On Development of a Collaborative ICT Infrastructure for Online HIV/AIDS Advisory Service Provision

Simon Samwel Msanjila

ICT Department, Faculty of Science and Technology, Mzumbe University,
Block C, Room 111, P.O. Box 87, Mzumbe-Morogoro, Tanzania
simon.msanjila@gmail.com

Abstract. The initiatives to combat the spread of HIV/AIDS across African society have been following different approaches ranging from workshops and seminars to posters across streets. One of the main challenges has been on the dissemination of relevant information related to HIV/AIDS advices to the appropriate in demand users. However, the advances in ICT have not been benefited in this area and particularly in developing economy countries. This paper first provides an understanding of needs and challenges for developing an online infrastructure (Collaborative Infrastructure for HIV/AIDS Advisory Services – CIHAAS system) that can facilitate the provision of HIV/AIDS advisory services to youths. It also addresses requirement identification, specification of services and functionalities of the proposed ICT infrastructure, and finally, it presents architectural design of the proposed system.

Keywords: ICT, HIV/AIDS advisory services, CIHAAS infrastructure.

1 Introduction

In spite of the promising trends in the establishment and provision of e-services in various higher level education institutions in Tanzania there is still no a harmonized and standardized collaborative ICT platform for this purpose and particularly for knowledge related to HIV/AIDS advisory service provision. The trends on the provision of these e-services to young generation in Tanzania is moving from being limited at an individual university (even at the level of a single unit or department) to a kind of an alliance constituting a number of universities, medical centers and individual medical professionals which intend to use an ICT platform to support the provision of HIV/AIDS advisory services. However in Tanzania, universities have different culture for which regulations are established (public or religious) which shall influence the formulation of guidelines related to content, type and format of knowledge on HIV/AIDS advices that can be uploaded to their repositories or shared and provided outside the respective university through the supporting systems. The systems should have *affective capability* to enable tune itself to match the specific requirements and regulations of each specific university [Afsarmanesh, et al 2011].

Development of ICT platform suitable for supporting the provision of ICT enabled online environment that is capable of facilitating the collaborative delivery of live and

offline HIV/AIDS advisory services to young generation will reduce the severity of the challenge related to the lack of knowledge in HIV/AIDS prevention. Although it is promising to have such solution in place and perfectly working, however, there is still unclear understanding on the customized technical requirements, and there are no proper architectural designs that could support making decision related to which suitable systems and platforms (ICT- infrastructures) to develop. This paper addresses the requirement analysis and modeling of ICT infrastructure capable of providing or facilitating the provision of HIV/AIDS advisory services. The paper also proposes an architectural ICT platform design based on standards of service oriented architecture.

2   Collaborative Networks

Collaborative network is addressed as a new scientific discipline that covers the study of alliances consisting of a variety of entities (e.g. organizations and individuals) that are largely autonomous, geographically distributed, and heterogeneous in terms of their operating environment, culture, social capital and goals, but that collaborate to better achieve common or compatible goals (e.g. problem solving, production, or innovation), and whose *interactions are supported by computer network* [Camarinha-Matos & Afsarmanesh, 2005]. *A collaborative network (CN) is a network consisting of a variety of entities (e.g. organizations, people, machines) that are largely autonomous, geographically distributed, and heterogeneous in terms of their operating environment, culture, social capital and goals, but that collaborate to better achieve common or compatible goals, thus jointly generating value, and whose interactions are supported by computer network.* [Camarinha-Matos, Afsarmanesh, 2005].Collaborative network paradigm has been increasingly penetrating in market and society due to continuous advances in ICTs and particularly, the internet technology. This paradigm has been evolving with contributions from multiple disciplines including computer science, engineering, management, economy, organizational ecology, sociology, etc. For instance, in terms of ICT application in industry, this new discipline is a natural consequence of a long term evolution ICT-enabled enterprise related developments.

As the health sector in developing countries is continuously being pushed to operate with business mind, the need for establishing joint efforts is surely witnessed to health specialized organizations and professionals. Considering the current trend, these actors can hardly equip themselves to meet current demands in terms of resources, capital, professional experts, required knowledge, etc. for the provision of HIV/AIDS advisory services Thus collaboration is also seen to be amenable.

