Interoperability issues for the Deployment of Unified Communications and Integrated Collaborations System in the Health Sector of Developing Countries: A case of Uganda

Excellence Favor[1] and Bakari M. M. Mwinyiwiwa[2]
University of Dar es Salaam, excellencefavor@yahoo.co.uk
University of Dar es Salaam, College of ICT, Department of Electronics and Telecommunication Engineering
bakari_mwinyiwiwa@yahoo.com

***Abstract*—Access to information holds the key to the empowerment of everybody despite where they are living. This research is to be carried out in respect of the people living in developing countries, considering their plight and complex geographical, demographic, social-economic conditions surrounding the areas they live, which hinder access to information and of professionals providing services such as medical workers, which has led to high death rates and development stagnation. Research on Unified Communications and Integrated Collaborations (UCIC) system in the health sector of developing countries comes in to create a possible solution of bridging the digital canyon among the communities. The aim is to deliver services in a seamless manner to assist health workers situated anywhere to be accessed easily and access information which will help in service delivery. The proposed UCIC system provides the most immersive telepresence experience for one-to-one or many-to-many meetings. Extending to locations anywhere in the world, the transformative platform delivers Ultra-low operating costs through the use of general purpose networks and using special lenses and track systems. The aim of this paper is to identify the interoperability issues anticipated in the deployment of the UCIC system in the health sector of developing countries and recommend possible solutions. These recommendations once adopted and implemented correctly will bring enhancement to the speed and quality of services offered by health workers. The capacities of UCIC will help health workers shorten decision cycles, accelerate service delivery and save lives by speeding access to information and by making it possible for all health workers and patients to collaborate everywhere.**

***Keywords*— Developing countries, Health sector, Interoperability, Unified communications and integrated collaborations.**

I. Introduction

The health sector Information and Communication Technology (ICT) infrastructure has to become an enabler for the medical strategy of growth, excellence and good performance by providing premier information services and contributing as a valued service provider for its citizens. Establishing a foundational infrastructure sets a platform on which higher level services can operate. Central to this platform system is the establishment of a Global Directory and Authentication Service. With these core services in place, attention and effort can be focused on other services that enhance medical business processes like email, data collaboration systems, Network Access Protection [1], Active Directory (AD) Rights Management Services [2] and System Central Management. Additionally, by simplifying and eliminating the duplicated effort of providing core platform services like network, directory and authentication [3], Information Technology will be able to provide high quality and efficient services to the health sector.

The health sector should be therefore able to deliver a robust infrastructure that caters for the following initiatives: Messaging – Email & Calendaring; Collaboration - Web Portal services [4], Intranet [5]; Unified Communication – Instant Messaging, Conferencing, Presence; System Management and Security [6]; Change management – Training & Process. UCIC is the integration of real-time communication services such as instant messaging (chat) [7], presence information [8], telephony (including IP based telephony) [9], video conferencing [10], data sharing (including web connected electronic whiteboards or Interactive white Boards) [11], call control [12] and speech recognition [13] with non-real-time communication services such as unified messaging (integrated voicemail, e-mail, SMS and fax). UCIC is not a single product, but a set of products that provides a consistent unified user interface and user experience across multiple devices and media types [14].

UCIC allows an individual to send a message on one medium and receive the same communication on another medium. For example, one can receive a voicemail message and choose to access it through e-mail or a cell phone. If the sender is online according to the presence information and currently accepts calls, the response can be sent immediately through text chat or video call. Otherwise, it may be sent as a non real-time message that can be accessed through a variety of media. TelePresence is a combination of cutting edge audio, video and network enterprise solutions, also hardware optimized environments and a software glue that holds the elements together to make the best high definition video presence available in industry today [15].

UCIC is a very new, unique, innovated technology that creates in presence, high definition, virtual meeting possible.

