Project Planning for a PAN Regional Health and ICT Research Network:

Review and Evaluation of Existing Project Outputs, Technology Scan and and an E-cology Conceptual Framework

IDRC Project No. 10336-001

Prepared

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1. Background, Scope and Objectives

1.1 IDRC Policy and Strategic Objectives

The International Development Research Centre (IDRC) is a public corporation created by the Parliament of Canada in 1970 to help developing countries use science and technology to find practical, long-term solutions to the social, economic, and environmental problems they face. Thus IDRC's mission is: Empowerment Through Knowledge. IDRC Support is directed toward developing an indigenous research capacity to sustain policies and technologies that developing countries need to build healthier, more equitable, and more prosperous societies. In carrying out its mission, IDRC provides funds and expert advice to developing-country researchers working to solve critical development problems that are crucial to their communities, provides expert advice and builds local capacity in developing countries to undertake research and innovate. With respect to information and communications technology (ICT) investments, IDRC's focus on the transformative nature of ICTs.

1.2 Project Scope and Objectives:

Guided by its mission and strategic approach IDRC targets its resources in regional contexts. For the purpose of this study the primary regional focus is the Pan Asia Networking program. Pan Asia Networking (PAN) seeks to understand the positive and negative impacts of Information and Communication Technologies (ICTs) on people, culture, the economy, and society, so as to strengthen ICT uses that promote sustainable development on the Asian continent.

The PAN program initiative supports research into innovative ways of adopting ICTs to address key development challenges, namely in the areas of health, education, livelihoods, and governance. PAN works with a variety of ICTs, however, at the heart of its programing are people — PAN believes that everyone in Asia should be given an opportunity to harness ICTs to better their lives. To meet this objective, PAN adapts its programing to the socioeconomic needs and technological shifting contexts of developing countries in Asia, ensuring that its research partners remain at the leading edge of technological improvements and development approaches.

Health and ICTs: Ingredients for a Regional Thematic Network

This overall goal of this study is to contribute to the realization of IDRC's vision to establish a regional research network that will focus on and provide a forum for assessing existing activities and fostering innovative use of ICTs in health care/services/delivery and education. This community will be characterized by regional leadership, technical and social innovation, scalability, policy relevance, capacity building, knowledge sharing and administrative resilience. The specific objectives of this study are:

1. To review and evaluate research outputs and project documentation from PAN's existing Health and ICT projects and make recommendations on if and how these would fit into a wider strategic regional research network.
2. To document the moving landscape of technological applications in the health field (including software tools, mobile, PDA and computer applications, etc.) and analyse their usefulness for the context of Asia and other developing countries.
3. To propose an e-cology conceptual framework for a developing country context.

2 Evaluation Framework

In order to determine if and how PAN's existing Health and ICT projects could fit into a wider strategic regional research network an framework was developed to provide a set of interrelated lenses to evaluate existing Health and ICT project research outputs and project documentation. The four lenses that make up the framework are: Health Domain(s), Adoption/Dissemination Maturity Stage, Technology Architecture and Strategy and Development Lifecycle and Continuous Improvement Process. These lenses are used to analyze and classify projects to expose patterns of potentially synergy among projects, identify potential starting points for “priming” regional collaboration, and to develop recommendations on how to shape the design of future projects to both benefit from and contribute to a regional research network.

2.1 Project Health Domains

This lens provides a view of the healthcare focus of projects both in terms of what clinical domain the project is focused on if any, and in terms of which of a number of interrelated “business” processes are supported by the ICT intervention. Clearly a strong catalyst for regional collaboration would be a critical mass of activity in similar or complementary health domains. The health domains defined in this study are:

- Clinical Focus – this is essentially the “content” domain and identifies the health issue, disease or other specific health subject are being addressed by the project. Examples include HIV/AIDS, pre-natal care, dengue fever etc.
- Research – this domain covers the ICT support of healthcare research. Examples include clinical trials and other forms of health research.
- Teaching and Learning – this domain encompasses the teaching of healthcare providers and other health professionals. Examples include continuous medical education of physicians, education of nurses and nurse practitioners.
- Delivery – encompasses ICT support of the delivery of care. This includes both administrative and clinical processes. Examples ICT systems in this domain include electronic medical records, medical imaging, and remote consultation systems.
- Wellness – this domain addresses both prevention and surveillance and monitoring of population health status. Examples include infectious disease prevention programs, disease surveillance such as malaria and dengue fever outbreak monitoring.

2.2 Adoption/Dissemination Maturity Stage

This lens helps to categorize initiatives in terms of where they are in the technology adoption lifecycle (see Fig.1). There are three stages defined in this lens: Readiness, Diffusion and Impact[1]. The stages are defined as follows:

- Readiness – in this stage projects are primarily focused on building the ICT solution and establishing the infrastructure needed to implement it

1 Adapted from Simpson, R. (1999). Defining and Measuring E-commerce. OECD Workshop.

- Diffusion – in this stage projects have completed the development phase and are focused on raising awareness and understanding of the solution in order to build a critical mass of users to support their research or other objectives.
- Impact – in this later stage of maturity projects have had their solutions and infrastructure in place for some time, there is a critical mass of use and it is possible to reliably and scientifically observe and measure the impact of the ICT intervention in terms of the initial goals and objectives of the initiative.

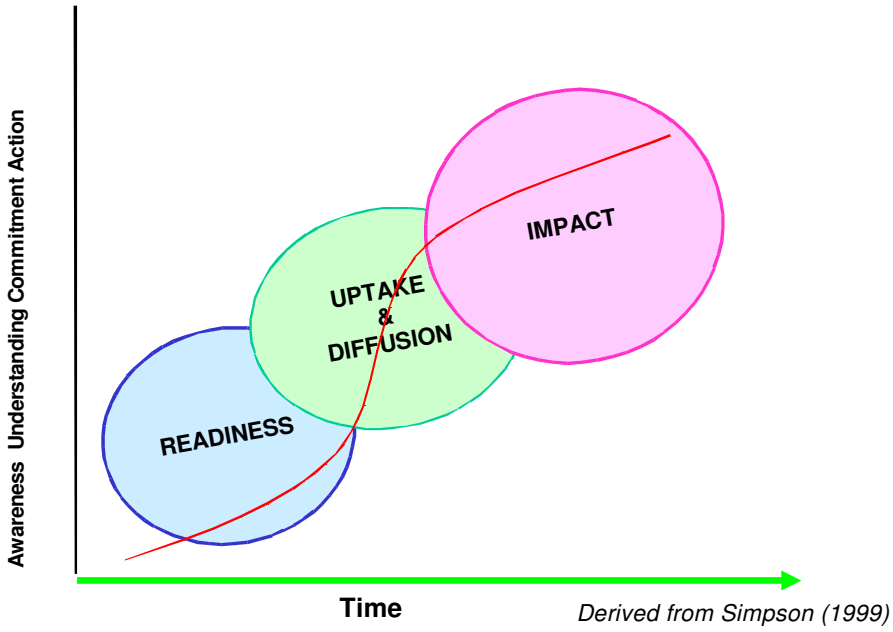


Fig. 1: Technology Adoption Maturity Stages

2.3 Technology Architecture Strategy

The Technology Architecture lens provides a view of the key technical characteristics of the ICTs employed in a project. Identifying these characteristics identifies opportunities for synergy, reuse, improvement and technical collaboration in the regional network. It also provides a tool for leveraging IDRC investment in ICT research and development. The Technical Architecture components are:

- Architecture – this component encompasses the technology architecture model employed. Examples include a centralized client server system, standalone, or distributed. Opportunities for regional collaboration will be greater if there is a critical mass of similar or complementary technical architectures employed in the ICT projects.
- Standards – this component identifies whether health IT or other standards are used in the project such a HL7. Knowing which standards are used helps determine how portable the solution is and ultimately whether regional collaboration can extend into the areas of data and knowledge sharing.
- Language – this component identifies in which languages ICT solutions are implemented. Clearly there will be greater opportunity for projects to fit into a wider regional research network if a common language is employed or if the solution is easily translated.

- Development – this component identifies whether the ICT solution is developed “in house” or purchased. Like the following category, this gives an indication of how easily the ICT assets of the project can be shared and improved in the regional network, and therefore whether a project would be a good fit for that setting.
- Licensing – the type of ICT and other intellectual property licenses either adopted or inherited by the project are critical to determining whether regional participation is possible or can be effective. Proprietary licenses for example will significantly limit the range of possibilities with regard to sharing and collaborative improvement of software and other ICT assets.
- Assets – this component describes the ICT assets developed by the project

2.4 Development Lifecycle, Collaborative Improvement Processes

This lens focuses on the ICT development “culture” of a project and encompasses the development lifecyle employed, the degree to which ongoing peer review processes used, implementation of collaborative support systems, and the degree to which development is driven by end users. The key elements of this lens are:

- Peer Review – is an open, evidence based, peer review process apparent. Peer review is an essential element of effective, collaborative research in the healthcare sector. Projects employing peer review process for both content and software will be more strongly predisposed to effective participation in a regional research network.
- User Driven – is there an iterative user driven culture and development process evident. Effective user participation in healthcare ICT development is a critical success factor for developing effective solutions, and facilitating change management and adoption. Projects employing participatory methods are more likely to be a good fit for regional collaboration.
- Collaborative Platforms/Process– are there tools and processes in place to facilitate participatory development, peer review and continuous improvement.
- Development Lifecycle – what type of ICT development lifecycle does the project employ, a sequential hierarchical approach versus an iterative improvement model
- Software Development – was the ICT developed in-house or acquired as a turnkey or commercial application. As a general rule of thumb, software that is developed in-house would be more amenable to supporting a research network because of more flexibility regarding intellectual property.
- Active – are the ICTs and the project organization still active. Projects that are no longer active may be able to provide assets to a regional research collaborative, but are unlikely to be good candidates for initiating a network.

The presence of ongoing peer review, participatory involvement of users, and support for collaborative processes in ICT projects suggest a strong “IT cultural” fit and predisposition for effective participation in a regional research network setting. The type of development lifecycle used provides an indication of of flexibility and adaptability in developing and enhancing ICTs. Projects that employ more modern, development lifecycles such as “extreme programing” are more likely to be amenable to collaborative development and open to external input and iterative improvement that typify the feedback processes and culture found in virtual ICT communities such as regional research networks. Organizations using traditional hierarchical approaches such as the waterfall method, are more likely to be less flexible or responsive to external input and rapid, iterative improvement.

2.5 Summary

In summary this multidimensional evaluation framework provides means to distilling the complex nature of health ICT research and development into a rich yet, common set of criteria that can be used to determine: whether there is a critical mass of PAN projects to help initiate a regional research network for healthcare ICTs, how and on what basis a network can be initiated, and where there is common ground and strong alignment among the numerous community members.

3 Review and Evaluation of Project Documentation and Research Outputs

3.1 ICTs for Health Services in Rural Mongolia

Overview

Mongolia has unique demographic and environmental characteristics which significantly impact healthcare delivery. With large distances to cover and a sparse population, transportation and communication is especially important and difficult in Mongolia. The Mongolian health system also faces many other challenges not directly related to disease incidence, including: extreme climatic conditions, a low density population spread over huge areas, growing health care demand, and a bloated health system with serious problems in cost-effectiveness and quality of services. Mongolia has inadequate health care and medical services and a shortage of health care professionals. Because of inadequate infrastructure (telecommunications, roads, and transport), it is more difficult to provide health care in remote and rural areas and to transport patients properly.

Objectives

The general objective of this project is to initiate research, development and experimentation in distance medical diagnosis and consultancy and in distance learning for rural medical doctors using Internet based applications. The specific objectives are:

- To create a knowledge sharing e-platform on health care, distance consultation, and diagnosis for all medical personnel.
- To establish distance diagnosis centers at the Health Sciences University of Mongolia in Ulaanbaatar and within medical centers in three selected rural areas.
- To experiment with new methods of delivering Internet based distance diagnosis and consultation of health care for patients
- To build and strengthen a research and practitioner network of health care between specialist family doctors and front line medical personnel.
- To investigate, assess, and adapt various medical distance diagnosis technologies using low bandwidth Internet.
- To develop web based e-learning materials for education of rural doctors.

3.1.1 Project Health Domains

Clinical Focus

Distance diagnostic priorities were based upon the morbidity and mortality data of selected rural areas. The most common three diseases focused on were those of the circulatory system, respiratory system, and digestive system.

Research

This project's ICT infrastructure is not specifically designed to support health research.

Teaching

The ICT distance learning solution was developed with the goal of providing doctors in rural areas the same continuous training and retraining available to their peers working in urban hospitals. The

advisory team prioritized disease topics for distance learning lectures based on morbidity and mortality in the rural population. The following subject areas were defined: Breast cancer, Gastric cancer, High blood pressure, Ischemia, Esophagitis, Hepatitis and Brain trauma. The subtopics for each included: Epidemiology,Background theory, Classification, Clinical locations, Choice and analysis of testing, Diagnostic methods, Differential diagnosis, Treatment, Prophylactic measures, Rehabilitation.

Delivery

The “Doctor” system was developed to facilitate tele-consultation. The system supported two types o f consultations: treatment (77.1%) and diagnosis (22.9%). The types of data transmitted included: Rural physicians complete their patient application. The test battery consists of urinalysis, blood test, biochemistry, X-ray, ECG, and immunology. The application functionality includes:

- User (doctor) management, doctor registration.
- Patient management
- Diagnosis module: request or reply X-ray, Ultrasonic and Cardiogram
- Database synchronization, audit trail, update

Wellness

The project did not employ ICTs to address disease prevention or wellness initiatives.

3.1.2Adoption/Dissemination Maturity Stage

This project concluded in what would be an early Diffusion stage as the development of the ICT platforms had concluded and the system had been implemented.

3.1.3Technology Architecture and Strategy

The ICT solutions developed by this project are potentially highly reusable as they are based on open source components. It does not appear that the system is tightly integrated with the data capture systems and that manual intervention is required to transfer data from an ultrasound system, for example, to the “Doctor” system for transmission to remote consultants.

Architecture	Standards	Language	Development	Licensing	Assets
Centralized web based client server, standalone CD ROM (for training)	XML RPC	Local	In House	OSS possible: use of Apache, PHP and MySql	e-Library system (Green Stone) full text databases. Distance learning system (Apache,PHP, MySql) Distance diagnosis support system including patient information system

3.1.4Development Lifecycle and Continuous Improvement Process

Significant effort was made in this project to scientifically quantify and analyze the use and impact of the tele-consultation system on care delivery. The system significantly affected the type of treatment

selected (73.45% of prescribed treatments were changed) and the diagnosis (36.9% were changed). The project conducted a comparative analysis of cost efficiency, speed, and quality of diagnosis before and after the introduction of the distance diagnosis technology.

Peer Review	User Driven	Collaborative Platforms/Process	Lifecycle	Active
Yes	High	Yes	Waterfall assumed	Yes

3.1.5Comments

This project was very effective at targeting its ICT research and development on on key health problems in the region. It accomplished this by establishing distance diagnostic priorities on the morbidity and mortality data of the rural areas being served. This is one of the few projects reviewed that adopted this approach.

3.2 ICT for Rural Development in Mountainous and Remote Areas of Northern Pakistan

Overview

The population of the region is about 1 million, scattered in over 600 rural villages. Gilgit, the regional capital, is the largest urban concentration in the area. Given the isolation and the lack of means for communication in the region, access to ICT can enable the people in the regions to gain greater economic and education opportunities.

Objectives

The key areas of intervention will include the development of tele-health facilities for better access to health practitioners; distance learning for improving education. In addition to the health domain the project also addresses: capacity building in ICT; enhancing agri-extension; promotion of rural business; conservation of cultural and natural heritage; and village-level planning and development. The areas of operation will cover Gilgit, Hunza, and Baltistan.

3.2.1Project Health Domains

Clinical Focus

The clinical focus for ICT research for this project encompasses: cardiology, dermatology, nephrology, gastro-entrology, and general medicine.

Research

This project's ICT infrastructure is not specifically designed to support health research.