3   Collaboration Environments for Medical Experts and Youths

This work applies two specific forms of collaborative networks, namely one short-term type and one long-term type constituting medical organizations and medical professionals as entity members, namely: *Temporary Teams of Medical Experts* (TTME) and *Medical Advices Collaborative Environment* (MACE) defined as:

A TTME is an association of (legally) independent individual medical experts that come together and share knowledge and skills to achieve a common goal, such as providing HIV/AIDS advisory services to on demand university students.

In practice, TTME are configured constituting individual medical professionals who are members of the MACE environment and, therefore, the potential TTME partners are selected among the best-fit MACE expert members.

A MACE is defined as a "strategic" alliance of medical organizations, medical professionals, and youths and related supporting institutions adhering to a base long-term cooperation agreement and adopting common operating principles and infrastructures, with the main goal of increasing both their readiness and preparedness such as related to acquiring relevant knowledge and skills enough for collaboration in responding to complex queries of customer students on demanded HIV/AIDS advisory services.

4   Motivation for e-Services for HIV/AIDS Advices

The provision of e-services on advices related HIV/AIDS issues in developing countries is still limited traditional approaches such as face to face contacts. Tanzanian universities for example still do not effectively collaborate through computer network facilitation to share knowledge on these issues. Different universities have different repositories of knowledge such as digital repositories of publications of their academic staffs. However, there are still no inter-accesses of this rich and on demand knowledge among universities and thus stored advisory services on HIV/AIDS could be an example. Consequently, even the much needed web supported services such as for HIV/AIDS advisory e-services are difficult to initiate due to the lack of suitable collaborative ICT infrastructure. Collaborative provision of automated services shall benefit from the advances of collaborative network paradigm and penetration of internet technology within the societies. Fast developments in information technology and computer communications have acted as a boosting factor to the emergence of new forms of collaboration, and for this case collaborative networks applied in the area of HIV/AIDS advisory service provision can be mentioned. However, there exist a number of other common and important aspects that cannot be neglected if the application of this concept in this domain has to be realized. Poor communicational interchanges among partners also lead to mistrust, suspicion and ultimately discouragement and lack of commitments in a MACE environment or TTME consortium. Other related issues include the fairness / transparency / equality / reciprocity, etc., within the MACE. The aspects are also related to value systems, social protocols, etc. and cause negative emotional states.

5   Analysis and Specification of the CIHAAS System

The need for collaborative provision of e-services across Tanzanian universities is amenable, particularly considering the shortage of relevant professional staffs (e.g. those in the field of medicine,). In the same line and so for HIV/AIDS advisory service provision; there are a number of factors hindering students from accessing necessary information and advices physically to their location including following:

- **Feeling shame:** It is still perceived in the society that people with HIV/AIDS got the infection due to their irresponsible behavior related to sexual relations such as having a number of casual sex partners. Such type of life is not culturally supported although it is not legally prohibited. People do feel shame to face to face ask for advices to medical doctors on the ground that they will be seen as they have been misbehaving.
- **Studies' pressure:** Students do feel lacking enough time to handle their studies. Although the HIV/AIDS issue is sensitive, students might take it as less important for the purpose of spending more time in studies.
- **Distance from service centers:** Sometimes universities are located relatively far from centers where good and quality services and qualified medical professionals can be found. Thus students might fail to access such services due to distance reasons.
- **Unavailability of information:** University students have the ability to learn through reading various documents. However as it is still practiced in Tanzania, HIV/AIDS information is still provided through paper based means. Considering the cost of printing, the increasing of number of university students in the country, and the country financial position, printed copies are usually not enough to meet the actual requirements.

5.1   Elicitation of User Requirements for CIHAAS System

Identification of users of the CIHAAS system is based on the analysis of potential stakeholders for three defined general *service objectives* related to the provision of HIV/AIDS advisory services, namely:

Provision of demanded services: This service objective addresses the facilitation and provision of required advisory services including verification of the content of the provided information, verification of the quality of the services, etc. The potential stakeholders for this service objective are: MACE manager, CIHAAS system administrator, TTME planner, medical professional members, medical organizations, and MACE membership applicants.