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It is known that predominantly it is about productivity, getting people in front of others and in a very virtual environment, but creating that in presence experience is the key aspect [16]. Furthermore, TelePresence is about improved responsiveness for health workers to be able to respond to patients, to be in presence of patients, also for subject matters to get in front of the patients very promptly, therefore TelePresence enables that to happen. The aim of this research work is to develop an environment with seamless flow of information in the health sector by using UCIC system, thus enabling prompt medical services delivery in the health sector which will reduce the death rate in the developing countries

The Health sector Information Technology optimization should begin with infrastructural and foundational elements such as Directory, Identity and Authentication services. The services will lay the foundation for an evolution towards a high-value IT service structure, followed by such services as Microsoft Unified Collaboration including Messaging and Unified communications, firewalls, endpoint (Forefront) security, Microsoft office applications, Active Directory Rights Management Services (AD RMS), Network Access Protection (NAP), Management infrastructure, legacy clean-up and optimization, and then on to a state of other expanded well-tuned services where as the user is in the middle as shown in figure 1.

II. Interoperability

Interoperability is defined as the ability of information and communication technology (ICT) systems and of the business processes they support to exchange data and to enable sharing of information and knowledge [17]. Similarly, the ISO TC204 document N271 [18], provides a definition of interoperability as the ability of systems to provide services to and accept services from other systems and to use the services so exchanged to enable them to operate effectively together. Interoperability is thus a basic ingredient of data-sharing. Interoperability is a concept which is required for UCIC systems for data sharing and is enforced through adoption of consistent standards for digital/spatial data technical specifications such as data formats, database schema, object concepts and application syntax.

Interoperability issues in Uganda have not been given much attention essentially because previously, government functions were not computerized and interactions between government organisations were manual, often resolved by the intuitive powers of human beings. Recently, the Government of Uganda has provided policy and legal framework for electronic transactions by instituting cyber laws such as Electronic Transactions Act (2011), Electronic Signatures Act (2011) Computer Misuse Act (2011) and the Land Information Systems Draft issues paper (2011).

A.Policies

Institution of ICT transaction enabling laws implies that more complex interactions requiring exchange of digital data will be initiated between government organisations, the business community and the general public. However, implementation of the laws will require, first and foremost, establishing of frameworks for addressing interoperability issues. Elsewhere, the need for addressing interoperability has been identified at national and regional level by developing policies and infrastructures for exchange of digital data. Some good examples are the European Interoperability framework, Infrastructure for interoperability and data exchange rules [19], the US Spatial Data Infrastructure [20] and the Asia and Pacific Spatial Data Infrastructure [21]. Although these examples provide a good foundation for developing similar frameworks in Uganda and other developing countries, information-sharing infrastructures should be developed after understanding the needs of the society, the operating social system environment and technical environment that the infrastructure is to support.

Figure 1: Conceptual Diagram of UCIC Places User in the Middle.

In this study, interoperability was broken down into sub-components of organizational interoperability; semantic interoperability and technical interoperability as specified in the European Interoperability Framework [17]. Assessment of interoperability along the three aspects provided a structured and comprehensive framework for describing of all the salient issues pertaining to digital data accessibility and utilization in Uganda.

B. Assessing Organizational Interoperability in Uganda

An organizational structure consists of activities such as task allocation, coordination and supervision, which are directed towards the achievements of organizational goals. Organizational interoperability can be seen as an important enabler of all aspects of interoperability, semantic as well as technical [22]. Therefore, organizational interoperability is a first precursor to data exchange. The organizational aspect of interoperability as defined in the European Interoperability Framework document [17] is concerned with interactions between institutions that wish to exchange information and may have different internal structures and processes as shown in figure 2.

C. Organisational Interoperability Issues

Within the context of digital and spatial data utilisation,

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organisational interoperability is facilitated by an efficient and relevant Digital and Spatial Data Infrastructure (DSDI).

However, this is lacking in Uganda largely because government has been slow in putting in place legal, institutional frameworks and mechanisms for setting up a National DSDI.

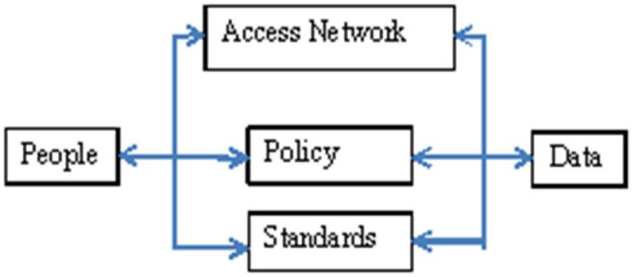

Figure 2: Digital data exchange infrastructure [23].