Teaching

This project's ICT infrastructure is not specifically designed to support clinical training of healthcare providers.

Delivery

The ICT platform developed for this project will assist in care delivery by providing better access to health professionals vi remote consultation capability for ‘Second Specialist Opinion’ and mostly through store and forward technology. Teleconsultation services are focused on cardiology, dermatology, nephrology, gastro-entrology, and general medicine. More than 300 patients have received specialist consultation in nearly three months, with exponential increase in the number of patients in these early months of Telehealth services. Two areas of high demand that were noted were dermatology and women's health. The project established a fully functional Telehealth Centre at Skardu, hired a Telehealth consultant and five medical specialists at Islamabad to provide teleconsultancy services for a test phase transitioning to a full-fledge teleconsultancy service for patients in Skardu.

Wellness

The project did not employ ICTs to address disease prevention or wellness initiatives.

3.2.2Adoption/Dissemination Maturity Stage

This project can be classified as being in the late Readiness to early Diffusion stage with a growing number of participants. There should be sufficient critical mass to observe and measure any positive impact on healthcare.

3.2.3Technology Architecture and Strategy

The telehealth application planned for this project was a combination of a store and forward teleconsultation capability along with video conferencing equipment. VSAT network technology, digital cameras and video conferencing equipment. The store and forward technique was used to transmit the brief personal and medical data of patients, pictures of patients and lesions, etc, ECG (scan or snap shot image), and X-rays (in the form of a scan image, snap shot or live view).

Architecture	Standards	Language	Development	Licensing	Assets
Store and forward, Centralized	None Identified.	Not identified, assume local	In House plus COTS	Not identified	Video conferencing

3.2.4Development Lifecycle and Continuous Improvement Process

Project documentation noted that formal independent evaluation of the project was being arranged, no formal evaluation is presented. Anecdotal positive evidence of the impact of the technology is presented primarily in regard to dermatology.

Peer Review	User Driven	Collaborative Platforms/Process	Lifecycle	Active
Some	Low to moderate	None Identified	Waterfall assumed	Yes

3.2.5Comments

This is a complex ICT initiative serving several domains besides healthcare. The limitations of video

conferencing over limited bandwidth networks and the lack of additional ICT support systems such as patient medical records are noted.

3.3 Technology-Supported Distance Non-Formal Training and Education in Water, Sanitation and Hygiene (Philippines)

Overview

This is two-year study to determine the effectiveness of using ICT as a tool for teachers and students to teach and learn about WASH issues, and in effecting changes in the knowledge, attitudes and practices of people with regards to proper hygiene and sanitation. The key research question was: Is the delivery of non-formal educational materials, such as modules on water, sanitation and hygiene, using ICT-enabled distance education (DE) tools and technologies, more effective than traditional methods in improving the knowledge, attitudes and behavior of students on our research communities?

The general purpose of the proposed research is to identify issues, problems, opportunities, resources and strategies for deploying distance education technologies (tools, methods and systems) to empower groups and organizations, representing both gender groups, involved in non-formal education, specifically in the training and teaching on health, hygiene and sanitation to distant Filipino communities.

Objectives

The health ICT related objectives of the study were:

- To find partners and assess their resources in terms of content, manpower and ICT infrastructure, determine their ICT needs and capabilities and to develop ICTs as important distance educational tools.
- To examine current distance education delivery systems in the Philippines, with a view to selecting scalable and sustainable models that may be applied to the teaching and learning on WASH issues.
- To design, develop, implement and evaluate informative, educational and communications (IEC) materials and tools.
- To pilot the IEC materials and the ICT and distance education methodologies

3.3.1 Project Health Domains

Clinical Focus

The clinical focus of this project was personal hygiene and its relationship to dengue fever, diarrhea, scabies, typhoid fever and environmental hygiene.

Research

This project's ICT infrastructure is not specifically designed to support health research.

Teaching

This project's ICT infrastructure is not specifically designed to support clinical training of healthcare providers.

Delivery
This project's ICT infrastructure is not specifically designed to support healthcare delivery.

Wellness
The WASH CD-ROM consists of 5 hygiene related disease prevention modules:

- Your Health Is In Your Hands – A Module on Health & Hygiene
- Your Health Is In My Hands – A Module for Hygienic Food Preparation
- Safe Water, Safe Environment for My Healthy School – A Module for Hygiene and Sanitation in Schools
- Health and Hygiene at Home - Hygiene and Sanitation Module for Mothers
- Health and Safety At The Farm - Health and Safety Module for Farmers

Information if provided on disease causation, symptoms and prevention for the following diseases: Dengue Fever, Diarrhea, Scabies, Typhoid Fever. Disease prevention information is also provided for the following contexts of daily life: Environmental Hygiene, Hygiene and Health at the Home and in the Farm, and Modules on Health and Hygiene at the School and Street Vendors.

3.3.2Adoption/Dissemination Maturity Stage

The health ICT platform for this project can be classified as being in the Diffusion and Impact stages. Development is completed and a critical mass of users is being

3.3.3Technology Architecture and Strategy

The ICT architecture adopted for this project is quite flexible. The wellness education modules can be deployed via the Internet, local Intranet or by standalone PC using CD ROM. Internet access to the modules was implemented using the facilities of a multipurpose community telecentre (MCT) linked to a server with a broadband satellite Internet connection. MDFI also developed an online, web-based Data and Research Management System called WASH Research On-line Survey (ROS) System. This system is a PHP-based, open source, server-side, HTML-embedded scripting language used to create dynamic Web pages. This system enabled the Research team to keep an online database of the study population and generate the reports needed by the research.

Architecture	Standards	Language	Development	Licensing	Assets
Centralized web server/Intranet/Standalone CD ROM	None identified	Filipino, English, Cebuano dialect	In House	OSS possible	CD ROM hygiene wellness education modules

3.3.4Development Lifecycle and Continuous Improvement Process

The development and improvement of the ICT platform and content for this project was participatory and had a high degree of end user involvement. In both the urban and rural sites, there was a significant increase in both knowledge and attitudes in water, hygiene and sanitation, as determined using quizzes and attitude survey forms before and after intervention using the ICT-enabled WASH distance education module. The project notably leveraged existing resources by employing the IDRC-funded Multipurpose Community Telecentres.

Peer Review	User Driven	Collaborative Platforms/Process	Lifecycle	Active
Yes	Yes	Yes, online research management system	Waterfall assumed	Yes

3.3.5Comments

The study revealed that although the level of knowledge improvement using ICT-based modules was good, it was still not as significant as improvements amongst non-formal education students who studied using the traditional face-to-face approach. The project employed a highly participatory methodology that involved the whole community which facilitated localization and adaptation of the technology. The project noted that this intervention " will enrich the community of researchers in the region, and form the basis for a rich database for expertise and information sharing". In this regard this is a good example of how a local health ICT research network can be established. Using this bottom up approach a network of networks can be established more effectively and with a stronger likelihood of long term sustainability.

3.4 IT-mediated Rural Women Education and Dissemination of Health Information - A pilot in Tamil Nadu, India

Overview

The overall health goal of this multi-purpose project was to use an ICT platform to address the lack of awareness of health issues among young and middle aged rural women. This is a common problem in India and other developing / underdeveloped countries. Raising the awareness of these vulnerable segments can have a significant impact on their welfare and the future generation and reduce health risks. In addition to the principle investigators the project partnered with and leveraged the infrastructure of Seethalakshmi Ramaswamy College (SRC) to demonstrate the long-term economic viability and the social benefits of such a program in a developing country such as India, with complex social and religious interrelationships.

Objectives

The specific objectives of the project were to design and evaluate a multipurpose web-based women education/health information tool targeting rural women in Tamil Nadu, India. The health objectives addressed include:

- Understand the health information needs of young women in rural areas of Thiruchirapalli District, Tamilnadu where SRC is located.
- Examine ways of disseminating health information that is needed in the rural community.
- Train the first generation rural students studying at SRC to become the core torchbearers for this pilot and use them as nodes to promote health and educational messages in their respective rural communities.
- Examine the value of a ICT based system to disseminate health information to villages.

3.4.1Project Health Domains

Clinical Focus

The clinical context of this project are three areas of women's health: HIV/AIDS disease prevention, pre-natal care and post-natal care. The goals of the project for these areas included pilot an ICT based solution that improves dissemination of health information.

Research
This project's ICT infrastructure is not specifically designed to support health research.

Teaching
This project's ICT infrastructure is not specifically designed to support clinical training of healthcare providers.

Delivery
The ICT solution was designed to support pre-natal care by providing early registration for pre-natal care.

Wellness
The project focus was to raise awareness and understanding of high priority issues affecting women's health for the following:

- HIV/AIDS – To raise awareness and understanding of Opportunistic infection & Vertical transmission- HIV/AIDS.
- Pre-Natal Care – To provide advice and guidelines for nutrition during preganancy
- Post Natal Care – To provide advice and guidance on Breast Feeding, Personal hygiene, Nutrition, and Immunization

3.4.2Adoption/Dissemination Maturity Stage

This project was a pilot study and it is not apparent whether it continued to implementation as an ongoing concern. The CD based approach required manual dissemination of knowledge etc. While this presents an inherent weakness in that is not “just in time” its strength is that face to face meetings are a powerful seeding strategy at the outset of ICT initiatives. Over 1000 women from 25 villages participated in various stages of the program The questions raised after ICT demonstrations and comments such as ‘men should also be given such messages’ showed that the approach was effective in conveying and establishing understanding of the material presented. Apparently the novelty of employing ICT tools was helpful in attracting more people.

3.4.3Technology Architecture and Strategy

The ICT platform consisted of CD based training material, and training and information dissemination software package

Architecture	Standards	Language	Development	Licensing	Assets
Centralized web server (not clear if this was implemented) standalone CD	Non identified	Tamil	In House	Could not be determined	Web based and CD of wellness educational material for HIV/AIDS, Pre-Natal Care and Post Natal Care

3.4.4Development Lifecycle and Continuous Improvement Process

Leveraged existing capacity building efforts, expertise and infrastructure by partnering with Seethalakshmi Ramaswamy College (SRC) The methodology employed was responsive to user input to improve design and content adapted to local community needs to maximize participation. Two ICT based information modules that were developed during the project met with a significantly positive feedback from rural participants and a follow up showed that their level of awareness was better. Pre and post intervention surveys done to measure impact and the report provides a detailed description of where impact was made by the intervention.

Peer Review	User Driven	Collaborative Platforms/Process	Lifecycle	Active
Yes	Research driven	None identified	Waterfall assumed	Could not be determined

3.4.5Comments

The research in this pilot suggests that, in rural communities, a locally focused system is much more useful than only deploying a web based system via the Internet. A combination of IT with motivated individuals and face to face meetings was an effective strategy. The use of a CD in conjunction with meetings and seminars lowers the readiness threshold significantly as there is less infrastructure required before diffusion can begin. Broader diffusion and impact can be attained by “franchising” the model and using a central site as a dissemination point and collaboration platform to improve the content and process.

3.5 Impact of Remote Tele-medicine in Improving Rural Health, India

Overview

In the absence of healthcare facilities in the villages, the rural people tend to visit the nearest towns for their healthcare needs. Since a visit to a doctor in town has financial implications for the villagers in terms of transportation and consulting costs, not to mention loss of work/pay, the villagers tend to use this as a last resort. This usually means that they either tend to self-medication or that they approach a doctor at a late stage. More dangerous is to use remedies prepared by unauthenticated practitioners.

Objectives

The objective of this project is to deploy a cost-effective remote diagnostic telemedicine solution at select villages and monitor the social and economic benefits of such a healthcare solution to the villagers. The project tests a low cost medical kit, called ReMeDiTM, developed by a partner company Neurosynaptic Communications Pvt Ltd., that can work in conjunction with a rural kiosk and transmit data remotely to a doctor in a town. The data sets that can be captured are Electrocardiogram ECG, blood pressure, temperature, and heart rate.

3.5.1Project Health Domains

Clinical Focus
This project has no specific clinical focus for the ICT platform being developed.

Research
This project's ICT infrastructure is not specifically designed to support health research.

Teaching
This project's ICT infrastructure is not specifically designed to support clinical training of healthcare providers.

Delivery
This project aims to field test a low cost medical kit that can work in conjunction with a rural Internet kiosk to transmit vital signs data remotely to a doctor in a town. The data sets that can be captured are Electrocardiogram ECG, blood pressure, temperature, and heart rate. This will enable better remote diagnosis and consultation.

Wellness
The project did not employ ICTs to address disease prevention or wellness initiatives.

3.5.2Adoption/Dissemination Maturity Stage

The ICT platform can be classified as being in the Readiness phase. The solution has been developed but is being tested. The business model to provide sustainability is also in the testing phase. The project team has noted the importance of creating public-private partnerships with Governments, NGOs and health institutions to establish remote health delivery to rural areas. They see that such partnerships improve the quality of services being offered and increase acceptance of it by villagers.

3.5.3Technology Architecture and Strategy

The project will reuse existing Internet kiosks which provide remote access to villages in this region. The project will employ a commercially developed kit which will provide electronic capture and transmission of vital signs.

Architecture	Standards	Language	Development	Licensing	Assets
Distributed	None Identified.	Not identified	Integration of commercial solution	Proprietary	Commercial vitals capture and transmission kit.

3.5.4Development Lifecycle and Continuous Improvement Process

The villagers in the project areas were involved providing feedback through Participatory Rural Appraisal and surveys. A significant drop in participation was noted after the launch of the service and a survey designed to analyse the reasons for this drop.

Peer Review	User Driven	Collaborative Platforms/Process	Lifecycle	Active

None identified	No	No	Not identified	Yes

3.5.5Comments

The combined testing of a business model and a health ICT platform can make it difficult to determine the value of the ICT platform in making a positive impact on healthcare. Competing services were identified and given the scarcity of human and other resources for the provision of good healthcare, it would be more effective to determine how to apply technology to develop synergy with existing services rather than competing with them.

3.6 ICT-Enabled Life Skill and Sexuality Education for Adolescent Girls

Overview

In India, there are approximately 10 million pregnant adolescents and adolescent mothers throughout the country at any given time. Unfortunately, education, health and family welfare programs are not adequately addressing the special needs of adolescents. ICTs have great potential to reach these girls and provide sexuality education as well as opportunities to develop skills needed to plan their career and life in general. Today's girls are tomorrow’s women, and being young and educated they have great potential to solve women's problems and village issues. This project employs computer, Internet, and digital cameras to educate, organize and empower these girls.

Objectives

The objectives of this project are to educate and empower adolescent girls in selected cities and villages using computers, digital cameras and the Internet. to provide comprehensive sexuality education and life skills training to adolescent girls in urban and rural areas in Chennai, India

3.6.1Project Health Domains

Clinical Focus

Female Sexuality, sexual health.

Research

This project's ICT infrastructure is not specifically designed to support health research.

Teaching

This project's ICT infrastructure is not specifically designed to support clinical training of healthcare providers.

Delivery

Wellness

The objectives of the ICT platform developed by the project is to provide comprehensive sexuality education and life skills training to adolescent girls in urban and rural areas in Chennai, India, to devise culturally sensitive ways of approaching the topic of sexuality education, and general

women's health issues. The specific subject areas covered are:

- Growing up (including puberty)
- Sex and Sexuality
- Sexual Violence, Abuse and Decision Making (including counseling and legal resources)
- Sexually Transmitted Diseases
- Knowledge Assessment and Feedback

3.6.2Adoption/Dissemination Maturity Stage

The maturity stage of this project was *Readiness* as the web based course material has been completed and is online. Further evaluation was not possible as website is in Tamil language.

3.6.3Technology Architecture and Strategy

There was limited information regarding the technology architecture employed for the ICT platform. It is essentially a centralized web based system and the software components used are not identified.

Architecture	Standards	Language	Development	Licensing	Assets
Centralized web based	No Health ICT standards used (not needed)	Tamil	In House	Could not be assessed.	Web and CD based courses on sexuality for adolescent girls.

