm of staff issues, there was vision and leadership from senior ICT management, which greatly affected the ability to successfully implement an E-learning environment at Kamiti secondary and Maseno University. This study highlights the importance of a vision from the ICT managers to the success of implementation [13]. II. Strategic vision: Were the information security objectives identified?

Also the three schools from the study had employed people in ICT management positions to ensure that there was strategic vision and leadership through the change process. Both primary (NEPAD e-schools) school and University (Maseno) exhibited similarities in organizational structure, which resulted in the successful implementation of the E-learning environment, which met confidentiality-through proper authentication and access controls; integrity-tried to use VSAT(NEPAD) and Cisco internetworking devices(Maseno); and availability- using secured network and VSAT. The donors/sponsor in the NEPAD project employed a key player in the organizational structure, a middle management tier for the VSAT co-ordination.

This is equivalent to employees undertaking fractional duties of ICT co-ordination and teaching within the school. In all these cases both government (through NEPAD e-schools initiatives) and KENET appeared to be the link between the strategic planners at the ICT management level and the teachers who were to deploy the E-learning environment at the facilitation level. This ICT co-ordination at these schools played highly in the successful implementation of E-learning. This co-ordination level is the expected level of identifying the risks, vulnerabilities and any malfunctions. But what assistance did the institutional leader require in order to improve security management capability in their areas: - primary, secondary, or tertiary?

KENET presents levels of ability and willingness in planning security and managing resources for the implementation of E-learning [14]. However, there seems to be no known process owner (Chief Security Officer) directly assigned to follow through with after-install services. To understand the applicability of the ISM3 in this exploratory research, it is important to understand ICT level Management because ISM3 requires every information security process to have an identified process owner who delegates operation or maintenance of a process to another role, while retaining responsibility and supervision for the process.

6. 2 Discussion

It is through well-defined processes that information Security is improved, risk is reduced and maturity is measured. The evaluation matrix exhibits the capabilities of incorporating strategic, tactical, and operational management that ultimately ensures effective management of the E-learning implementation process in a way that would reduce risk of loss of and integrity data; ensure availability of E-learning resources; and confidentiality of both teachers and students at the respective institutions. ISM3 is the best process-oriented approach to evaluate E-learning implementation maturity at this point in time. As a maturity model, ISM3 provides an architecture model applicable at any security maturity level of any size of organization. It can be applied

cleanly with high sophistication to assure business objectives, which are specifically tailored to security design, implementation, operations, management, and assurance processes. It is structured into maturity levels based on strategic, tactical and operational security metrics so that organizations can choose any appropriate level to move in stages towards it.

The key objective of this research was to evaluate and discuss the applicability of information system management maturity model (ISM3) in E-learning implementation at primary, tertiary, and secondary levels of education in Kenya based on security objectives. One thing that is very apparent in this research is that even though E-learning has much in common with in-class teaching, there is one crucial and notable difference in how the process is often organized. E-learning was introduced as a project with a clearly defined start, but vague security objectives in that need to be met at limited budget. Thus, to explore the feasibility of the project aspect, security was not relevant. In this research our focus was on the process model.

After successfully applying ISM3 model to relatively new E-learning implementation in Kenya education system, we tested the applicability of ISM3 to identify the various levels of maturity. Security objectives were expressed in fairly general terms such as: 1) Use of services, access to storage, and user's restrictions to authorized assets; 2) Making sure that expired or end of life-cycle repositories are permanently destroyed or sanitized; 3) Personal information of learners and teachers is accessible for a valid purpose to authorized users on a need-to-know basis; 4) secrets are accessible to authorized users only; 5) Appropriately licensing and accessibility to authorized users (teachers and learners); 6) physical security to the Information repositories and systems (servers), among others. And because every project is exposed to some risks, overall ISM is an essential task in project management. In the typical security models, the first step is to identify what might be worth protecting.

From table 8, we establish in this research that the security concept of E-learning can be evaluated, although the implementation of the system remains hidden. There is more security awareness, better security infrastructure especially network security management incorporated in the E-learning implemented at the tertiary level as compared to the IS employed at secondary schools. The primary E-learning implementation (NEPAD project) is a donor funded project with better ICT strategic and operational management. In all these cases there is maturity at level 1. This means that at least the E-learning implementers have taken basic technological measures and achieved security objectives at level 1. None of the three institutions achieved level 4, and only

Maseno (tertiary) achieved level 3 maturity. This may also reflect the country's increasing dependence on donors and partners in the field of information security technological advances in order to satisfy local demand.

Information security maturity in e-learning implementation at primary, secondary and tertiary (college/university) can be measured. It is not necessary to consider whether the asset is really valuable enough to protect or simply create a list of all assets, but to clearly identify what level of security one needs to achieve to ensure that the four basic security requirements confidentiality, Integrity, Availability, and non-repudiation are achieved.

6.3 Recommendations:

1. Senior management of each respective institution should be trained on security awareness and education and made responsible to ensure integration of security controls throughout the organization.
2. All the security targets require that data with similar criticality and sensitivity characteristics be protected consistently regardless of where in the E-learning system it resides, coordinate IS with physical security, and finally ensure an effective IS awareness program has been implemented throughout the organization
3. Appropriate reporting mechanisms should be in place to allow management to make judgments as to the fulfillment of those responsibilities.
4. Determine the return on security investment as the best measure of quality e-learning implementation

7 Conclusion

ISM3 is proposed as one of the main ways of overcoming some of the key challenges in effectively implementing quality E-learning in Kenya. ISM3 metrics do not measure risk or security directly, but use process metrics that measure: Activity - number of work products produced in a time period; Scope: The proportion of the environment or system that is protected by the process. ISM3 is sensitive to security objectives that mitigate risks, the level of maturity in Information security management and maximizes the return on security investment, and to the availability of information security process metrics in E-learning. The exploratory study draws on literature reviews, E-learning policies and strategies, which have been developed by the MoE in conjunction with KENET in E-learning implementation. Examples were drawn from case studies in primary, secondary schools and higher institutions where E-learning has been implemented. Resulting information acquired from the case studies were evaluated for the purpose of testing

applicability of Information security management maturity model on the E-learning implemented in Kenyan primary, secondary, and tertiary levels of education.