D. Users and Environment

Change management is a critical part of any project that leads, manages and enables people to accept new processes, technologies, systems, structures and values. It's the set of activities that helps people transition from their present way of working to the desired way of working. The focus of change management is to address the people and organizational factors that will both drive and obstruct change throughout the organization. The ultimate goal of any change initiative is to ensure everyone in the organization is ready, willing, and able to appropriately perform their role in the new environment (interoperate). Management Agility – Growth and restructuring are part of normal operations for the Health sector of Uganda. The IT infrastructure needs to handle these events as a more natural part of the IT ecosystem instead of as a major exception to the IT operations to ensure interoperability. – the attitude of UCIC users, envisioning, planning and implementation of a proper change management process will bring about interoperability to a success.

E. Assessing Technical Interoperability aspects in Uganda

In the European Interoperability Framework document, technical interoperability encompasses key technical/ technological aspects such as open interfaces, interconnection services, data integration and middleware, data presentation and exchange, accessibility and security [24] services. This definition compares with the technological interoperability definition [25] which is the ability of a GIS to integrate services and data from multiple sources and in different formats. In this assessment the age of devices, mobile computing trends, access to internet, usage of cloud computing based services, applications, services on line and protection of computers in Uganda are discussed as this aspects relate to technical interoperability of UCIC system:

F. Average age of computers

About fifty eight percent of computers in government institutions are between 0 and 3 years, with the average last major purchase of computers by the majority of government institutions having been made in 2010 as shown in figure 3

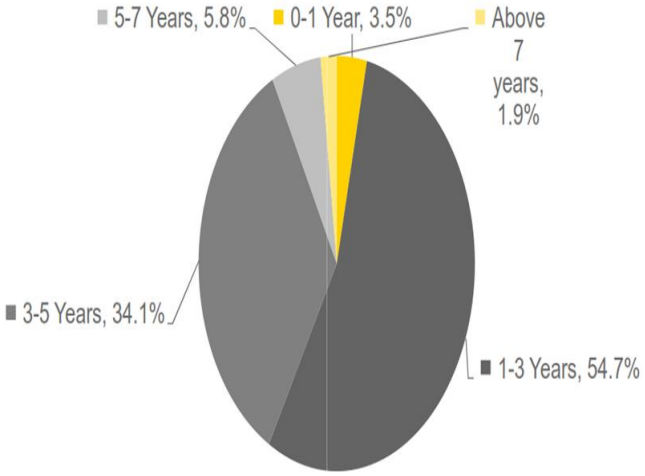

Figure 3: Average age of computers in Government institutions [26].

G. Mobile Computing Trends

The current trend shows that 21% of government institutions offer services or information to end users that can be accessed using a mobile phone as shown in figure 4.

Considering that the mobile phone penetration rate in the country is at 51% according to the Uganda Communications Commission, it is vital for more government institutions to engage in developing e-government initiatives that can be implemented with mobile phone technology accessible platforms. 23.6% of respondents in government currently permit the use of tablet. Only 13.6% of respondents have made policy adjustments to mitigate the risks related to mobile computing.

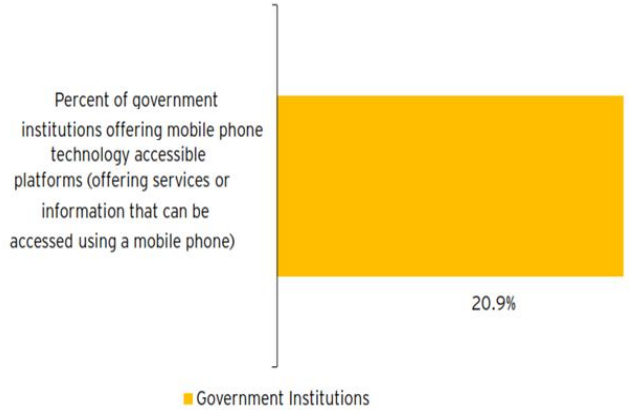

Figure 4: Mobile phone technology accessible platform (EG5) [27].

While personal adaptation rises, business use for tablet computers lags. For the first time, consumer technology trends are driving business technology demands. However, as the use of tablets continues to rise, institutions struggle to find ways of keeping pace with the security concerns that come with them. Establish governance and guidance for the use of both mobile devices and their associated security software products. Banning the use of mobile devices may actually increase the risk exposure.