3.6.4Development Lifecycle and Continuous Improvement Process

Significant time was invested in interactive user participatory design of the solution. Clinical experts were enlisted to provide input on curriculum and course improvements.

Peer Review	User Driven	Collaborative Platforms/Process	Lifecycle	Active
Limited peer review of clinical content	High	Chats, Video conferencing planned	Could not be assessed.	Yes

3.6.5Comments

This is one of several projects that would benefit from availability of a common web based course development and elearning platform. Several mature platforms of this kind exist, such as Moodle. Standarization on one or two of these platforms would facilitate collaborative improvement of courses and reuse of course materials. It would also enable a greater percentage of project budgets to be applied to course development.

3.7 Using ICT to build capacities of HIV/AIDS Service Providers in India

Overview

In this project SAATHII aims to develop an Electronic Resource Centre on HIV/AIDS in India. The centre aims to address these critical needs through HIV/AIDS e-training programs, interactive e-

forums linked to online databases, technical assistance and e-support tailored to organizations' specific resource needs. The project intends to assess these programs using both quantitative and qualitative analyses, the results of which will constitute core determinants of an enhanced response to the fight against HIV/AIDS in India.

Objectives

The general objective of this project is to strengthen the response to HIV/AIDS in India through the application of information communications technology. ICT will be used to build the capacity of service-providing organizations, particularly in rural and semi-urban areas, facilitate best-practice sharing and collaborations; and provide tailored support aimed at enabling access to specific technical resources. The specific objectives are to develop an Electronic Resource Centre on HIV/AIDS in India including e-training programmes, interactive e-forums and e-support.

3.7.1 Project Health Domains

Clinical Focus

The clinical focus of this project is HIV/AIDS.

Research

The research capability provided by this infrastructure will involve enabling qualitative and quantitative assessment of information content in the various forums that are created.

Teaching

This project will provide an integrated Online Resource Centre for HIV/AIDS in India consisting of the following web based services:

- E-training: A total of 15 HIV/AIDS modules will be developed
- E-forums: To facilitate and enhance collaboration, information exchange and sharing of best practices and strengthen technical capacity among stakeholders in India through electronic bulletin-board forums in collaboration with global network of SAATHII volunteers and advisers. Forums have been developed for professionals working on prevention, care, support, treatment and planning/policy related to HIV/AIDS in India. Most forums are publicly viewable but require registration to post.
- E-Library: The E-library is a collection of resources on HIV/AIDS in India including links and documents on a variety of clinical, social and policy areas. You can search this library and also contribute links that you consider relevant.
- E-support: To provide focused support and referrals to organizations with specific resource needs assessed during the course of field visits and through e-trainings and e-forums. Twelve organizations will be selected to receive e-support during the project period.

Delivery

The project did not employ ICTs to address care delivery.

Wellness
The project did not employ ICTs to address disease prevention or wellness initiatives.

3.7.2Adoption/Dissemination Maturity Stage

The project's primary dissemination target is national. There are four categories of stakeholders involved in the fight against HIV/AIDS being targeted in India: non-profit HIV/AIDS service-provider organizations in rural and semi-urban areas who have access to the Internet; physicians, counselors and social workers involved in offering prevention, treatment, care and support services; HIV/AIDS positive people; members of the public seeking up-to-date information on HIV/AIDS related issues ranging from prevention to treatment to policy. The project has completed initial development and its ICT platform operational. It is ready to transition into the Diffusion stage as well as demonstrate positive Impact in its early adopters.

3.7.3Technology Architecture and Strategy

Architecture	Standards	Language	Development	Licensing	Assets
Centralized web based	No health ICT standards employed (not necessary)	English	In House	OSS Possible: Use of PANTOTO content management and collaboration server.	Library; Content management and discussion forums tailored to support HIV/AIDS health providers: Anti-retroviral therapy Gender and Sexuality HIV and Nutrition HIV Program Communication HIV_AIDS Counselors' Forum Home Based Care Infected, Affected and Vulnerable Children Legal Issues Prevention SAATHII General Forum UNGASS India Review

3.7.4Development Lifecycle and Continuous Improvement Process

The project will make the e-forum technology available for general use beyond the project period. Reuse and dissemination will be facilitated by creation of a Frequently Asked Questions and Best Practices documents for wider dissemination on the website with ‘smart search’ functionality. Continuous improvement through peer review will be conducted by publishing research papers and reports based on analyses of the e-training, e-forum and e-support components, comparisons with the offline training and support programmes, and quantitative and qualitative analyses of the capacity-enhancement obtained by the participants in these programs.

Peer Review	User Driven	Collaborative	Lifecycle	Active

		Platforms/Process		
Yes	High	Yes	Waterfall	Yes

3.7.5Comments

This is one of a few projects whose outputs could be verified and publically viewed via the Internet.

3.8 Web-based Integrated Dengue Hemorrhagic Fever (DHF) Surveillance System in Indonesia

Overview

Dengue Hemorrhagic Fever (DHF) is the leading cause of hospitalization and death among children in Indonesia and other endemic areas in the developing world. However, case detection and management, disease surveillance, and community-based control of dengue transmission are often uncoordinated resulting in an inability to prevent and manage DHF outbreaks. This action research project aims to involve the local government, community members, health care and public health personnel in the development of an integrated, web-based geographic information and decision support system. The system is expected to improve the detection and management of DHF cases in the community and become a model of DHF control approach in other endemic areas. It may also be applied for other communicable diseases.

Objectives

The primary objectives of this project are to improve the detection and management of dengue hemorrhagic fever cases, and the prevention and control of dengue transmission in the community. It will do this by integrating DHF surveillance and control activities among health care personnel and public health administrators through a web-based geographic information and decision support system,

3.8.1Project Health Domains

Clinical Focus

This project's clinical focus is the management of dengue hemorrhagic fever (DHF).

Research

This project's ICT infrastructure was not specifically designed to support health research.

Teaching

This project's ICT infrastructure will facilitate training and education on DHR management by documenting the successes and failures of DHF case management and control.

Delivery

The ICT infrastructure developed in this project will assist in health care delivery by enabling better coordination of resources in the management of dengue fever outbreaks.

Wellness

This project's ICT infrastructure is focused on enabling better coordination of case detection and management, disease surveillance, and community-based control of dengue transmission. The ICT platform will to integrate DHF surveillance and control activities among health care personnel and public health administrators through a web-based geographic information and decision support system. Hospitals, community health centers and health offices will be able to: monitor the incidence and time-space clustering of DHF cases and fatalities in the community; develop guidelines in the mobilization of resources to minimize DHF morbidity and mortality, especially in the form of web-based interactive programs; and enhance learning processes in the success and failures of DHF case management and control in the community.

3.8.2Adoption/Dissemination Maturity Stage

This project is in the early Readiness stage given that the ICT platform has according to the project timeline, just completed.

3.8.3Technology Architecture and Strategy

The high level technical architecture for the ICT platform is a centralized database with web based access. The platform is based on open source components, in particular the MySql database and the PHP programming language for development of the web interface.

Architecture	Standards	Language	Development	Licensing	Assets
Centralized, web-based	None identified	Indonesian	In House	OSS Possible: based on PHP, MySql	Web-based DHF surveillance system.

3.8.4Development Lifecycle and Continuous Improvement Process

The main output of the project is a report on the effectiveness of the web-based DHF surveillance system . The report will be published on the website, and rewritten to be published in a peer-reviewed journal.

Peer Review	User Driven	Collaborative Platforms/Process	Lifecycle	Active
Yes	Medium to High	None apparent	Waterfall	Yes

3.8.5Comments

This project employs off the shelf open source components which increase the likelihood of broader adoption and open up the possibilities of further collaborative improvement. What is not clear is how this system would integrate, leverage or compliment a generalized medical record system such as an EHR. Point soultions like this one are effective in the short term, but can become barriers to establishing an integrated health delivery system.

3.9 Development of ICT-Based Mobile Tele-medicine System with Multi Communication Links for Urban and Rural Areas in Indonesia

Overview

This project aims to develop an ICT-Based Mobile Tele-medicine System with Multi Communication Links for urban and rural areas in Indonesia.

Objectives

The key objectives identified for this project are:

- Develop an ICT-based mobile telemedicine system that can be functioned as an emergency health care unit for urban and rural area.
- Improve and enhance the health care services to people in urban and rural area, especially for medical consultations and medical care for patients who live far from city areas.
- Establish a pilot project of application wireless local area network in pre-hospital environment for capturing data by using PDA, laptops, and cellular phones. The captured data will then be transmitted to a physician or nearest hospital.
- Improve management of medical resources particularly in rural and undeserved areas by using these technologies, so patients who are in a remote location may still have access to medical expert opinion.

3.9.1Project Health Domains

Clinical Focus

This project does not have clinical domain, problem or health goal as its focus.

Research

This project's ICT infrastructure was not designed to support health research.

Teaching

The system can also be used for distance education and other health care service applications.

Delivery

The primary focus of this project is supporting health deliveriy by extending expert-based health care to understaffed remote sites via telecommunications. The telemedicine application will support diagnostics, consultation, and recording and reporting of patient’s information. They will be used for community health care and can be adapted for implementation in emergency situations in urban and rural areas.

Wellness

The project did not employ ICTs to address disease prevention or wellness initiatives.

3.9.2Adoption/Dissemination Maturity Stage

The maturity stage of this project was *early Readiness,*the development of the ICT platform was a key deliverable of the project. Recommendations have been made to provide funds via State Annual Budgeting Planning – RAPBN to ensure sustainability and outreach.

3.9.3Technology Architecture and Strategy

The proposed system will develop a portable telemedicine unit that will exploit wireless technology and combine it with other communication technologies such as wireless digital cellular, radio packet or ordinary fixed telephone lines to satisfy different local and demographic requirements. The system can be operated in both on-line mode and store and forward.

Development will be done in house and will focus on developing the hardware and software communication interface modules to provide voice, data and video capability. The Mobile Telemedicine Unit will consist of three components: 1. the medical devices that performs measurement and acquisition of medical data/information including a set of video camera equipment; 2. the communication platform which will consist of medical device interfacing platform and communication manager, and 3. a processing data unit. Medical devices connected to the unit may vary, according to the medical services most needed by the community.

Architecture	Standards	Language	Development	Licensing	Assets
Distributed/Client Server	GSM, CDMA No Health Standards Id'd No indication of use of existing medical device interfacing standards.	Indonesian ?	In House	Mixed: Windows OS, Delphi GUI, OSS: Database, Webserver	Interfacing platform and interfaces to be developed for ECG, Fetal heart rate monitor, blood pressure monitor, digital camera. Communications manager and interfaces. Patient medical record.

3.9.4Development Lifecycle and Continuous Improvement Process

Clinical evaluation of the system will be implemented through the evaluation of the accuracy of the diagnosis. Technical evaluation will include a comparative study to selected Asia Pacific countries, i.e. India, Australia, to learn from their experience in developing mobile telemedicine systems. Technical performance evaluation will include: compatibility, scalability, interoperability, and reliability of equipment and systems. User input will be obtained via a survey which will cover data security, usability, effectiveness, and the degree of invasiveness of the technology.

Peer Review	User Driven	Collaborative Platforms/Process	Lifecycle	Active
None Apparent	Low	No	Waterfall	Yes

3.9.5Comments

The project documentation notes that one of the most important factors to be taken into account is accommodating the wide range of data formats and protocols. Significant effort is required to develop these interfaces from scratch. There is a significant body of work available as open source upon which this project can build on, in particular the Mirth interface engine project (www.mirthproject.org) and code developed by The Regenstrief Institute (www.regenstrief.org).

3.10 Development of ICT-based Telemedicine System for Primary Community Health Care in Indonesia

Overview

This project involved the development of a pilot Internet and communication technology-based telemedicine system for primary community health-care in urban and rural areas of Indonesia. The project utilized existing Internet technology to enhance PC-based medical stations and performed field-testing as a key aspect of its work. The pilot telemedicine network consists of six medical stations for community health centres, and a station for each referral hospital, health office, and a test laboratory respectively. The project includes software development, as well as system and network integration.

Objectives

- Develop, implement, install & conduct a trial run of 6 Puskesmas medical stations in selected under-served and rural areas in Indonesia as a base for establishing a Pilot network of Primary Community Health Center (Puskesmas) Internet-based Telemedicine
- Implement a pilot Digital Healthcare Infrastructure on available Internet technology by linking all major components of the Primary Community Health-care delivery system

3.10.1 Project Health Domains

Clinical Focus

Maternal mortality.

Research

This project's ICT infrastructure was not specifically designed to support health research.

Teaching

This project does not address the clinical training of healthcare providers.

Delivery

The telemedicine system was developed to support the following care delivery activities: medicine data recording & reporting, patient data recording and reporting, tele-coordination, community health education, and limited tele-consultation. A community health service registry was also developed which provided information on community health resources such as doctors, labs, pharmacies etc.

Wellness

The project was focused on the application of telemedicine to reduce maternal mortality. The Maternal Health-care Digital Record Module provides physiological measurement modules to improve the early detection and diagnosis of selected maternal pregnancy related problems and facilitate monitoring the pregnancy. The modules include a PC-based Ultrasonic fetal heart-rate monitor; PC-based Sphygmomanometer and PC-based Electronic scale. Web based community health education capability was designed and implemented in an number of community health centers.

3.10.2Adoption/Dissemination Maturity Stage

This project can be classified as being in the Readiness phase as it's focus is the development and testing of the defined telemedicine application. It is not clear whether the platform has progressed further to Diffusion.

3.10.3Technology Architecture and Strategy

The ICT platform is based on freely available open source software components, they included: Linux, Apache Web Server, MySql, PHP and Perl. The software produced by this project was made freely available to others.

Architecture	Standards	Language	Development	Licensing	Assets
Centralized web server	None identified	Indonesian	In House	OSS Possible	Maternal Health-care Digital Record Module Medicine Data Recording & Reporting Software Package Patient Data Acquisition, Recording & Reporting Software Package Biometrics/Fingerprint Identification System Community Health Service Information System

3.10.4Development Lifecycle and Continuous Improvement Process

The development lifecycle and improvement process is summarized in the following table.

Peer Review	User Driven	Collaborative Platforms/Process	Lifecycle	Active
None	Initial design	None	Waterfall	Dormant

3.10.5Comments

This project appears to be dormant.

3.11 Community Health Information Tracking System (CHITS)

Overview

In this study, open-source tools from the Linux community combined with participatory people-centric strategies were employed to develop a local health center-based information system for service delivery. The initial focus was to enable implementation of a child injury surveillance system by health workers. The ICT strategy was first based on using SMS because of its widespread penetration in the Philippines and its wireless capabilities. After preliminary investigations, however, the researchers discovered several issues associated with SMS such as constraints in economics (cost of sending messages) and existing national and local health policies (only government health centers can submit official health data). The project responded to these factors by shifting strategies and creating a computer-based information system that served, primarily, the needs of the health center facility and, secondarily, of the national public health system. The project hence evolved into a local health center-based information system for service delivery, the core foundation from which all other community health services can be based including but not exclusively child injury.

Objectives

The key objective of the project was to create a generic software engine which would be the foundation of a Community Health Information and Tracking System.

3.11.1 Project Health Domains

Clinical Focus

The initial focus was, child Injury surveillance and then shifted to include tuberculosis, immunization, maternal care, family planning or anti-tuberculosis treatment.

Research

The CHITS database has the potential to provide a basis for community based health research.

Teaching

Training was developed in a number of areas for village health workers including injury surveillance. Training included identifying objectives, preparing content, manuals and certificates. A two-level certification course covering data quality concepts and personal record management was developed for to ensure data standardization to facilitate data integration with the CHITS application.

Delivery

The original SMS portion of the project was expanded to include clinical reminders, which enables health center staff to send SMS messages generated from system templates to patients for follow-up and medication intake reminders for TB patients. An interface was created for community health workers to be able to enter drug intake data to assist in the care of TB patients. The system is also being used for a national surgical registry and blood bank information system.