Accessing of provided services: This service objective addresses the facilitation for access of the services based on user rights. This includes classification of services per user rights, provision of validation techniques to ensure right users, provision of right user interface for different modes of service delivery such as live or offline, etc. The potential stakeholders for this service objective are: MACE manager, system administrator, TTME planner, medical professional members, medical organizations, and university students.

Administration of the collaborative environment: This service objective addresses the services supporting the management and administration of the CIHAAS system. The service objective also addresses the required functionalities for management and administration of the MACE environments. The potential stakeholders for this service objective are: MACE manager, CIHAAS system administrator, TTME planner, medical professional members, and medical organizations.

Seven user groups are classified on the basis of these three general service objectives. These seven User Groups (UG1 to UG7) and their respective user requirements are presented in Table 1.

Table 1. Identification and classification of users of the proposed system

User group	User roles & rights	User requirements (UR)
UG1: CIHAAS administrator	• Highest administrative rights • Can view and execute all services • Can create and change user's rights	1. Viewing and change the rights and indicators for registering a new user of the system 2. View, modify and create advisory provision and accessing services in the system 3. Create, modify and execute services for the management of stored knowledge
UG2: MACE manager	• 2nd highest administrative rights • Can view, execute, modify all services	4. View and execute services for the management of MACE members and memberships 5. Defining, authorizing and assigning rights to users of the system based on their membership level in the MACE environment. 6. Supporting CIHAAS system users, such as the medical professionals or students, in providing or accessing the right content of the HIV/AIDS advices. 7. Managing the advices related data in the CIHAAS system.
UG3: TTME planer	• Third highest administrative rights • Can manipulate advisory provision services	8. Execute services for analyzing and assessing the competencies of medical professionals for establishing an expert temporary team 9. Execute services to change its own MACE membership profile 10. Execute services to provide and view advisory services in the system
UG4: medical professionals	• Basic user rights • Can view advices available • Can upload the requested advices • Can comment of uploaded services	11. Execute services to change its own MACE membership profile 12. Execute services to provide and view advisory services in the system 13. Execute services support accessing knowledge repository in the CHIAAS system
UG5: medical organizations	• Basic user rights • Can view advices available • Can upload the requested advices Can comment of uploaded services	14. Execute services to change its own MACE membership profile 15. Execute services to provide and view advisory services in the system 16. Execute services support accessing knowledge repository in the CHIAAS system
UG6: students	• Basic user rights • Can view advices available	17. Execute services to view advisory services in the system 18. Execute services to send specific service request to medical professionals
UG7: MACE guests	• Guest user rights • Can view public information only	19. Execute services TO view public information related to HIV/AIDS advisory services in the system

6   Specification of System Requirements for the CIHAAS System

Functional Requirements: Statements of services that the system should provide, how the system should react to particular inputs and how the system should behave in particular situation. Design of the CIHAAS system is based on the service oriented architecture (SOA) and in particular the web service technology. The provision of services related to HIV/AIDS is based on the concepts of e-services and thus acting as a platform supporting collaborative online service provision. Accordingly, the specified functionalities are referred to here as **services**. The system shall provide five integrated learning services namely service S1 to service S5.

Service S1 - Static information provision: The system shall provide or support publishing information that students can access through the web-based CIHAAS system irrespective of time and physical location. Considering the continuously increase of availability of internet accesses in universities in Tanzania such

information can easily and efficiently be disseminated to students. Thus the system shall provide a website interface for publishing well categorized and classified information based on the nature of knowledge, user rights, and hosting university.