From the exploratory study drawn on literature reviews, E-learning policies and strategies, and the three case studies, ISM3 was used to test applicability of evaluating the security in the e-learning implemented in Kenya. Of the many ways of overcoming some of the key challenges in effective implementing of quality e-learning in Kenya, ISM3 was chosen to be the most appropriate. The 1) Strategic and tactical management in the Kenyan E-learning implementation context was defined as the output (from the processes) of either products or services. And because SM3 requires an organization to state its security objectives, which are typically used as the basis for design, implementation and monitoring of the ISM system. Security objectives in these cases have been expressed in fairly general terms using the information system model, such as:

1. Use of services and access to repositories by only and restricted to authorized users;
2. Personal information of students and teachers is accessible for a valid purpose to authorized users only and is held for no longer than required;
3. Access control to authorized users only;
4. Third party services and repositories are appropriately licensed and accessible only to authorized users;
5. Information repositories and systems are physically accessible only to authorized users at all times [13]. And by using ISM3 as the baseline, KENET E-learning implementation achieved the minimum level of information security management maturity at level 1 of ISM3.

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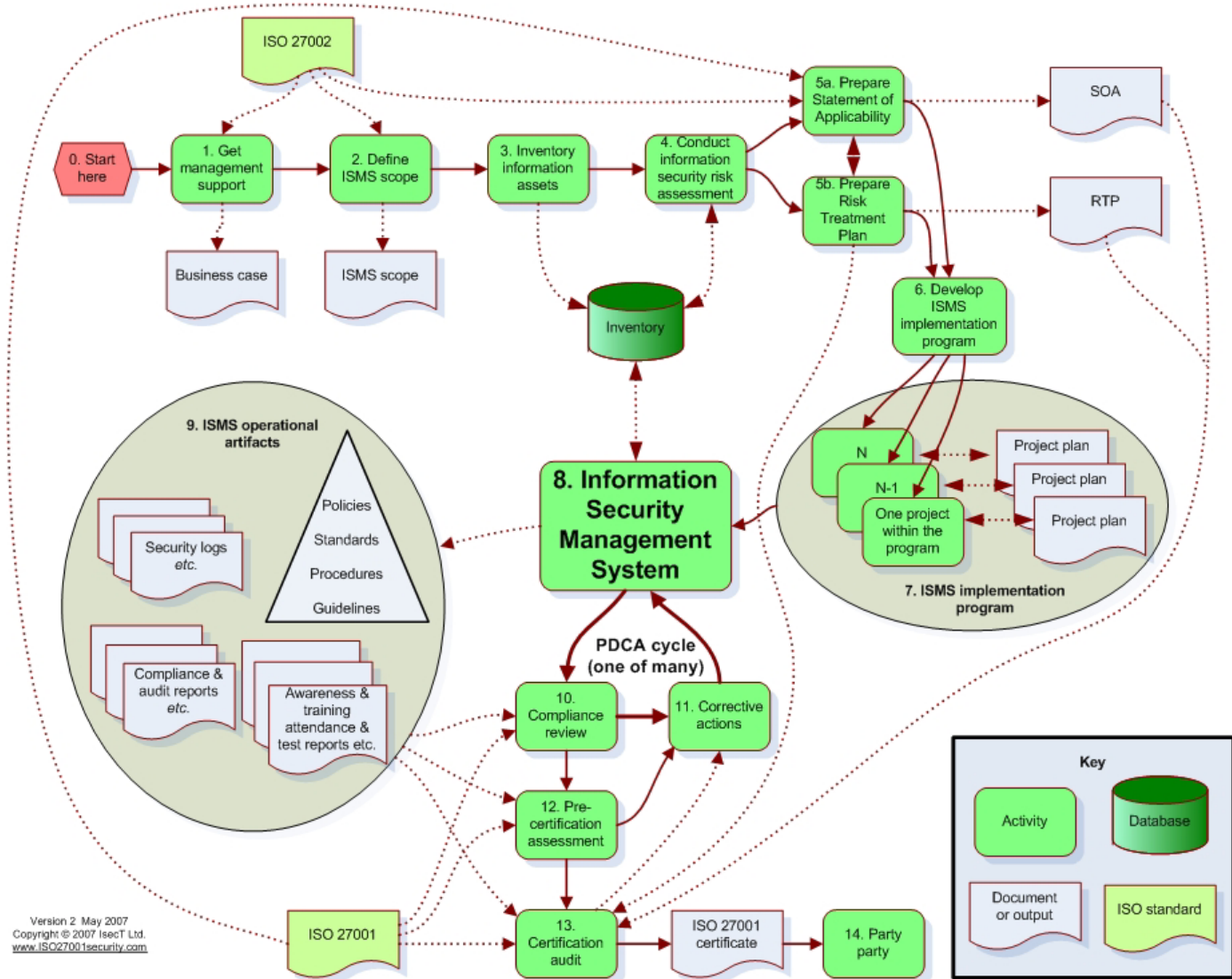
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