Wellness
Child injury prevention, family planning and anti-tuberculosis treatment are key areas of health prevention and wellness facilitated by the CHITS platform.

3.11.2Adoption/Dissemination Maturity Stage

Researchers discovered encountered several roadblocks to Diffusion associated with the original ICT strategy such as constraints in economics (cost of sending messages) and existing national and local health policies (only government health centers can submit official health data). The project has moved from the Readiness phase to Diffusion as use of its generic engine GAME is expanded to other efforts including blood bank and a surgery registry. Partnerships have been initiated: e.g. the National TB Program and the Philippine Coalition Against TB (PhilCAT).

3.11.3Technology Architecture and Strategy

The ICT platform developed by this project draws heavily on open source technologies. To help reduce implementation cost and maintenance, the Linux Operating System running the KDE desktop was selected. Other open source components used included MySql, PHP, open source code libraries like JPGRAPH for object-oriented graph display, and FPDF, a PDF-generation engine for creating the summary reports. All source code produced by this project is available at the BerliOS open source Internet software repository.

Architecture	Standards	Language	Development	Licensing	Assets
Centralized or Peer to Peer	ICD 10	Multilingual capability	In House	OSS	GAME engine 40 Modules including Child Injury Surveillance

3.11.4Development Lifecycle and Continuous Improvement Process

Along with the modular architecture, modern rapid prototyping and spiral development processes were employed by the project which facilitate rapid iterative improvement of ICT applications. The preliminary systems investigation methodology employing immersion and ethnographic investigation is an excellent strategy for user driven design and localization. The software has been released as Open Source and is available for peer review. The project involved a high degree of user involvement and interaction.

Peer Review	User Driven	Collaborative Platforms/Process	Lifecycle	Active
Yes	High	Yes	Spiral	Yes

3.11.5Comments

The researchers were originally leaning towards an SMS technology-centric implementation of an information system. With deeper analysis and understanding of the needs and requirements of end users, the researchers were able to adjust their technology strategy to better serve the genuine needs of community health workers. The researchers noted that developing a community based health

information system is a challenging task, closely approximating the level of difficulty found in the development of hospital and clinical information systems. Given this difficulty It is not clear whether the developers considered adapting one of a number of potential open source health platforms that could have been the basis for a community health information system.

3.12 M-DOK : Mobile Telehealth and Information Resource System for Community Health Workers

Overview

This project aims to learn from and build upon the previous implementations of mobile technology for rural health and customize it to the Philippine setting. Delivery of healthcare services and information at the rural level can be improved with the use of innovative information communication technologies. This project aims to develop a user-friendly graphic interface for a mobile phone tele-health information system over Short Message Service (SMS) and pertinent health information content for rural users customized to the mobile screen.

Objectives

The overall objectives of this project are to transmit real-time diagnosis and treatment data from the community health worker to a remote physician. Specific objectives include:

- To deliver low-cost healthcare diagnostic and management information to rural patients through a mobile telehealth system
- To provide relevant healthcare information to the point of care to community healthcare workers using information modules on multimedia card
- To develop a mobile electronic patient record system using SMS
- To facilitate development of an online network of health care providers and researchers through mobile

3.12.1 Project Health Domains

Clinical Focus

There is no specific health problem or domain as a central focus. Treatment guidelines for at least two diseases TB and Malaria will be disseminated via the network.

Research

This project's ICT infrastructure was not designed to support health research.

Teaching

This project does not address the clinical training of healthcare providers.

Delivery

The focus of the project is to enable better dissemination of health information and delivery of healthcare for community health workers. The system will include an electronic patient record and health survey form with information upload/retrieval using SMS, and a localized health information reference database including:

- WHO Model Essential Drug List
- Country-specific drug list for Philippines
- Tuberculosis treatment guidelines
- Malaria treatment guidelines
- Other treatment guidelines

Wellness
The project did not employ ICTs to address disease prevention or wellness initiatives.

3.12.2Adoption/Dissemination Maturity Stage

The maturity stage of this project was *early Readiness* as the software is in development and testing. This solution has the potential for broad and rapid diffusion and impact because it leverages the ubiquitous, low cost technology mobile telecommunications infrastructure.

3.12.3Technology Architecture and Strategy

The ICT platform to do this will consist of a mobile electronic patient record system using Symbian/Java using SMS Relevant health information references on multimedia card storage, such as diagnosis and treatment guidelines, and drug lists. This project aims to develop a user-friendly graphic interface for a mobile phone tele-health information system over Short Message Service (SMS) and pertinent health information content for rural users customized to the mobile screen. This project employs a Java/Symbian-enabled mobile phone to transmit real time diagnosis and treatment data from the community health worker at the point of care to a remote physician. Deployment of the technology developed in this project is thus applicable to the majority of developing countries that require cost-effective hardware platforms and have little or no General Packet Radio Service (GPRS).

Architecture	Standards	Language	Development	Licensing	Assets
Centralized Knowledge Server Distributed	None identified	Not identified	In House	OSS Possible	Mobile EHR SMS Based: Treatment guidelines Drug lists

3.12.4Development Lifecycle and Continuous Improvement Process

The project leverages learning from other similar projects such as PDA based initiatives such as the Satellife PDA project and Jiva Teledoc. Deployment of hand-helds similar to Satellife will be too expensive and will not scale in other developing countries. These hand-helds also do not have the capability to transmit data. The Jiva Teledoc project is capable of transmitting health information, but this utilizes GPRS. GPRS is not widely available in rural areas in the Philippines and in most of the developing world. The project leverages existing infrastructure of the Philippine Council for Health Research and Development's Internet multipurpose community telecentre.

Peer Review	User Driven	Collaborative Platforms/Process	Lifecycle	Active

No formal process	Staged user input	Online documentation	Waterfall	Yes

3.12.5Comments

The mobile phone SMS platform is best suited for very simple applications. Careful design and testing will be required to ensure that effective EHR type of functionality is achieved. Although there is significant potential to integrate mobile telephones and SMS functionality with the healthcare ICT ecosystem, it is not clear whether this project's outputs will be designed to do so. There are several fully functional EHRs which could be used to integrate this technology and avoid creation of “island of automation”.

3.13 Pioneering Blood Bank Network System in Sri Lanka

Overview

The goal of this project was to develop a computer Network system which stores donor data and responds to inquiries using dial up modems,telephone voice as well as on-site inquiries. During emergencies, the present blood bank facilities are not sufficient to cater to the routine blood needs of the state and private hospitals.

Objectives

Short term technical objectives of the project were to:

- To make known the availability of blood donors enlisted in the proposed system through a single window
- To enable hospitals and concerned people to source their individual requirements through this network
- To avoid/reduce wastage of the excess supply of blood by not bleeding and stocking but selective bleeding only as and when required.

3.13.1Project Health Domains

Clinical Focus

This project does not have clinical domain, problem or health goal as its focus.

Research

Long term health research benefits identified for the ICT platform developed for the project were:

- To enable doctors,hospitals and blood banks to interact and network through computer based electronic media to disseminate various research findings from National and International sources
- To promote blood research activities for further effective blood management through the studies on blood preservation,plasma,proteins,leukocyte antibodies,donor criteria etc.

It is not apparent from the project documentation whether these benefits have been realized.

Teaching
This project does not address the healthcare teaching domain.

Delivery
A key benefit identified to healthcare delivery was to provide better coordination and information on the availability of blood donors. This would:

- enable hospitals and concerned people to source their individual requirements through this network,
- to avoid/reduce wastage of the excess supply of blood
- to facilitate better blood supply to remote regions
- to improve the blood supply from the present one third to hundred percent
- improve the quality of donors

It is not apparent from the final report whether any of these goals have been achieved.

Wellness
The project did not employ ICTs to address disease prevention or wellness initiatives.

3.13.2Adoption/Dissemination Maturity Stage

The maturity stage of this project was *early Readiness,*the development of the ICT platform was a key deliverable of the project.

It appears from the documentation that significant legal and other hurdles were encountered in trying to establish coordination with the various agencies involved in blood bank services. Blood services are a highly regulated aspect of health systems and this characteristic would act as a significant impediment to broad and rapid diffusion of any ICT platform.

3.13.3Technology Architecture and Strategy

The ICT platform for this project was centralized web based service which consisted of a central host based on two Windows 95 PCs Networked Using Windows'95 Workgroup Operating System. The database system used to develop the application was "Wildcat" Database Management System (Client Server DBMS)". Remote location clients were based on "Wildcat navigator" which enabled searching for donors and blood related information.

Architecture	Standards	Language	Development	Licensing	Assets
Centralized Web based	None identified	Unknown	In House	Unknown, Proprietary DBMS	Unknown

3.13.4Development Lifecycle and Continuous Improvement Process

An ongoing continuous improvement process does not appear to have been established for this project.

Peer Review	User Driven	Collaborative Platforms/Process	Lifecycle	Active

No	No	No	Waterfall	Inactive?

3.13.5 Comments

The project documentation and further Internet search did not provide any factual evidence that the project resulted in a viable service or platform. Blood services are a highly regulated area in most countries and this type of intervention must have the full cooperation of the various regulatory agencies before being approved for funding. It would also be valuable to establish “heart beat” or ping process for projects once past the conclusion phase so that it will be easier to determine whether they are still active and making progress.

3.14 Development of a Web-based Medical Information Repository Integrated with an Artificial Intelligence-based Medical Decision Support System, Malaysia

Overview

The project serves as a prototype system to demonstrate the value of information sharing via a web-based repository in medical practice, training, and research using ICT and AI methodologies. It is envisaged that medical practitioners and researchers will be able to access anonymous medical records via the Internet and AI based decision support capability. The goal is to help clinicians to apply the most effective curative and rehabilitative regimes to enhance quality of healthcare of patients in poor and remote areas where infrastructure and medical expertise are scarce

Objectives

The objectives of this project are to provide advanced, quality healthcare information and services for all, through the use of information communication technologies and artificial Intelligence methodology. The main objectives identified in this project are:.

- to establish a web-based repository for storage and analysis of patient records;
- to devise an intelligent software system based on the Adaptive Resonance Theory (ART) neural networks and other complementary techniques for medical decision support;
- to evaluate the effectiveness of the proposed MIR integrated with the DSS for early diagnosis of stroke patients (as a pilot study)

3.14.1 Project Health Domains

Clinical Focus

The clinical focus of this project is Acute Stroke Diagnosis.

Research

The anonymous medical records of patients, including physical symptoms, family history, and bio-chemical test results can be useful for stroke research.

Teaching

The anonymous medical records of patients, including physical symptoms, family history, and bio-chemical test results can be useful as a teaching resource. The MIR and DSS can be used as a

resource, which contains up-to-date healthcare procedures and information, for continuing education and training of clinicians and medical practitioners.

Delivery
The combination of a medical record system and decision support tool will facilitate clinicians to apply the most effective curative and rehabilitative regimes to enhance quality of healthcare of patients, in poor an remote areas. The tools to support care delivery will include:

- Structured data and information concerning complications of stroke
- Anonymous medical records of patients, including physical symptoms, family history, and bio-chemical test results—useful for medical practitioners and researchers;
- Heuristic prognostic and diagnostic rules elicited from medical specialists as well as from the decision support system.
- Disease statistics and facts—useful for healthcare administrators and policy makers

Wellness
The project will not employ ICTs to address disease prevention or wellness initiatives.

3.14.2Adoption/Dissemination Maturity Stage

The maturity stage of this project was *early Readiness*. AI based decision support in healthcare is not widely adopted and still in research and development.

3.14.3Technology Architecture and Strategy

The project plans to employ a generic approach for developing the DSS, such that the resulting system can be adapted for diagnosis of other diseases such as heart attack.

Architecture	Standards	Language	Development	Licensing	Assets
Centralized web based	None identified	Not indicated	In House	OSS Possible	Web based medical record AI decision support software

3.14.4Development Lifecycle and Continuous Improvement Process

The project development model for the decision support rules accommodates input from a variety of sources including medical students. It is not clear whether a medical evidence based evaluation process will be implemented to guide project development.

The project is seeking active collaboration with other clinical areas. Dr. CP Lim has embarked on in a research project in collaboration with Penang Hospital, Malaysia. It is also suggested that the project can be integrated with the tele-medicine flagship application under the Multimedia Super Corridor (MSC) project spearheaded by the Malaysian government.

Peer Review	User Driven	Collaborative Platforms/Process	Lifecycle	Active
Some	Yes	Yes	Waterfall	Startup

3.14.5Comments

It is not clear whether the project has considered alternatives to creation of a unique medical record system in conjunction with the development of the AI Decision support system. There are several open source medical records systems which could be reused and integrated with the AI system. Creation of a medical record system to support a single clinical domain can lead to fragmentation of health system data if clinical informatics standards are not followed.

3.15 Tele-medicine in Nepal

Overview

Nepal faces an acute shortage of doctors with a ratio of approximately 6000 to 1. In addition, health workers in rural health care, who serve most of the population, are isolated from specialist support and up to date information. The advent of ICTs has unleashed new opportunities to the delivery of health services. However, without considering local technological and cultural conditions, and the appropriateness of solutions and sustainability, tele-medicine could potentially have a negative impact on the continuity of the system. This pilot project was designed to gain experience in this area, emphasizing low cost connectivity techniques, including imaging, and the training of local health care workers who must take the lead in developing and operating tele-medicine projects.

Objectives

The specific objectives of the project were to:

- Establish a telemedicine pilot network in three areas of Nepal: Butwal (Western region), Jhapa (Eastern region), and Bhaktapur (Central region).
- Test the efficacy of images captured by digital camera for diagnosis and management of pathology, dermatology and radiology cases.
- Develop an Internet based computer program for uploading the cases captured through digital camera.
- Use e-mail for uploading images for diagnosis and management of patient.
- Establish an Internet based referral system through telemedicine for providing community health care in remote areas to reduce the burden of communicable and infectious diseases.

3.15.1Project Health Domains

Clinical Focus

The clinical focus of the project was the diagnosis and management of communicable and infectious diseases.

Research

This project's ICT infrastructure was not designed to support health research.

Teaching

The goal of the training element of this project was to create a pool of health professionals at who are trained in use of in the use of Digital camera and related equipment for capturing images suitable for

diagnosis and management of cases. Draft training materials were developed for Siddhi Memorial Foundation, Amda Hospital, Jhapa, and Children and Women hospital, Butwal

- Discuss training modalities and strategies with other partners to coordinate roles and encourage dialog/interaction between HealthNet Nepal and trainees
- Train partners on capturing images, filling cases in forms, using Internet and e-mail
- Collection of cases through by capturing images for radiology, pathology and dermatology

Delivery

The primary focus of ICTs employed in the project was to establish and test a simple email based referral system through tele-medicine to support community health care in remote areas by reducing the effort to diagnose and manage communicable and infectious diseases. The objective was to use technology to improve access to specialists in remote areas. The imaging modalities supported include Radiology, Pathology and Dermatology.

Wellness

The project did not employ ICTs to address disease prevention or wellness initiatives.

3.15.2Adoption/Dissemination Maturity Stage

The maturity stage of this project was *early Readiness*. A primary goal of the project was to understand the technological and cultural readiness of the health system to adopt Western telemedicine technology and to develop and test a solution that addressed the constraints of the Nepalese health ecosystem.

3.15.3Technology Architecture and Strategy

The primary technology strategy for this project was to employ email, based on store and foreword to transmit images and data. Email has many advantages in Nepal, it is cheap, hardware and software requirements are simple, and the information does not have to be transmitted in real time which is problematic given the lack of high speed communications infrastructure. Sending e-mail attachments such as image files, permits a form of low cost telemedicine. Modern digital cameras are small, robust, easy to use and cheap. Using this technology, low cost telemedicine is investigated using still images applied in the area of Radiology, Pathology and Dermatology. The project plan indicated that software developed would be based open source code, the project documentation reviewed does not indicate whether this was implemented.

Architecture	Standards	Language	Development	Licensing	Assets
Point solution Distributed	None identified	Local	In House	OSS Possible	Image capture and display software. Case studies.