H. Access to the Internet by type of access

Several government institutions have more than one way

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of connecting to the internet; however, the majority of institutions; 51% are connected via fixed broadband Fibre Optic Cable. 38% of institutions are connected via Fixed Broadband Wireless AP, while 33% are connected via Fixed Broadband Copper Cable. Figure 5 provides a summary of internet access type by government institutions. The fibre optic cable, wireless AP and the copper cable, all on fixed broadband are the most common connection options. Twenty percent of government institutions connect via mobile broadband reflecting the increasing importance of mobile computing and the transition to a mobile workforce in government. Of concern is the 6% of institutions still connected via Narrowband Dial Up.

Cloud computing based services

The currently available survey data reveals that 51.7% of government respondents are not using cloud computing-based services and have no plans to do so in the next twelve months. Government institutions are cautious in their adoption of cloud computing-based services due to the lack of clarity around security implications and measures. Of the 6.9% respondents using cloud computing services, none have approved policies for cloud computing. Figure 6 shows the percentage usage of cloud computing based services by government institutions.

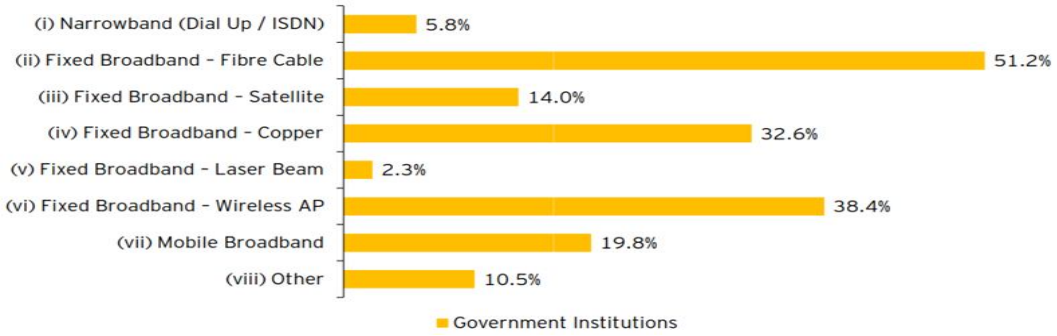

Figure 5: Percent of government institutions with access to the Internet by type of access [26].

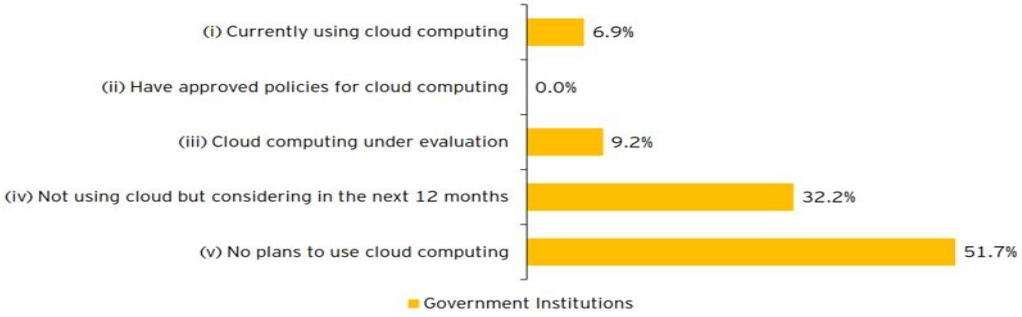

Figure 6: Percentage of government institutions that are currently using cloud computing based services [26].