Service S2 - Offline advisory service provision: It is expected that interested medical professionals will be registered in the system as members on the MACE environment. Their respective physical locations and employers will not be necessary since medical professionals shall join MACE environment on their own will. However, the public profiles and region/district location of each medical professional shall be made known to registered students in the system. This will enhance trust between medical professionals and students who might need services from anonymous providers. Provision of this kind of services adopts following approaches:

> **Service S2.1 - Email exchange:** With this service component, students in need of HIV/AIDS advisory services can select one or more medical professionals and send a private email. Although the emails of medical professionals will be hidden in the system but there will be an interface in the system providing this possibility.
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> **Service S2.2 - Uploading private request for advisory service:** With this service component, a student may upload a request for advices which can be responded by any registered medical professional. However, a student can also select specific medical professionals to respond to his/her queries. Collaboration among medical professionals is possible while responding to this type of queries through which each can provide additional information to those already provided online by other medical experts. The request is private, so other students cannot see the response.
>
> **Service S2.3 - Uploading public request for advisory service:** With this approach, a student has an option to upload a request for advices to the system and allow both his/her request as well as the responses to be seen by other students. Responding procedure by professionals is the same as stated in service S2.2.
>
> **Service S2.4 - Ongoing discussion forums:** This forum will allow medical professionals to discuss online the ongoing or emerging issues addressing relevant topics related to HIV/AIDS such an emergence of a new disease associated with HIV/AIDS. When sounding results are achieved in these discussions then with the decision and support of the forum convener the relevant content of the results can be made public to all registered students to enhance their knowledge.

Service S3 - Live advisory service provision: This service provides mechanisms and tools for real time discussion among medical professionals themselves or between medical professionals and students. The following methods shall be adopted:

> **Service S3.1 - Live text chat:** The system shall provide mechanisms for students and medical professionals to chat online using text messages. This method is very suitable to students who want to keep their anonymity medical professionals while being advised.
>
> **Service S3.2 - Live voice chat:** With little trust students might be open to chat to a medical professional who they have never met before using voice means. This method might enhance both the speed of chatting and the accuracy of the service delivery to the respective student.

Service S3.3 - Live video chat: A good level of trust between the student and the medical professional is needed for this type of service to be accepted by both parties. This may be achieved after several occasions of voice and text chats. This is most efficient way of providing advisory services but could lead to a problem if a misunderstanding emerges between the two parties considering the fact that already they know each other by face.

Service S4 - Advisory service retrieval: This service supports users of CIHAAS system to access various information and knowledge available in the system. The main beneficiaries of this service are the university students who will use this service to receive advisory information. The information can be accessed as private feedback on questions rose by specific students and responded by specific medical experts. The information can also be accessed as public data for members in the MACE.

Service S5 - MACE environment management: This service supports the MACE manager and CIHAAS administrator to handle issues related information management in the collaborative environment and membership management in the MACE environment. In relation information management this service support the MACE administrator to collect and store data related to medical expert profiles, university regulation profiles, medical organization profiles, students' details, MACE operating principles and regulations, MACE service domain, etc. The service also supports the classification and structuring of members and their membership rights in the system.

Non-functional Requirements: Statements on what need to be obeyed for the system to be capable to provide the required services to the user at the defined quality. Examples of non-functional requirements that shall be met by the intended ICT infrastructure include Privacy, Security, Reliability, and Interoperability.

Domain Requirements: Derived from the application domain of the system rather than from the specific needs of system users. Such requirements usually include specialized domain technology or reference to the domain concepts. They may be new functional requirements, constraints on the existing functional requirements or set out how particular competitions must be carried out. For the CIHAAS system domain requirements are classified into the following categories:

<u>Regulatory requirements:</u> Every university where students are attached has internal regulation on the type, content and format of information which can be shared or exchanged. In Tanzania, a university can be public, private or religious. HIV/AIDS related information might have some terms that might not be acceptable to certain institution such as religious. A particular domain requirement for this case could be content affective capability. In sense that the system must be aware to which university is being accessed and what terms or contents must be filtered to meet the regulation of the specific university.

<u>Health sector requirements:</u> These are international and local regulations that must supported or met with any system dealing with information in this domain. For example; such requirements may include details of students which can be public,

type of discussion between medical experts and students that can be handled virtually, how long information of a patient can be stored, etc.

National established regulation on health: Tanzania government has specific regulations on how to handle patient data. HIV/AIDS patients also in one way or another are affected by these regulations. To get permission on advices on HIV/AIDS regulations must be obeyed.

7   Towards Architectural Design of the CIHAAS System

Based on the services presented in Section 6, this section introduces the design of the CIHAAS system, addressing briefly its three architectures, namely: *the process architecture, interoperability architecture*, and *four-layer componential architecture*.