3.15.4Development Lifecycle and Continuous Improvement Process

User input was obtained via a user satisfaction and evaluation survey. The information gathered was used to modify reporting forms, databases and protocols. This appears to have been a single pass process rather than an ongoing and iterative process.

Peer Review	User Driven	Collaborative	Lifecycle	Active

		Platforms/Process		
No	Low	No	Waterfall	Possibly

3.15.5Comments

The final report for this project was not available, therefore this analysis was based solely on the project proposal documentation. The strategy of using simple store and forward technology to support consultation, diagnosis and disease management is innovative and reusable. The solution appears to be a point solution which may or may not be able to be integrated with a more holistic health ICT infrastructure. Reusability is also not clear as the software modules that were actually developed are not identified.

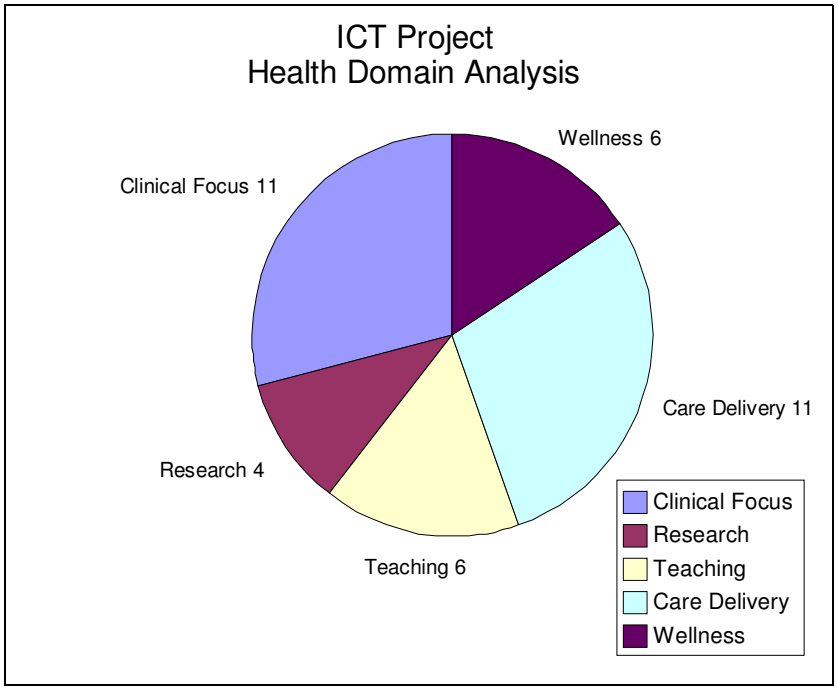
4 Synthesis of Project Documentation and Research Outputs

The following sections present a synthesis of the detailed evaluation of each set of ICT project reports. The evaluation framework is applied at a high level, across the projects to identify common patterns and groupings ICT initiatives within the lenses that make up the framework. Groupings that show significant promise of being leveraged into starting points for establishing a regional research network are identified and discussed. It is important to emphasize that what is being highlighted are potential first steps in a journey, and not a concrete design for a regional research network.

4.1 Health Domain Synthesis

This lens provides a view of the healthcare focus of projects both in terms of what clinical domain the project is focused on if any, and in terms of which of a number of interrelated “business” processes are supported by the ICT intervention. Clearly a strong catalyst for regional collaboration would be a critical mass of activity in similar or complementary health domains. The health domains defined in this study are:

The following figure provides an overview of the distribution of ICT projects by health domain. It gives a quick snapshot of which domains contain a potential critical mass of projects for establishing a regional research network.



The chart reveals that the majority of the fifteen projects reviewed have a clinical focus. This is significant as it indicates that there is greater potential for the existence of shared longer term objectives among the projects, an important catalyst for establishing a regional ICT research network. While Clinical Focus indicates that projects are driven to address a health issue or objective, the remaining domains help categorize the ICT projects by which niche in the health ecosystem they are

supporting. The chart shows that eleven of the projects apply ICTs to Care Delivery, making this the most populated domain, followed by six projects in each of the Teaching and Wellness domains. So far, the data suggests that there is that there is a strong likelihood of finding the necessary and sufficient ingredients to successfully establish a regional research network. The following more detailed analysis will endeavor to identify potential starting points for regional collaboration by grouping projects by health domain.

4.1.1 Clinical Focus

As previously described, the clinical focus of a project identifies the health issue, disease or other specific health subject are being addressed by a project. Establishing a regional research network will likely be easier if there is a critical mass of projects working in similar or related subject areas. This would stimulate collaboration through reuse, peer review and cross pollination based on common areas of interest. More importantly employing clinical focus as a design criteria for building a regional research network ensures that ICT investment is guided by health quality improvement and not just technical research and development. It provides the context for implementing an evidence based medical model for evaluation and improvement of ICTs so that they continuously adapt and evolve to more effectively address strategic healthcare goals and objectives.

The following table (Table:1) groups projects by the clinical subject area they focus on. Taking this perspective three broad clinical groups or categories were evident: Disease Management (4), Women's Health (4) and General Medicine (3).
Examining the various projects' clinical focus summarized in the table reveals significant common

No.	Project Name	Clinical Focus		Research	Teaching	Care Delivery	Wellness
		Category	Detail				
8	Web-based Integrated Dengue Hemorrhagic Fever (DHF) Surveillance System in Indonesia	Disease Management	Dengue hemorrhagic fever (DHF)				Yes
15	Tele-medicine in Nepal	Disease Management	Communicable Infectious Disease		Yes	Yes	
3	Technology-Supported Distance Non-Formal Training and Education in Water, Sanitation and Hygiene (Philippines)	Disease Management	Hygiene and its relationship to dengue fever, diarrhea, scabies, typhoid fever		Yes		Yes
14	Development of a Web-based Medical Information Repository Integrated with an Artificial Intelligence-based Medical Decision Support System, Malaysia	General Medicine	Acute Stroke	Yes	Yes	Yes	
1	ICTs for Health Services in Rural Mongolia	General Medicine	General medicine		Yes	Yes	
2	ICT for Rural Development in Mountainous and Remote Areas of Northern Pakistan	General Medicine	Cardiology, dermatology, nephrology, gastro-entrology, and general medicine			Yes	
4	IT-mediated Rural Women Education and Dissemination of Health Information - A pilot in Tamil Nadu, India	Women's Health	HIV/AIDS, Pre Natal Care, Post Natal Care			Yes	Yes
6	ICT-Enabled Life Skill and Sexuality Education for Adolescent Girls	Women's Health	Adolescent female sexuality, sexual health				Yes
11	Community Health Information Tracking System (CHITS)	Women's Health	Child injury surveillance, Tuberculosis management, Maternal care, Family Planning		Yes	Yes	Yes
10	Development of ICT-based Telemedicine System for Primary Community Health Care in Indonesia	Women's Health	Maternal mortality			Yes	

Table 1: Projects Grouped by Area of Clinical Focus

ground, and therefore potential synergy between the Disease Management and Women's Health groups. Most of the Women's Health projects were focused addressing infectious diseases and drilling down further reveals that disease management of HIV, DHF, and TB could provide a basis for initiating

collaboration. There is also common interest in addressing the challenges of pre and post natal care in the Women's Health.

The focus of the General Medicine group, on the other hand, as the name implies, is on a broad range of health issues such as cardiovascular disease and dermatology. In this case a potential network opportunity would be to expand the application and reuse of ICTs in General Medicine by addressing local gaps through pooling and sharing of components. For example an ICT initiative which does not address cardiology in one geography could adapt the cardiology content and/or functionality of another project.

All three groups share a strong practical orientation as they support Teaching, Care Delivery and Wellness, with only one supporting Research. These patterns suggest that there is also a strong practical impetus for sharing and collaborative improvement of the business process, knowledge, and decision support ICT components across these projects.

Examining the remaining projects which did not have a specific clinical health goal focus, also reveals potential areas of synergy between projects (see Table: 2). All of these projects primarily support Care Delivery, and of these three are focused on research and development of Telemedicine applications. Further examination of these projects under the Technology Architecture lens may reveal further

No.	Project Name	Clinical Focus	Research	Teaching	Care Delivery	Wellness
9	Development of ICT-Based Mobile Tele-medicine System with Multi Communication Links for Urban and Rural Areas in Indonesia	None			Telemed	Yes
5	Impact of Remote Tele-medicine in Improving Rural Health, India	None			Telemed	
12	M-DOK : Mobile Telehealth and Information Resource System for Community Health Workers	None			EHR	
13	Pioneering Blood Bank Network System in Sri Lanka	None	Yes		Blood Registry	

Table 2: Projects With No Apparent Clinical Focus

common ground for regional collaboration at an ICT component level.

In summary the information presented in the project reports suggests that there is sufficient “clinical” common ground, among a sufficient number of projects, to employ clinical focus as a possible catalyst for establishing regional ICT collaboration. Three clinical focus groups could provide a catalyst for a collaborative network: Women's Health, Disease Management and General Medicine. It would also be helpful to determine how closely these areas of clinical focus align with the healthcare priorities of the Pan Asian network member countries. Strong alignment could add significant momentum to building a an active and self sustaining research community.

4.1.2Research

The Research domain covers the development and implementation of ICTs to directly or indirectly support healthcare research. Examples include technologies to support evidence based improvement

of protocols and guidelines, clinical trials or making databases available or facilitating the dissemination of research studies. The four projects were found to have a research focus in their ICT initiatives are listed in the following table.

No.	Project Name	Clinical Focus	Research
14	Development of a Web-based Medical Information Repository Integrated with an Artificial Intelligence-based Medical Decision Support System, Malaysia	Acute Stroke	Case studies
7	Using ICT to build capacities of HIV/AIDS Service Providers in India	HIV/AIDS	ICT platform will enable qualitative and quantitative assessment of information content the associated forums
11	Community Health Information Tracking System (CHITS)	Child injury surveillance, Tuberculosis management, Maternal care, Family Planning	CHITS database for community health research
13	Pioneering Blood Bank Network System in Sri Lanka	None	Research dissemination, Promote studies of plasma, antibodies, proteins etc.

Table 3: ICT Projects Supporting Healthcare Research

Based on the information gleaned from the reports, projects 7 and 11 appear to have the greatest potential synergy for collaborating on ICTs to facilitate health research with disease management providing a common starting point. Overall there does not appear to be significant critical mass of projects focused on supporting health research with ICTs to kick start regional cooperation. Nevertheless, it will be valuable to explore how apply the lessons learned so far to initiating regional collaboration to advance the use of ICTs in support healthcare research. There is singificant strategic value in advancing the use of ICTs to establish evidence based feedback loops in healthcare research at a regional level as it would accelerate innovation, leverage collective invesment and lead to more rapid improvement in health quality.

4.1.3Teaching and Learning

This domain encompasses the use of ICTs to facilitate the learning and teaching of healthcare providers and other health professionals. The following table groups ICT projects that demonstrated a

No.	Project Name	Clinical Focus	Teaching
15	Tele-medicine in Nepal	Communicable Infectious Disease	Training in use of digital imaging technology
7	Using ICT to build capacities of HIV/AIDS Service Providers in India	HIV/AIDS	E-training courses, Library, Support, E-forum discussion forums: : Anti-retroviral therapy Gender and Sexuality HIV and Nutrition HIV Program Communication HIV_AIDS Counsellors' Forum Home Based Care Infected, Affected and Vulnerable Children Legal Issues Prevention SAATHII General Forum UNGASS India Review
11	Community Health Information Tracking System (CHITS)	Child injury surveillance, Tuberculosis management, Maternal care, Family Planning	Health worker injury surveillance, Health data quality and record keeping
8	Web-based Integrated Dengue Hemorrhagic Fever (DHF) Surveillance System in Indonesia	Dengue hemorrhagic fever (DHF)	Training and education on DHR management by documenting the successes and failures of DHF case management and control
14	Development of a Web-based Medical Information Repository Integrated with an Artificial Intelligence-based Medical Decision Support System, Malaysia	Acute Stroke	Case studies
1	ICTs for Health Services in Rural Mongolia	General medicine	Continuous medical education of rural doctors: Breast cancer, Gastric cancer, High blood pressure, Ischemia, Esophagitis, Hepatitis and Brain trauma. The subtopics for each included: Epidemiology,Background theory, Classification, Clinical locations, Choice and analysis of testing, Diagnostic methods, Differential diagnosis, Treatment, Prophylactic measures, Rehabilitation.
9	Development of ICT-Based Mobile Tele-medicine System with Multi Communication Links for Urban and Rural Areas in Indonesia	None	Potential platform for distance education

Table 4: ICT Initiatives Supporting Teaching

focus on supporting teaching and learning of health professionals. Common ground among four of the projects was their clinical focus on disease management. Overall, the analysis of the project reports suggests there is potential for cross pollination and collaboration at both the ICT platform level and content level with respect to teaching and learning. It will be worthwhile exploring how this niche can be nurtured as an area of collaboration during the design phase of the regional research network.

4.1.4Care Delivery

The following table groups ICT projects that demonstrated support for healthcare delivery processes both administrative and clinical levels in their research outputs. A column summarizing the type of ICT

		Clinical Focus			
No.	**Project Name**	**Category**	**Detail**	**ICT Category**	**Type of Care Delivery**
15	Tele-medicine in Nepal	Disease Management	Communicable Infectious Disease	Telediagnosis	Remote Imaging
14	Development of a Web-based Medical Information Repository Integrated with an Artificial Intelligence-based Medical Decision Support System, Malaysia	General Medicine	Acute Stroke	Decision support	Decision Support, Medical Records
1	ICTs for Health Services in Rural Mongolia	General Medicine	General medicine	Teleconsult	Teleconsultation support for circulatory, respiratory, and digestive systems
2	ICT for Rural Development in Mountainous and Remote Areas of Northern Pakistan	General Medicine	Cardiology, dermatology, nephrology, gastro-entrology, and general medicine	Teleconsult	Teleconsultation services are focused on cardiology, dermatology, nephrology, gastro-entrology, and general medicine
11	Community Health Information Tracking System (CHITS)	Women's Health	Child injury surveillance, Tuberculosis management, Maternal care, Family Planning	Medical record	Clinical reminders, TB drug intake data and treatment protocol, patient follow up and medication reminders,
4	IT-mediated Rural Women Education and Dissemination of Health Information - A pilot in Tamil Nadu, India	Women's Health	HIV/AIDS, Pre Natal Care, Post Natal Care	Registry	Early registration for pre-natal care
10	Development of ICT-based Telemedicine System for Primary Community Health Care in Indonesia	Women's Health	Maternal mortality	Teleconsult	Medicine data recording & reporting, patient data recording and reporting, tele-coordination, community health education, and limited tele-consultation
12	M-DOK : Mobile Telehealth and Information Resource System for Community Health Workers		None	Medical record	Mobile Cell Phone EHR, Treatment Guidelines, Drug Lists
13	Pioneering Blood Bank Network System in Sri Lanka		None	Registry	Blood Bank Registry
5	Impact of Remote Tele-medicine in Improving Rural Health, India		None	Remote monitoring	Remote vitals monitoring: electrocardiogram ECG, blood pressure, temperature, and heart rate
9	Development of ICT-Based Mobile Tele-medicine System with Multi Communication Links for Urban and Rural Areas in Indonesia		None	Teleconsult Telediagnosis	Telemedicine support of diagnostics, consultation, and recording and reporting of patient's information

Table 5: ICT Initiatives Supporting Health Care Delivery

support was added to provide further insight into potential technology synergy among projects supporting the delivery of care. This combined with the previous section summarizing patterns in Clinical Focus reveals a number of patterns for potential collaboration. Groups of projects with potential synergy are evident from both the perspectives of Clinical Focus and the type of ICT support provided. Looking at the type of ICT support, a group of initiatives that explored the use of ICTs to facilitate the provision of expert consultation in remote areas via telemedicine or teleconsultation technologies is evident. Three groups are evident from the perspective of Clinical Focus: Womens' Health, Disease Management, and General Medicine. It is therefore reasonable to conclude that there is both critical mass and sufficient common ground for collaboration in researching ICTs to support for Care Delivery.