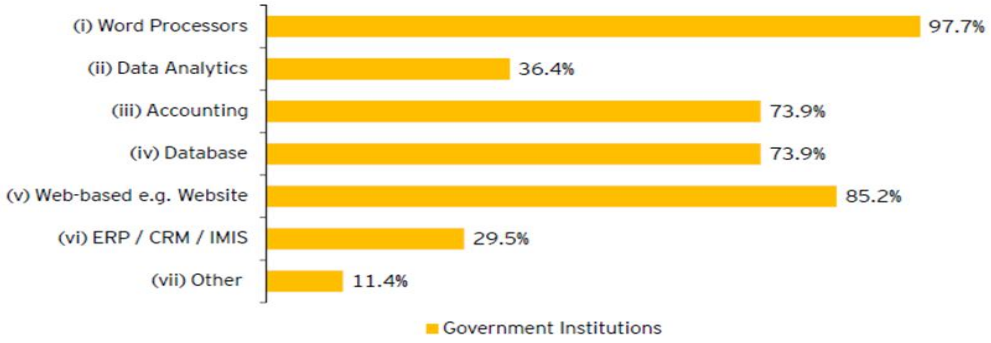

Figure 7: Type of applications used in government Institutions [26].

Software Applications

Ninety eight percent (98%) of government institutions have word processing applications, with 85% having web-based applications, and 74% having accounting and database applications. Thirty percent (30%) of government institutions have ERP / CRM / IMIS systems, reflecting a need for progression in this area to enhance the re-engineering of business processes that deliver services to businesses, citizens and other government institutions as shown in figure 7.

Online Services

With the vast majority of government institutions having applications that can support online transactions, it is important that the development of e-government initiatives that support online processes that will benefit businesses

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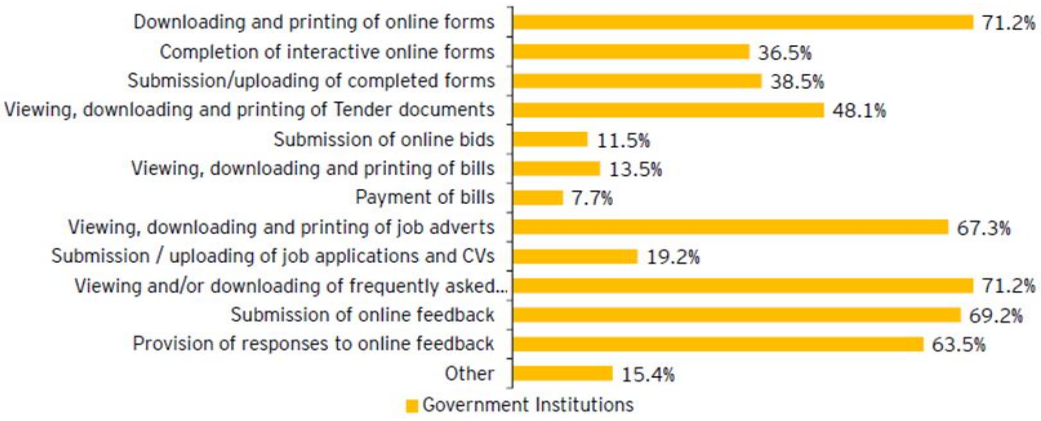

Figure 8: Percentage of Government institution providing services online [26].

and citizens is considered as a priority.The survey did not reflect a consistency in government institutions using other software applications outside of the commonly used MS Office products and Microsoft Operating Systems. Less than half (45%) of respondents indicated having a software upgrade strategy or policy or guidelines governing software upgrades. Figure 8 shows percentage of government institutions priding services online.

Usage of Shared IT Services

Seventy seven percent (77%) of Government institutions have shared IT services, 18% Enterprise resource planning (ERP) system, 36% have office productivity system, 12% Collaboration tools, 3 % Quality assurance tools as shown in figure 9.

ICT Indicators on ICT Infrastructure and Access

With only 1 person in every 100 people having a fixed telephone line or 1% of the population; there is a high likelihood that due to the infrastructure requirements for having a fixed telephone line, more and more people will use mobile phones to meet their communication needs due to the mobile nature of the modern workforce. Consequently, e Government initiatives are geared towards developing mobile phone technology accessible platforms as opposed to focusing on using fixed telephone line technology. With a 51% mobile phone penetration rate nation-wide more than half of the Ugandan population is ready to access e-Government services via the mobile phone. The majority of the fixed internet subscribers are mostly likely to be medium and large size businesses as well as government institutions. The awareness indicators are shown in figure 9. Mobile broadband subscriptions are 4 times the number of fixed internet subscribers and 12 times the number of fixed broadband internet subscribers.