CIHAAS system processes architecture: A process as perceived in the proposed system is defined as an interaction between participants (medical professionals and youths) and the execution of activities according to a defined set of rules in order to achieve a common goal. Figure 1 shows interactions pattern of process. A number of processes shall be supported by the infrastructural system during the provision of advisory services on HIV/AIDS issues to young generation. At conceptual level the processes are categorized as (1) among medical professionals and young generation, (2) among medical professionals, (3) among medical professionals and stakeholders.
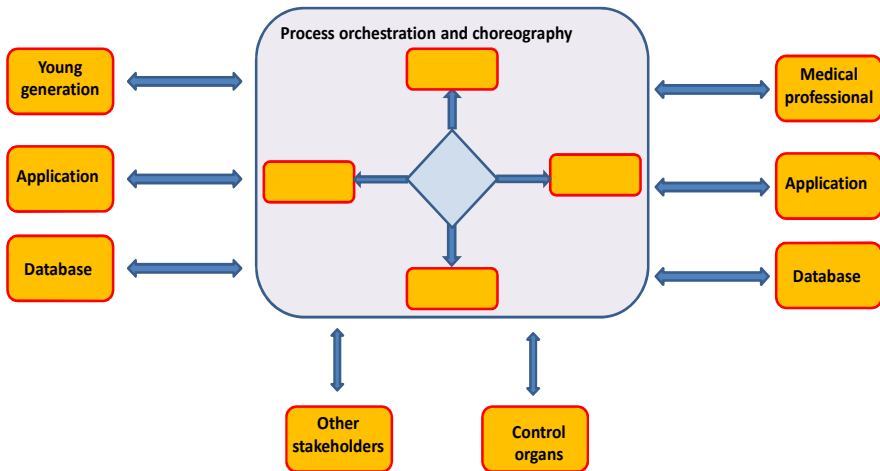

Fig. 1. Processes for the ICT infrastructure on HIV/AIDS advices provision

Interoperability architecture for the CIHAAS infrastructure: CIHAAS shall interact with local systems at the user site. As shown in Figure 2, interaction will occur for four main purposes: *(a) acquiring the local needed data, (b) exporting information from executed service to local repositories, (c) accessing basic services provided by the ICT-Infrastructure,* and *(d) supporting human user access.*
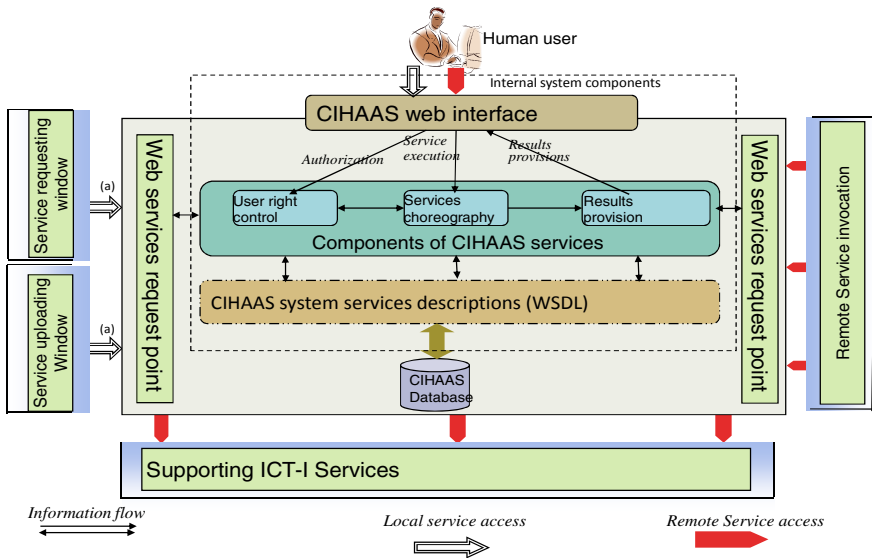
Fig. 2. Interoperability architecture of CIHAAS system

External interactions are supported by a number of internal components of CIHAAS system that are grouped into three categories, namely the component for: *(1) User right control, (2) Services choreography, and (3) Results provision.* The components for *user right control* provide functionalities for authorizing users (both human and system users) that wish to access the CIHAAS infrastructure. For the authorized users, these components also provide functionalities for classifying the services on the basis of the user rights as well as providing access to those services that each user is allowed to view or execute (such as public, restricted or administrative services).