4.1.5Wellness

This Wellness domain encompasses ICTs initiatives that support prevention, surveillance and monitoring of population health status. The following table identifies the ICT initiatives that involved

No.	Project Name	Clinical Focus		Wellness
		Category	Detail	
8	Web-based Integrated Dengue Hemorrhagic Fever (DHF) Surveillance System in Indonesia	Disease Management	Dengue hemorrhagic fever (DHF)	Integrated DHF surveillance and control through a web-based geographic information and decision support system
3	Technology-Supported Distance Non-Formal Training and Education in Water, Sanitation and Hygiene (Philippines)	Disease Management	Hygiene and its relationship to dengue fever, diarrhea, scabies, typhoid fever	Information provided on disease causation, symptoms and prevention for the following diseases: Dengue Fever, Diarrhea, Scabies, Typhoid Fever; and, for the following contexts: Environmental Hygiene, Hygiene and Health at Home, Farm,School and Street Vendors.
10	Development of ICT-based Telemedicine System for Primary Community Health Care in Indonesia	Women's Health	Maternal mortality	Physiological measurement modules to improve the early detection and diagnosis of selected maternal pregnancy related problems and facilitate monitoring the pregnancy
11	Community Health Information Tracking System (CHITS)	Women's Health	Child injury surveillance, Tuberculosis management, Maternal care, Family Planning	Child injury surveillance and prevention, family planning, immunization and anti-tuberculosis treatment
6	ICT-Enabled Life Skill and Sexuality Education for Adolescent Girls	Women's Health	Adolescent female sexuality, sexual health	Growing up, Sex and Sexuality, Sexual Violence, Abuse, Sexually Transmitted Diseases, Knowledge Assessment and Feedback
4	IT-mediated Rural Women Education and Dissemination of Health Information - A pilot in Tamil Nadu, India	Women's Health	HIV/AIDS, Pre Natal Care, Post Natal Care	HIV/AIDS Awareness opportunistic infection and vertical transmission, Pre Natal nutrition, Post Natal guidance for breast feeding, nutrition, hygiene, immunization

Table 6: ICT Projects Focused on Wellness

supporting Wellness to some degree. The projects are grouped by their area of clinical focus to provide additional insight into where there is a basis for collaboration in a regional network. The table reveals two clusters, one focus on disease management and the other on women's health. Both groups employed ICT based surveillance systems as well as patient education and guideline systems in the context of wellness. Several of these projects were also found to cluster in the Care Delivery domain. These patterns suggest that bringing together projects with a common clinical focus in care delivery and wellness would establish an excellent foundation for establishing a regional ICT research network.

4.2 Adoption/Dissemination Maturity Stage

The purpose of this component is to highlight patterns in level of maturity with respect to the technology adoption and innovation lifecycle (see Fig.1). As described earlier, the three stages defined in this lens are Readiness, Diffusion and Impact. The primary value of this lens is that can be used to identify which projects are relatively deeper into the technology innovation lifecycle and could therefore provide mentorship to other projects in a research network. The relative distribution of projects across the three categories will also reveal how much emphasis there is on initial technology research and development versus applying technology research and development to maximize impact on health outcomes.

The following table summarizes the pattern of maturity levels observed in the evaluation of the project outputs.

No.	Project Name	Maturity
1	ICTs for Health Services in Rural Mongolia	Diffusion
2	ICT for Rural Development in Mountainous and Remote Areas of Northern Pakistan	Readiness-Diffusion
3	Technology-Supported Distance Non-Formal Training and Education in Water, Sanitation and Hygiene (Philippines)	Diffusion-Impact
4	IT-mediated Rural Women Education and Dissemination of Health Information - A pilot in Tamil Nadu, India	Unknown
5	Impact of Remote Tele-medicine in Improving Rural Health, India	Readiness
6	ICT-Enabled Life Skill and Sexuality Education for Adolescent Girls	Readiness
7	Using ICT to build capacities of HIV/AIDS Service Providers in India	Readiness
8	Web-based Integrated Dengue Hemorrhagic Fever (DHF) Surveillance System in Indonesia	Readiness
9	Development of ICT-Based Mobile Tele-medicine System with Multi Communication Links for Urban and Rural Areas in Indonesia	Readiness
10	Development of ICT-based Telemedicine System for Primary Community Health Care in Indonesia	Readiness
11	Community Health Information Tracking System (CHITS)	Readiness-Diffusion
12	M-DOK : Mobile Telehealth and Information Resource System for Community Health Workers	Readiness
13	Pioneering Blood Bank Network System in Sri Lanka	Readiness
14	Development of a Web-based Medical Information Repository Integrated with an Artificial Intelligence-based Medical Decision Support System, Malaysia	Readiness
15	Tele-medicine in Nepal	Readiness

Table 7: ICT Project Maturity Levels

Applying this lens reveals that most of the ICT initiatives could be classified as being in the Readiness phase. Only three projects showed characteristics of having reached the Diffusion stage, while one project could be considered to have approached the Impact phase. The conclusion that can be drawn is that there is a heavy emphasis on early stage research and development. One can infer from this pattern that establishing a regional research network would be very helpful in minimizing duplication of effort by focusing new projects building on existing efforts and/or innovating. It also indicates that there is opportunity to target regional collaboration on efforts related to dissemination of ICT solutions and maximizing their impact on health outcomes.

4.3 Technology Architecture and Strategy

The Technology Architecture lens provides a view of the key technical characteristics of the ICTs employed in a project. The following table Identifies and documents these characteristics to reveal possible patterns for regional collaboration based on reuse, improvement and technical innovation at the technical level. It also provides a tool for leveraging future IDRC investment in ICT research and development by providing a framework for projects to explicitly identify how their technology strategies will encourage reuse and enhancement of new and previous work.

No.	Project Name	Architecture	Standards	Language	Licensing	Assets
1	ICTs for Health Services in Rural Mongolia	Centralized web based client server, standalone CD ROM (for training)	XML RPC	Local	OSS possible: use of Apache, PHP and MySql	e-Library system (Green Stone) full text databases. Distance learning system (Apache,PHP, MySql) Distance diagnosis support system including patient information system
2	ICT for Rural Development in Mountainous and Remote Areas of Northern Pakistan	Store and forward, Centralized	None Identified.	Not identified	Not identified	Video conferencing
3	Technology-Supported Distance Non-Formal Training and Education in Water, Sanitation and Hygiene (Philippines)	Centralized web server/Intranet/Standalone CD ROM	None identified	Filipino, English, Cebuano dialect	OSS possible	CD ROM hygiene wellness education modules
4	IT-mediated Rural Women Education and Dissemination of Health Information - A pilot in Tamil Nadu, India	Centralized web server (not clear if this was implemented) standalone CD	Non identified	Tamil	Could not be determined	Web based and CD of wellness educational material for HIV/AIDS, PreNatal Care and Post Natal Care
5	Impact of Remote Tele-medicine in Improving Rural Health, India	Distributed	None Identified.	Not identified	Proprietary	Commercial vitals capture and transmission kit.
6	ICT-Enabled Life Skill and Sexuality Education for Adolescent Girls	Centralized web based	No Health ICT standards used (not needed)	Tamil	Could not be assessed.	Web and CD based courses on sexuality for adolescent girls.
7	Using ICT to build capacities of HIV/AIDS Service Providers in India	Centralized web based	No health ITC standards employed (not necessary)	English	OSS Possible: Use of PANTOTO content mangement and collaboration server.	Library; Content management and discussion forums tailored to support HIV/AIDS health providers
8	Web-based Integrated Dengue Hemorrhagic Fever (DHF) Surveillance System in Indonesia	Centralized, web-based	None identified	Indonesian	OSS Possible: based on PHP, MySQl	Web-based DHF surveillance system.
9	Development of ICT-Based Mobile Tele-medicine System with Multi Communication Links for Urban and Rural Areas in Indonesia	Distributed/Client Server	GSM, CDMA No Health Standards Identified No indication of use of existing medical device interfacing standards.	Indonesian ?	Mixed: Windows OS, Delphi GUI, OSS: Database, Webserver	Interfacing platform and interfaces to be developed for ECG, Fetal heart rate monitor, blood pressure monitor, digital camera. Communications manager and interfaces. Patient medical record.
10	Development of ICT-based Telemedicine System for Primary Community Health Care in Indonesia	Centralized web server	None identified	Indonesian	OSS Possible	Maternal Health-care Digital Record Module Medicine Data Recording & Reporting Software Package Patient Data Acquisition, Recording & Reporting Software Package Biometrics/Fingerprint Identification System Community Health Service Information System
11	Community Health Information Tracking System (CHITS)	Centralized or Peer to Peer	ICD 10	Multilingual capability	OSS	GAME engine 40 Modules including Child Injury Surveillance
12	M-DOK : Mobile Telehealth and Information Resource System for Community Health Workers	Centralized Knowledge Server Distributed	None identified	Not identified	OSS Possible	Mobile EHR SMS Based: Treatment guidelines Drug lists
13	Pioneering Blood Bank Network System in Sri Lanka	Centralized Web based	None identified	Not identified	Unknown, Proprietary DBMS	Unknown
14	Development of a Web-based Medical Information Repository Integrated with an Artificial Intelligence-based Medical Decision Support System, Malaysia	Centralized web based	None identified	Not identified	OSS Possible	Web based medical record AI decision support software
15	Tele-medicine in Nepal	Distributed, Point Solution	None identified	Local	OSS?	Image capture, display software, Case studies

Table 8: ICT Project Architecture and Strategy Summary

The dominant technology architecture employed that could be inferred from the project documentation was a centralized, web based, client server architecture. Several projects used a combination of Linux or Microsoft operating systems, with Apache, PHP and MySql as their basic platforms. Use of a common or complementary platforms provides an excellent foundation for regional collaboration as it makes it easier to share applications and application components developed on these platforms. It therefore would be beneficial to require projects to explicitly document their technology architecture and platform components to facilitate building a regional research network.

Looking at the standards dimension of technology architecture and strategy, the project reports did not provide sufficient information on the use of health informatics standards such as HL7 and technology standards to determine whether standards use is sufficiently consistent to support regional collaboration. Standards provide a strategic foundation for facilitating collaboration by maximizing compatibility at several levels including technology infrastructure, data and knowledge. It will be very beneficial to support the establishment of future regional networking efforts to require projects to employ existing open standards where they exist and identify which standards they are using.

The language(s) supported by each ICT project is also a key contributor to facilitating regional collaboration. Support for multi-language capability would be ideal and standards exist to facilitate this. In the majority of cases project documentation did not provide clear indication of what languages were supported by the ICT initiative. The language supported in many cases had to be assumed to be the local language. Indonesian was identified as the common language for several projects. Again it would be very helpful for projects to explicitly identify which languages they support, and internationalization capability should be established as a prerequisite for participation in a regional research network.

The analysis of software licensing element of technology architecture involved identifying the type of software license employed, in regard to both the software used and created by the project. The type of license employed is relevant because the type of license will have a direct impact on cost, reuse, integration and interoperability. Experience in the health sector has demonstrated that proprietary licensing in most cases presents significant barriers to collaboration in terms of cost, reuse and interoperability, while open source licenses by design facilitate sharing, reuse and improvement of ICTs. Most of the projects evaluated used software components, such as the Apache web server or MySql database, which are based on open source licenses. What was not clear in most of the projects was the type of license if any that was applied to the ICT components developed by the project. Projects should be required to clearly identify the type of license(s) associated with the software components they use and create. Unless there is a significant business case to the contrary, open source licensing should be adopted as the standard license for health ICT initiatives where collaborative improvement is a key goal.

The final element of technology architecture used to characterize the projects was an asset inventory. The objective was to identify, and in some cases infer, the kind of technology assets that each project could potentially make available to a regional research network. Clearly an important aid to regional collaboration would be the establishment of a cataloged and indexed repository of ICT assets. Several general purpose public repositories of this kind such as Sourceforge exist. The European Commission funded SPIRIT project (www.euspirit.org), an early attempt to develop a repository for collaborative peer reviewed development of health ICTs, could serve as a model. A key recommendation is that a regional research network initiative should implement or adapt the infrastructure necessary to facilitate sharing and collaborative improvement of software and related assets.

4.4 Development Lifecycle, Collaborative Improvement Processes

This lens focuses on the ICT development "culture" of a project and encompasses the development lifecyle employed, the degree to which ongoing peer review processes used, implementation of collaborative support systems, and the degree to which development is driven by end users. The presence of ongoing peer review, participatory involvement of users, and support for collaborative processes in ICT projects suggest a strong "IT cultural" fit and predisposition for effective participation in a regional research network setting. The type of development lifecyle used provides an indication of of flexibility and adaptability in developing and enhancing ICTs. Organizations using hierarchical software development lifecycles, such as the traditional "waterfall" method, are more likely to be less flexible or responsive to external input and rapid, iterative improvement. Projects that employ more modern, development lifecycles such as "extreme programing" are more likely to be amenable to

No.	Project Name	Peer Review	User Driven	Collaborative Support	Lifecycle	SW Development	Active
6	ICT-Enabled Life Skill and Sexuality Education for Adolescent Girls	Yes	Yes	Chats, Video conferencing	Unkonwn	In House	Yes
3	Technology-Supported Distance Non-Formal Training and Education in Water, Sanitation and Hygiene (Philippines)	Yes	Yes	Research management system	Waterfall assumed	In House	Yes
1	ICTs for Health Services in Rural Mongolia	Yes	Yes	Yes	Waterfall assumed	In House	Yes
14	Development of a Web-based Medical Information Repository Integrated with an Artificial Intelligence-based Medical Decision Support System, Malaysia	Yes	Yes	Yes	Waterfall	In House	Startup
11	Community Health Information Tracking System (CHITS)	Yes	Yes	Yes	Spiral	In House	Yes
8	Web-based Integrated Dengue Hemorrhagic Fever (DHF) Surveillance System in Indonesia	Yes	Yes	No	Waterfall	In House	Yes
2	ICT for Rural Development in Mountainous and Remote Areas of Northern Pakistan	Yes	Yes	No	Waterfall assumed	In House plus COTS	Yes
4	IT-mediated Rural Women Education and Dissemination of Health Information - A pilot in Tamil Nadu, India	Yes	Yes	No	Waterfall assumed	In House	Unknown
7	Using ICT to build capacities of HIV/AIDS Service Providers in India	Yes	Yes	Yes	Waterfall	In House	Yes
12	M-DOK : Mobile Telehealth and Information Resource System for Community Health Workers	No	Yes	No	Waterfall	In House	Yes
10	Development of ICT-based Telemedicine System for Primary Community Health Care in Indonesia	No	Yes	None	Waterfall	In House	Dormant
15	Tele-medicine in Nepal	No	Yes	No	Waterfall	In House	Unknown
9	Development of ICT-Based Mobile Tele-medicine System with Multi Communication Links for Urban and Rural Areas in Indonesia	No	Yes	No	Waterfall	In House	Yes
13	Pioneering Blood Bank Network System in Sri Lanka	No	No	No	Waterfall	In House	Unknown
5	Impact of Remote Tele-medicine in Improving Rural Health, India	No	No	No	Not identified	Integration of commercial solution	Yes

Table 9: Development Lifecycle, Collaborative Improvement Processes

collaborative development and open to external input and iterative improvement that typify the feedback processes and culture found in virtual ICT communities such as regional research networks.

In Table: 6 projects are first grouped by whether they employed peer review, and then sorted again by whether a user driven approach was adopted. Nine projects adopted some form of peer review and almost all of the projects employed some level of user participation during the development process. Only four of the project reports provided a clear indication that a platform to support collaboration had been implemented. ICTs in all but one of the projects were developed in-house and almost all the projects appeared to have employed a traditional, hierarchical software development lifecyle.

In summary, even though most of the projects appear to have employed a less flexible development

methodology, it is most likely because of a lack of familiarity with newer methodologies. One can conclude that at least nine of the ICT projects reviewed are very likely to have the kind of flexibility and development “culture” that would be amenable for participation in a regional research network initiative.