Technical Interoperability Issues

The assessment results for technical aspects for interoperability of UCIC system show that the age of the computing devices will allow the UCIC system to integrate in the communications system since 54.7% of the devices are compatible to the deliver triple play services (voice, data and video conferencing). Access to internet is via fixed broadband and mobile broadband using latest technologies. Cloud computing is being adopted at very steady rate.

- 55% Intranet and Relational database management systems
- 40% computing.
- 36 % Office productivity
- 34% Unified communications
- 31% Content management systems
- 19% Use the national IT Backbone
- 10% Business Continuity Management

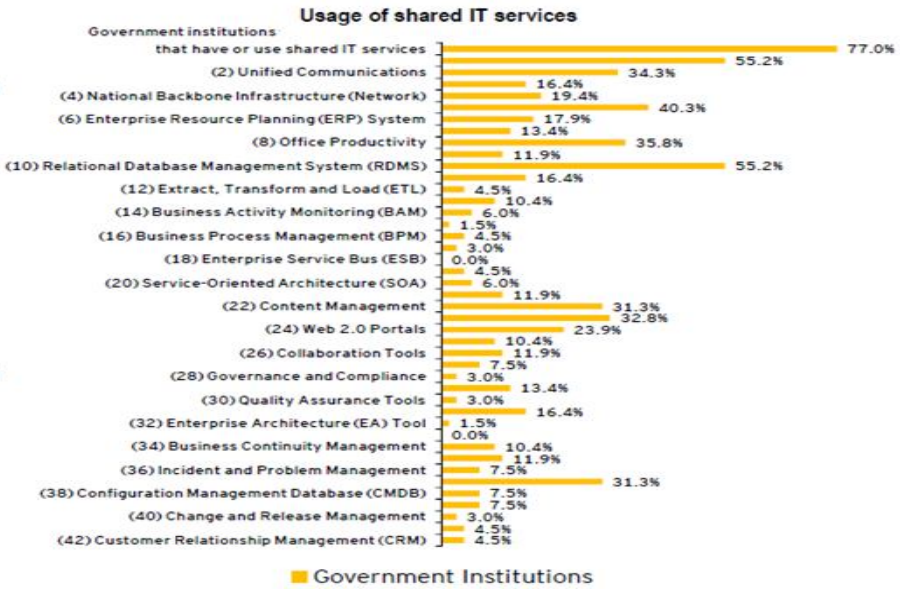

Figure 9: Usage of shared IT services [26].

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There is uniform usage of standard applications. The systems are protected by either firewalls and/or antivirus at various levels thus online services are accessed with few risks. The indicators lay a good platform for interoperability of UCIC system to the health sector systems of Uganda.

Assessing Semantic Interoperability

The European Interoperability Framework categorizes semantic interoperability as that aspect concerned with ensuring that the precise meaning of exchanged information is understandable by any other application that was not initially developed for this purpose. Semantic assessment and translation are key aspects of interoperability because the two ensure that digital and spatial data exchanged between different organizations is consistent in terms of meaning. Assessment of semantic similarities involves comparison of the meanings of concepts used in various databases for the purpose of establishing the necessary links between different spatial ontologies [25]. Many approaches for semantic similarity assessment such as semantic networks [28], the knowledge base approach [29]; [30] and Semantic Proximity approach [31] have been employed for semantic similarity assessment.

Data Semantic Interoperability Issues

Among all the aspects of interoperability, semantic interoperability is the least understood and appreciated in Uganda. This is not surprising, according to the stage sophistication model, where interoperability becomes a requirement once an organization tends to the topmost stages This trend is illustrated by figure10.ganda, most organisations do not have any services online, a number are currently putting some of the information online while very few and mainly those in the private sector have reached the case handling stage. Interoperability issues associated with data semantics have not yet posed a big threat because of limited exchange of digital and spatial data. However, semantic International Journal of Spatial Data Infrastructures Research, 2012,Vol.7, 488-507 498 related issues will be fully understood once organisations reach the top levels of the model and begin encountering problems in data exchange.