The components for *services choreography* provide internal mechanisms and/or functionalities to organize the order and time for the execution of a number of services in response to each received user's request. The components for *results provision* organize and provide proper responses to requests received by the system, such as returning specific results for the successful requests, or returning negative response for the rejected requests.

The four-layer componential architecture of the CIHAAS system: The four-layer componential architecture of the CIHAAS system adopts the standard definitions for web service technology. Thus it addresses the classification of internal components (system modules) into four layers. The components of CIHAAS system, as shown in Figure 3, are classified into these four main layers, namely: the *presentation layer, the process layer, the description layer,* and *the message layer,* as described below.

Layer 1- Presentation layer: This layer deals with the delivery of HIV/AIDS advisory information from the process layer to the web interface in a format that is readable by humans. The layer also handles the transformation of data submitted by
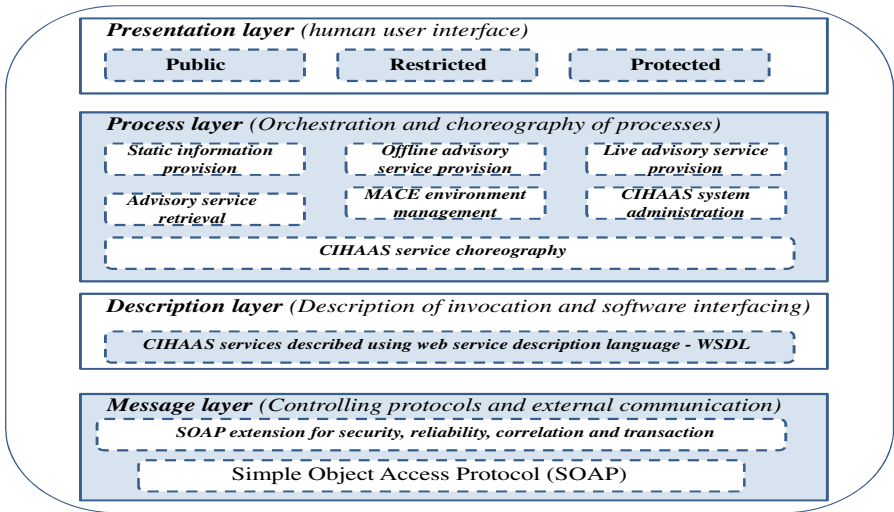
Fig. 3. Four-layer componential architecture of the CIHAAS system

human users, such as medical experts and university students, to the format that is acceptable by various modules at the process layer [Field & Hoffner, 2003]. The CIHAAS system manages and deals with some sensitive and ethically protected information that in most cases the owners may consider as proprietary, such as results of discussion on *personal sickness history*. The access of the system is classified into the *public interface, the restricted interface* and *the protected interface*.

Layer 2 - Process layer: The process layer is responsible for defining the logic of the invocation of various processes that need to be executed in order to provide the requested integrated service. The process scheduling constitutes *orchestration and choreography processes.* [Papazoglou & Georgakopoulus, 2003; Peltz, 2003].

Layer 3 - Description layer: Description layer deals with the provision of the grammatical specifications of the services provided by the CIHAAS system, to support the external invocations by remote systems.

Layer 4 - Message layer: The message layer defines the protocols for communication among systems and exchanging information across the network so that a receiving server/client may be able to interpret it [Peltz, 2003]. The standard applied communication protocol for web services is SOAP (Simple Object Access Protocol). Besides the standard SOAP protocol, additional mechanisms can be added to improve the security, reliability, adaptability, and so forth, of the system.

8   Conclusion

This paper has addressed the challenge on specification and design of a collaborative ICT infrastructure aimed at supporting the online provision of HIV/AIDS advisory services. The paper also presented the needs for e-services in this domain as well as the configuration of collaborative network for supporting joint initiatives of members.

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