4.5 General Observations and Conclusions

The following are general conclusions and observations spawned by the evaluation process that are felt to be relevant to facilitating the creation of a regional ICT research network:

- Adapt and adopt an evidence based evaluation and continuous improvement model for ICT interventions that is focused on health quality improvement. The complexities and challenges of ICT initiatives in healthcare make it relatively easy for project focus to gravitate toward technology itself and away from the primary goal of exploiting technology to improve healthcare outcomes and health quality. The evidence based medical model provides a proven framework for guiding and evaluating innovation in the health sector. Adapting this model to ICT initiatives will significantly improve the odds technology evolve in way that improves healthcare.
- Adopt open source processes and licensing for all content and software. Unless there is a compelling business to the contrary all intellectual property developed by network participants should be licensed under an open source license. This will avoid the creation of barriers to collaboration and significantly leverage investment through maximizing reuse and improvement of ICT assets.

- Adopt open ICT standards whenever they exist. A prerequisite of participation in regional collaboratives should be the adoption open ICT standards, especially health ICT standards. Projects should also be required to explicitly identify which standards they employ. This will facilitate reuse of ICT components and knowledge as well as sharing and aggregation of data.

- Establish an ICT classification system or taxonomy to facilitate comparison, identify previous reusable work more easily (avoid reinventing wheels)

- Establish a regional research network repository for ICT assets which would include software, knowledge bases, data and documentation.

- Related to the previous point, establish an inventory of “externally developed”, proven health and other ICT components which can be reused or improved by network stakeholders, thus leveraging investment and minimizing “reinventing wheels”

- Establish standardized project reporting formats to facilitate identification of potential areas of collaboration and project evaluation.

- Lower barriers to diffusion by employing hybrid strategies. Several projects employed a combination of ICT technologies, such as the use of CDs and Internet based services to overcome infrastructure limitations and maximize geographic penetration.

- Projects should build on health ICT platforms such as electronic health records (EHR) rather than create vertical “boutique” solutions. There is a strong tendency for the creation of ICT “stovepipes” in healthcare. For example an initiative focused on HIV/AIDS will develop its own

version of a patient medical record rather than adapt an existing EHR. This is not only inefficient it also leads to fragmentation of health information making very difficult to build longitudinal health records or share data for research and population health management.

5 An E-cology Model for Health ICT Evolution

5.1 It's Time for a New Paradigm

“There's only one thing more painful than learning from experience, and that is not learning from experience.”

Author Unknown

There is a global consensus that integrated health ICTs are essential to improving health outcomes, providing better quality of care regardless of location, and reducing costs. Yet the current reality in the “developed world” with respect to healthcare ICT innovation, development and adoption is one of a crisis of gridlock. The symptoms of this crisis are many and varied and include the following:

- There are chronic problems achieving the level of ICT integration and interoperability needed to meet strategic healthcare goals – This is in spite of years of effort to establish software industry compliance with health ICT standards such as HL7.

- The cost of achieving sufficiently broad dissemination of ICTs at a national level is not affordable – The price tag for the UK NHS electronic health record (EHR) initiative is estimated to reach £26 billion, while Canadian estimates for national EHR implementation are in the order of $10 billion.

- Re-inventing of the wheel is pandemic, both between and within national and local health systems - There is little to no cross pollination and sharing of experience and assets between healthcare communities.

- It is difficult to measure the effectiveness of health ICT investments on health outcomes – Health ICTs are themselves barriers to guiding and evaluating investments in technology because poor interoperability and integration make it extremely difficult to aggregate the data needed to conduct proper evaluations.

- ICTs have become as important to health improvement as pharmaceuticals but ICT development and innovation lack the scrutiny and discipline of “evidence based” peer review processes that other “life critical” interventions are subjected to.

- Legacy, proprietary based software industry models are poor dance partners with the collaborative, “evidence based” culture of health innovation.

One thing is clear, and that is retracing the footsteps of the “developed world” in pursuing research, development to establish healthcare ICT infrastructure will very likely lead to the same gridlock. More significantly, the human opportunity cost of ICT strategies which are ineffective in improving health outcomes has become an “elephant in the living room” which can no longer be ignored nor tolerated. This is especially relevant in the regions served by IDRC, as resource constraints significantly amplify this opportunity cost.

What is needed is a paradigm shift in the development, improvement and dissemination of ICTs in

healthcare, or to quote Albert Einstein: *"The significant problems we face cannot be solved at the same level of thinking we were at when we created them."*

The roots of this paradigm shift can be found in the fact that "*Health care organizations have traditionally been viewed as if they were like machines that operate in accordance with the Newtonian laws of cause and effect, with linear relationships between actions and results. However, it is increasingly evident to administrators and researchers that health care organizations do not meet such mechanistic expectations – they are much 'messier' and more complex than this model suggests.*"[2] Health systems, are in fact complex adaptive systems that behave like natural ecosystems in which "bottom up" innovation strategies are critical to success. Some of the key characteristics of complex adaptive systems exhibited by healthcare systems include the following:

- *Non-Linearity* - Behavior and workflow is seemingly chaotic, unpredictable and non-linear. A good example is a patient visiting their doctor to attend to a sore throat. The initial diagnosis is often not definitive and the potential paths that addressing this problem can take are numerous.
- *Unpredictable* - Relationships between providers are inherently complex and fluid, and adapt dynamically the best way to address a health goal or problem emerges during an encounter.
- *Self-organizing, Local Control* - Control and decision making in healthcare is highly distributed and localized to the point of care as opposed to top down.
- *Nested, Interacting Systems* - Systems exist within systems in the healthcare ecosystem. Healthcare is holistic in that the frame of reference includes individuals, the systems and subsystems that make up an individual, the relationship between individuals, and their environment.

The purpose of this part of the report is to introduce a paradigm shifting conceptual model which embodies an "e-cological" approach to ICT innovation, research, development and dissemination that is in harmony with the complex, adaptive systems nature of health care ecosystems. The model provides a framework for harnessing the naturally occurring "bottom up" forces and emergent behavior found in complex adaptive systems such as healthcare systems. It does this by establishing a context for collaborative, open, peer review, evidence based innovation and technology transfer processes. The overall goal of the model is to drive ICT innovation, research, development and dissemination in healthcare so that it is more effective and responsive in improving healthcare quality and outcomes and learns from experience.

5.2 E-cology Model Design Principles

A set guiding principles were developed to help shape the e-cology model. They are based on lessons learned from extensive experience in health ICT initiatives, the pitfalls experienced in the developed world, the evaluation of the project outputs, and the complex nature of healthcare systems:

> *Health Focus* – A clear and sharp focus on achieving healthcare goals and objectives must permeate and drive every aspect of ICT evolution to effectively facilitate continuous quality

2 "Complex Adaptive Systems: A Different Way of Thinking About Health Care Systems", Australian Primary Health Care Research Institute, October 2004
Plsek PE. Redesigning health care with insights from the science of complex adaptive systems. In: *Crossing the Quality Chasm.* Washington, DC: National Academy Press; 2001:322–335
Crossing the Quality Chasm: A New Health System for the 21st Century (2001), Institute of Medicine.

improvement and better health outcomes. The basic elements include: ensuring patient safety by doing no harm and facilitating and expanding access to evidence based, high quality care. Without this focus as a guide it is easy for ICT initiatives to lose sight of the fact that technology is a means to an end.

Openness – Free exchange of ICT's DNA in the form of code, data and knowledge is essential to effective evolution. This free exchange is a critical design element as it creates the essential context for evolution's simple recipe of "differentiation, selection and amplification"[3] to shape ICT development and innovation.

Vertical and Horizontal – Simultaneous vertical and horizontal perspectives on ICT strategy and structure are essential to flexibility, adaptation and support of health focus. The model encourages the creation vertical solutions (e.g. developing an HIV registry) using common sets of reusable, horizontal infrastructure "Lego blocks", while horizontal "Lego" blocks are designed to support vertical application. These "Lego: blocks can consist of

User Driven Development and Enhancement – There is overwhelming evidence that the most well accepted and effective health ICT solutions are those developed with the direct and frequent participation of end user healthcare providers. This principle aims at harnessing the power of participatory development to empower users to interactively and collectively drive the evolution of ICTs. The end user provides the direction and "evolutionary force" in the e-cology model.

Evidence Driven Evolution – This principle integrates continuous evidence feedback loops into the e-cology model. This synchronizes ICT evolution with the evidence based medical model by embedding evidence based, collaborative peer review in the software lifecycle. The result is continuous ICT improvement which is more tightly coupled with measurable improvement in health quality objectives.

Iterative, Incremental Improvement – The model adopts an iterative, improvement process in contrast to the infrequent, major release approach employed in many ICT initiatives and products. Small, frequent incremental changes provide a more effective, responsive and less risky evolutionary strategy for ICT development and innovation. Software improvements are released early, and released often to maximize the benefits of collaborative input and scrutiny.

5.3 E-cology Model Components

The e-cology model consists of the following interrelated components: health focus, integrated health business process elements, and technology architecture or building blocks. In addition, two key processes or sets of "business rules" bring the model to life: an evidence based, continuous improvement process in conjunction with a set of rules for effective cooperation and collaboration.

3 "Origin of Wealth: Evolution, Complexity, and the Radical Remaking of Economics", Eric D. Beinhocker, Harvard Business School Press and Random House 2006

5.3.1Health Focus

The Health Focus component of the model (see Fig. 1) sets the direction for an ICT initiative by defining its health goals and objectives and provides the context for defining the criteria for ongoing measurement and evaluation of the effectiveness of ICT development with respect to its impact on health outcomes.

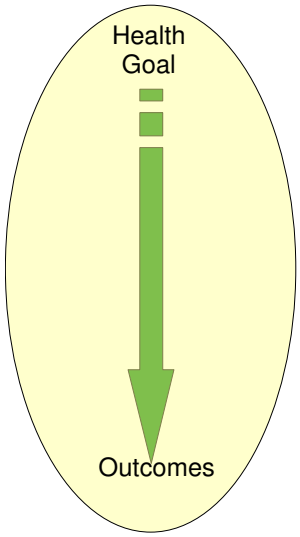


Fig. 1: Health Focus

5.3.2Health Business Processes

The Health Business Process (see Fig. 2) component of the E-cology model consists of the four integrated and interrelated healthcare business processes defined and used in the project evaluation framework.

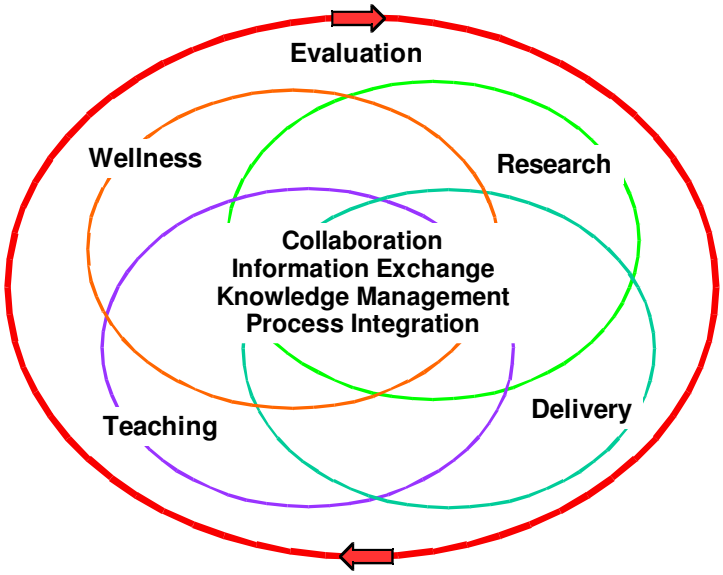


Fig. 2: Integrated Health Business Process Component

The following is the definition for each health business process domain as described earlier in the evaluation framework:

- Research – this domain covers the ICT support of healthcare research. Examples include clinical trials and other forms of health research.
- Teaching and Learning – this domain encompasses the teaching of healthcare providers and other health professionals. Examples include continuous medical education of physicians, education of nurses and nurse practitioners.
- Delivery – encompasses ICT support of the delivery of care. This includes both administrative and clinical processes. Examples ICT systems in this domain include electronic medical records, medical imaging, and remote consultation systems.
- Wellness – this domain addresses both prevention and surveillance and monitoring of population health status. Examples include infectious disease prevention programs, disease surveillance such as malaria and dengue fever outbreak monitoring.

As illustrated in Figure 2, the E-cology model establishes a holistic view, and underscores the fact that these business processes are strongly related and often directly interact in health systems. This holistic perspective is essential to the design and development of effective health ICTs because it drives implementations that enable data, knowledge and workflows to support much needed integrated health business processes. The outer ring in Figure 2 depicts the ongoing evaluation process that links the Health Business Process, Health Focus and Technology components of the model. This continuous evaluation process mimics the evidence based medical model[4] and provides a framework for rigorous critical peer review and selection of ICT solutions based on the best available scientific evidence.[5] This holistic perspective will also help avoid the “stovepipe” application and “islands of data” pitfalls that are common and have become a major barrier to innovation and improved care in the developed world's healthcare ICT landscape.

5.3.3Technology Architecture

The third component of the model (see Fig. 3) consists of the technology architecture and building blocks used to develop healthcare ICT solutions. This component of the model assists in explicitly defining the characteristics or DNA of the technology used to build health ICT solutions. It identifies

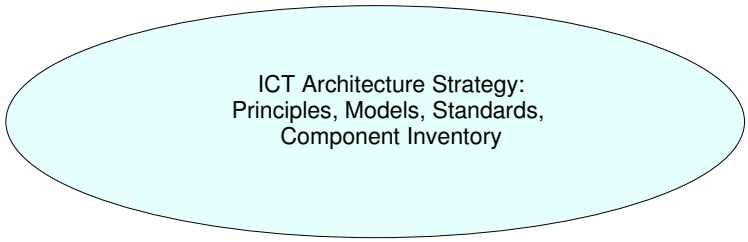


Fig. 3: Technology Architecture

key design principles, models (e.g. client server), standards (e.g. HL7) for each technology component or platform that is used to create an ICT solution. By making these characteristics explicit the model provides a way to easily determine the technical compatibility of an collection of existing ICT solutions and their components, and plan for better interoperability, integration and reuse in future solutions.

4 Sackett DL, Rosenberg WMC, Gray JAM, Haynes RB, Richardson WS. Evidence based medicine: what it is and what it isn't. *BMJ* 1996;312: 71-2

5 Davidoff F, Haynes B, Sackett D, Smith R. Evidence based medicine. *BMJ* 1995; 310: 1085-1086

5.4 The E-cology Model

The following diagram (see Fig. 4) assembles the previously described E-cology model components into the fully integrated E-cology model.