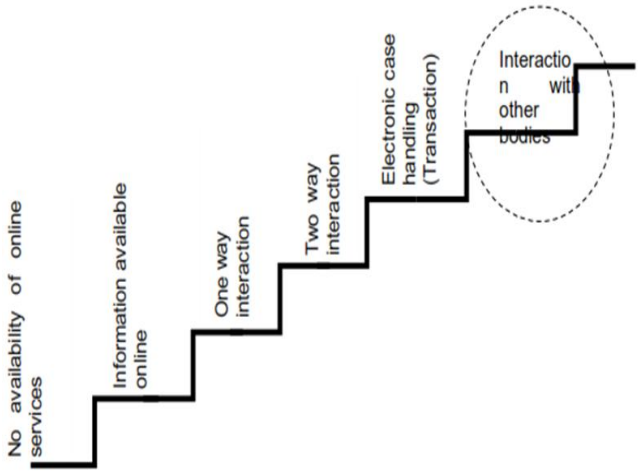

Figure 10: Stage Sophistication Model [30]

III. Challenges Of Interoperability For Ucic

In the study of the interoperability issues a number of challenges were identified as follows:

- Disparate/fragmented IT initiatives and systems
- Lack of uniform structure for ICT personnel
- Lack of standards on ICT infrastructure, applications and software
- Inadequate staffing and limited ICT skills
- Poor management of IT programmes and projects leading to high failure rates
- Limited sharing of information across different players
- High cost of ICT infrastructure and facilities including licenses coupled with procurement styles and modes that do not facilitate harnessing the economies of scale
- Slow generation of content leading to irregular update of websites and web portals

Converging voice and video onto IP networks causes a pileup at the corporate gateway. NAT/firewalls and other gateway security devices are designed for data security. These data-centric solutions end up blocking IP-based voice and video calls at the boundary between trusted and non-trusted IP networks.

A. *Solution against blockage IP-based voice and video calls*

A VoIP or unified communications (UC) security solution can and must coexist with existing data networking and security equipment. This means that introducing application-aware firewall protection for the voice and video traffic using a network design that works in conjunction with existing security devices. A VoIP/UC security gateway must also offer broad interoperability with PBX systems, video content distribution networks and external carrier networks, which requires support for a wide range of protocols and interface standards. The ICT institution should cooperate to have standard ICT infrastructures, applications, software and access modes. Change management should be adopted, sharing of information and training of staff that are agile and dynamic in IT changes should be supported.

IV. Summary

When it comes to digital and spatial data interoperability, Uganda is still at the preliminary stages and this has been caused by manual processing of digital and spatial data by government bodies. Although the government has made policies and laws that support digital transactions for the business community and the general public, little effort has been made in ensuring interoperability of business processes and associated data. In the digital and spatial data industry, the availability of multiple government organisations with similar but semantically different datasets is a manifestation of lack of efforts towards ensuring organisational, semantic and technical interoperability. The current project on development of a Land Information System (LIS) where

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identification and authentication of parties to a land transaction requires access to national ID database is a clear example that interoperability should be a major agenda for the government of Uganda. A number of management information systems that are relevant to the health sector are either operational or are being planned. According to key informant interviews and the Monitoring and Evaluation Plan for the HSSIP 2010/11–2014/15, these include: health management information system, human resource information system, supply chain management system, integrated financial management system, global information system, and pharmaceutical information portal. The pharmaceutical information portal will form the basis for the central health data bank the one-stop centre for information about the health sector. Interoperability of all these initiatives will form an environment with seamless flow of information in the health sector by using UCIC system, thus enabling prompt medical services delivery in the health sector which will reduce the death rate in the developing countries.

Documentation of datasets and processes as part of organizational culture is still missing in Uganda. Without documentation of datasets, their discovery and utilization will be limited to the organizations where they are produced. Without metadata developed for digital data, the role and applicability of the digital data is hardly beyond the previous role of the manual records. Therefore efforts invested in computerization without producing metadata are almost futile efforts. Interoperability at organizational, semantic and technical levels will only be achieved if organizations change their culture about documentation. This will require considerable effort in awareness and capacity building.

V. Conclusions

Interoperability of digital datasets will increasingly become a big issue as more institutions recognize the benefits of using UCIC in their operations. Postponement of efforts to address the bottlenecks of data sharing will lead to increments in the number of non–interoperable datasets in Uganda. This will eventually lead to increased investment in efforts to rectify inconsistencies when data sharing becomes inevitable. A UCIC Infrastructure is seen as a means towards addressing interoperability issues in a unified and sustainable manner.

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