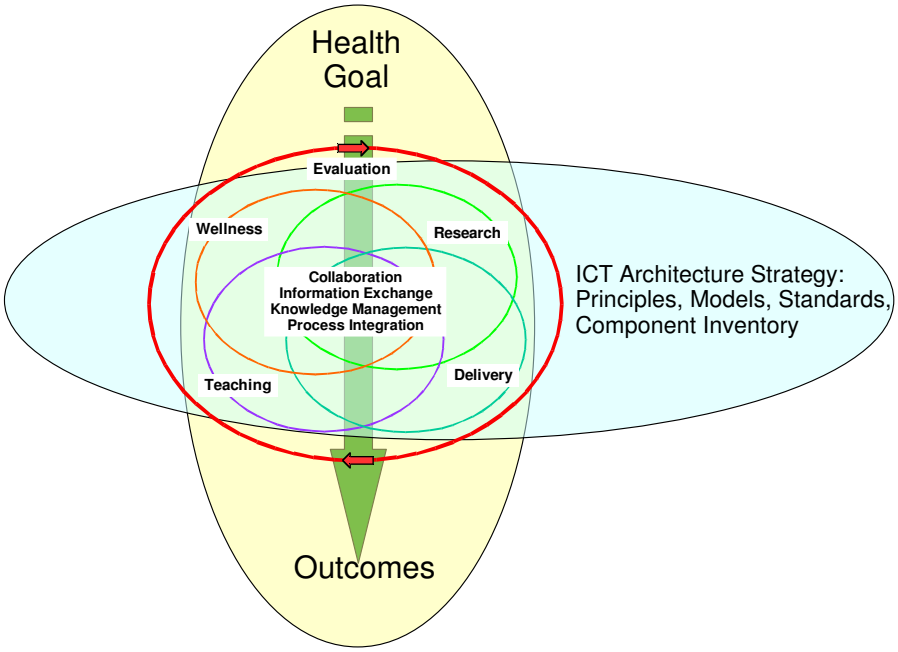


Fig. 4: The Health ICT E-cology Model

The diagram illustrates how the model implements and integrates the following key design principles:

- *Health Focus* – the direction and focus of the entire model is to support the measurable achievement of health goals as illustrated by the large arrow extending from Health Goal to Outcomes. The key is to establish a good enough vision or goal which creates a wide space for natural creativity to emerge from local actions within the community.
- *User Driven Development and Enhancement* – Health professionals set the goals for the model and thus provide the direction and "evolutionary force" for the e-cology model.
- *Vertical and Horizontal Perspective* – The vertical and horizontal ovals represent the simultaneous vertical and horizontal perspectives on ICT strategy and structure that are essential to flexibility, adaptation and support of health focus.
- *Evidence Driven Evolution* – Continuous evidence based evaluation as represented by the arrowed ring encircling the four health domains links continuous ICT improvement to measurable improvement in achieving health quality objectives.

The remaining principles are embodied in the following three process strategies which are critical to breathing life into the model and making it work in practice:

Strategy 1: Openness – All community ICT DNA in the form of code, data and knowledge must be free to be exchanged and not encumbered by proprietary intellectual property licenses or restrictions. Free exchange of information is essential for rapid and effective adaptation.

Strategy 2: Rapid Iterative, Incremental Improvement – Improvements to ICT components and

solutions should be small, frequent and incremental to provide rapid low risk evolution while minimizing the change management challenges that drastic changes bring with them.

Strategy 3: Establish and Enforce Social Context and Contracts That Promote Collaboration – Extensive research, such as Axelrod's study of the "prisoner's dilemma"[6], has demonstrated that effective collaboration can be promoted and sustained as a dominant force by creating the right strategic setting for cooperation. Some key strategies to do this include: increasing the likelihood that community members will interact over the long term; teaching and encouraging reciprocity; changing payoff structures to support reciprocity and cooperation; and, making it easy to recognize community members from past interactions.

The model in its current form is intended to be simply a starting point, as it too is expected to evolve via the same open, collaborative peer review that it employs. The model creates the context for an adaptive healthcare ICT ecosystem, whose components change organically, "reflecting the interaction of [healthcare strategy], technological innovation, social development and business practice"[7]. As such it provides a holistic framework for harnessing the power of healthcare ecosystems to drive ICT innovation and adoption toward more effective continuous improvement of healthcare business processes and health outcomes.

6 Robert Axelrod, *The Evolution of Cooperation* (New York: Basic Books, 1984).
Robert Axelrod and Michael D. Cohen, Harnessing Complexity: Organizational Implications of a Scientific Frontier, (New York: Free Press, 2000; paperback edition New York Basic Books, 2001).
Collaborative Governance - A Guide for Grantmakers, The William and Flora Hewlett Foundation

7 "Origin of Wealth: Evolution, Complexity, and the Radical Remaking of Economics", Eric D. Beinhocker, Harvard Business School Press and Random House 2006

6 Health ICT Technology Scan

The purpose of this section is to document the moving landscape of technology platforms and solutions in the health field and analyze their usefulness for the context of Asia and other developing countries. The goal is to highlight key ICT trends and examples of ICTs that are particularly appropriate and relevant to supporting healthcare improvement strategies in areas served by IDRC. Selection of trends and examples was influenced by the lessons learned developing and applying the evaluation framework, the E-cology model and in particular by the following characteristics:

- Zero to very low cost to maximize the potential for broad diffusion and scalability
- Modular, reusable solutions that can be used in combination with other components to create new solutions
- Flexible solutions that can be easily re-purposed to address specific health objectives or business processes
- Open source and open standards based solutions with active communities to facilitate adaptation and increase the likelihood of long term sustainability
- Strategic fit with a holistic, integrated approach to health ICT infrastructure development to avoid creating “islands of automation”

This survey is not intended to provide a detailed assessment of the full range of technology applications that are relevant healthcare settings. It is also important to note for future work that it would be very beneficial to frame an ICT environmental scan in the context of a high level health technology architecture which includes guiding principles, standards, and implementation models. This will provide better guidance in selecting ICT components so that initiatives are driven by health strategy rather than the technology itself. This is especially important in healthcare given the scarcity of resources as the opportunity cost of investing in initiatives that are not directly driven by health quality improvement objectives is extremely high. It is recommended that development of a guiding architecture be considered as part of the scope of the regional research network design team.

6.1 ICT Categories and Trends

The following is a summary of key, current healthcare ICT trends observed in the environmental scan. While not exhaustive by any means this analysis will be helpful in identifying where there is active development of ICTs that can be leveraged, where opportunities for collaboration and cross pollination exist, and where duplication of effort can be avoided.

- *Integration platforms* – A number of open platforms are emerging that address the interoperability and integration challenges found in many current health ICT ecosystems. These technologies can be used to create integrated regional health information networks where there is a heterogeneous mix of legacy systems. They can also be used at a “micro” level to integrate an existing application with other applications and services, e.g. integrating an EHR to receive laboratory results from external services.
- *Integrated Solutions* – Mature, open highly integrated ICT platforms such as EHRs that support enterprise (hospital or health system) and smaller health organization business processes are becoming a viable option to expensive proprietary solutions. Several provide equivalent level of functionality to ERP solutions in manufacturing and other sectors.
- *Cross Pollination is Occurring* – Platforms and solutions from other sectors are being increasingly adapted for use in the health sector. A good example are high level decision

support tools which capture and summarize data from front line production systems. These technologies can be used for decision support within an organization or at a regional level to support population health management and resource allocation and planning.

- *Commoditization of Data Capture* – Increasingly sophisticated, consumer focused health monitoring devices are driving down the cost of remote health monitoring devices to the level that ICTs that support telehealth can be made ubiquitous.
- *Open Source Collaboration in Healthcare is Maturing* – Open source ICT development processes and communities are becoming increasingly prevalent in healthcare sector. Major organizations in the health sector such as the California Health Care Foundation, European Commission and US Department of Health and Human Services have made significant commitments to health ICT initiatives that are based on open source strategy.
- *Collaboration Platforms* – Open platforms such as content management systems, e-learning systems and workgroup support software are becoming mature and well accepted building on the path established by web servers such as Apache.
- *Leveraging Modular Components* – Software components have reached levels of functionality and maturity that enable new more complex components that provide new or increased levels of functionality to be assembled like "Lego" blocks. Complex medical imaging systems, for example, have been "assembled" by combining previously independent imaging subcomponents setting a new standard of what can be done by building and leveraging reusable ICT solutions and components.

6.2 Solution Descriptions

The following solutions were identified during the technology scan as ICT building blocks that have significant potential and relevance to the goals, objectives and regions served by IDRC. In many cases what makes them especially relevant is that the communities and processes that provide the development and stewardship for these solutions demonstrate show strong congruence with the E-cology model presented earlier. Lastly, it is important to note that given the scope of this study this is not a complete an exhaustive list. It is recommended that IDRC in collaboration with its community build on this initial inventory and improve its value by maintaining a simple peer review or user satisfaction rating system.

6.2.1 Integrated ICTs for Support of Care Delivery

VistA/VistA-Office EHR – Hospital and Primary Care EHR/PHR/HIS[8]
http://www.worldvista.org / http://www.va.gov/vista_monograph/

The U.S. Department of Veterans Affairs (VA) developed and continues to maintain a robust EHR and Health Information System known as VistA - the Veterans Health Information Systems and Technology Architecture. This system was designed and developed to support a high-quality medical care environment for the military veterans in the United States. VistA has a proven track record of supporting a large variety of clinical settings and medical care delivery systems. Facilities range from small clinics that provide solely outpatient care to large medical centers with significant inpatient populations and their associated specialties, such as surgical care or dermatology. These systems focus on clinically relevant record keeping that improves patient care by improving clinical and administrative decision-making. The VistA system is in production today at hundreds of VA medical centers and outpatient clinics across the United States. Versions of the system are in active use in the

8 Note: In the interest of full disclosure, the consultant is a Director and Officer of WorldVistA

U.S. Department of Defense Military Health System, the U.S. Department of Health and Human Services Indian Health Service, and internationally as well, e.g., Mexico IMSS, Berlin Heart Institute of Germany (Deutsches Herzzentrum Berlin, Deutschland), and National Cancer Institute of Cairo University in Egypt.

The fundamental goal of the VistA-Office project has been to encourage the broader adoption and effective use of EHRs among primary care physicians by adapting VistA to make a highly functionality, robust, flexible open source EHR solution available for primary care. The Centers for Medicare & Medicaid Services (CMS), an agency of the Department of Health and Human Services (DHHS), has partnered with several US federal agencies on the development of VistA-Office EHR, including the Veterans Health Administration (VHA) of the Department of Veterans Affairs (VA), Indian Health Services (his) and Health Resources and Services Administration (HRSA). WorldVistA is the official steward and technology transfer organization for VistA-Office EHR.

Indivo – Personal Health Record/Access Management

http://www.indivohealth.org/

Indivo is a personally controlled health record system that enables patients to own complete, secure copies of their medical records. Indivo places a strict emphasis on patient control and ownership of medical information and offers the detailed technical infrastructure to provide this control. Hence the term "personally controlled health record" to describe Indivo. The Indivo system is essentially an inversion of the current approach to medical records, in that the record resides with the patients and the patients grant permissions to institutions, clinicians, researchers, and other users of medical information. Indivo is a distributed, web-based, personally controlled electronic medical record system that is ubiquitously accessible to the nomadic user, built to public standards, and available under an open-source license.

OSCAR – Primary Care EHR

http://www.oscarmcmaster.org/

OSCAR is an open source, primary care, electronic health record system, initially developed by the Department of Family Medicine, McMaster University. Its components are web-based applications designed for the delivery of evidence resources and decision support at the point of care for both patients and providers. It incorporates the following major components

- OSCAR-McMaster - an Electronic Medical Record
- OSCAR-Resource - a Clinical Resource Content Management System
- OSCAR-Citizens - a patient portal

6.2.2Modular Solutions Supporting Clinical Specialties

OsiriX – Medical Imaging Workstation

http://homepage.mac.com/rossetantoine/osirix/Index2.html

OsiriX is an image processing software dedicated to DICOM images produced by medical equipment (MRI, CT, PET, PET-CT) and confocal microscopy (LSM and BioRAD-PIC format). It can also read many other file formats: TIFF , JPEG, PDF, AVI, MPEG and Quicktime. It is fully compliant with the DICOM standard for image communication and image file formats. OsiriX is able to receive images transferred by DICOM communication protocol from any PACS or medical imaging modality (STORE SCP - Service Class Provider, STORE SCU - Service Class User, and Query/Retrieve) .

OsiriX has been specifically designed for navigation and visualization of multi-modality and multidimensional images: 2D Viewer, 3D Viewer, 4D Viewer (3D series with temporal dimension, for example: Cardiac-CT) and 5D Viewer (3D series with temporal and functional dimensions, for example: Cardiac-PET-CT). The 3D Viewer offers all modern rendering modes: Multi-planar reconstruction (MPR), Surface Rendering, Volume Rendering and Maximum Intensity Projection (MIP). All these modes support 4D data and are able to produce image fusion between two different series (for example: PET-CT).

Osirix is at the same time a DICOM PACS workstation for medical imaging and an image processing software for medical research (radiology and nuclear imaging), functional imaging, 3D imaging, confocal microscopy and molecular imaging.

Osirix supports a complete plug-ins architecture that allows you to expand the capabilities of OsiriX for your personal needs! This plug-in architecture gives you access to the powerful Cocoa framework with an easy object-oriented and dynamic language: Objective-C.

6.2.3ICT Integration Tools and Platforms

Care Data Exchange – Interoperability Platform
http://www.sbccde.org/

The Care Data Exchange uses peer-to-peer technology to access clinical results from multiple systems across healthcare organizations. Using the CDE, authorized users within the network will be able to access a “patient-centric” view of clinical and administrative results, including patient demographics, medical records, medical transcription, eligibility and referral information, and laboratory, radiology and pharmacy data. The CDE platform is made up of four primary components:

- Identity Correlation Service (ICS). Rationalizes and correlates patient demographic data from different systems within or across participating health organizations to identify patient records. The ICS correlates patient information against a master patient index (MPI) that acts as a repository for demographic data for all patients in the defined network.
- Clinical Information Architecture (CIA). A supporting integration tool that enables an automatic interface to extract patient demographic data from participant sites.
- Information Locator Service (ILS). Searches the defined network of participating healthcare organizations for patient information and clinical results and provides referring hyper-link locators where data can be sourced.
- Access Control Service (ACS). Manages and authorizes access to data according to rules set by the data holder through data access and security policies and enables compliance with privacy regulations.

A web-based interface to the CDE will allow a clinician to access patient information. A similar web-based interface will allow a patient to view the same information.

OHF – Interoperability Platform
http://wiki.eclipse.org/index.php/OHF

The Open Healthcare Framework addresses part of an need to improve the levels of interoperability between applications and systems within and across healthcare organizations – corporate and regions. The project will implement extensible frameworks and exemplary tools for implementations of key health informatics standards based components and support the objectives of many government health departments to encourage the use of interoperable open source infrastructure to lower integration barriers. The frameworks, components and tools created by this project will be used by

vendors and integrators to build workstation applications, gateways and server applications in healthcare infrastructures. The overall architecture for the OHF platform consists of the following:

- Interoperability Stack - The Interoperability Stack is a physical data center that hosts patient medical documents. It conforms fully to the HL7 international healthcare standard. It has two separate components: the registry that hosts the metadata for patient and document search, and the repository that stores the contents of medical documents. In the event of patient search, the search is done in the registry; a list of matching patient is then returned. In the event of document retrieval, the registry accesses the repository, pulls the document and returns it. If the EMR application requests a creation, change or deletion of a document, the repository will first take the appropriate action and update the document, and then it will request a change in the metadata within the registry. A security component lies on top of both the repository and the registry and performs the permission handling.
- OHF Plug-ins - The OHF Plug-ins includes three distinct mechanisms (PDQ, PIX, and XDS), each consists of two components: the component that retrieves files (the consumer component) and another component that creates files (the source component). The PDQ plug-in handles the search of patient with demographic information including patient ID, full name, address, gender, date of birth, and contact information and returns a list of possible matches. Next, the PIX plug-in handle the cross-reference and comparison of patient metadata. Lastly, the XDS plug-in finds a list of documents for the matching patient and retrieves the full content of a selected document.
- OHF Web Services - The OHF Web Services reside inside the AXIS SOAP Engine, which has been ported to an OSGi bundle inside Tomcat. Once the Web Services acquires the SOAP envelope from the EMR application, it calls a series of internal methods provided by the Adapters. These internal methods are dehttp://www.eclipse.org/birt/phoenix/intro/signed to cast the received call object to OHF objects recognizable by the PDQ, PIX, and XDS plug-ins. Once the casting is done, the OHF objects are passed onto the plug-ins.
- OHF Bridge - The OHF Bridge provides a simple API consisting of methods that allow an EMR application to search patients with demographic information, and then create, retrieve and save patient documents. The API is initially developed for the LAMP environment, and will be extended to other platforms such as Java and .NET. Once an EMR application accesses a method to request a call to the interoperability stack, the call is packaged into a SOAP envelope and then sent to the OHF Web Service.

Mirth – Integration Engine

http://www.mirthproject.org/

Mirth is an HL7 interface gateway that allows for message filtering, transforming, and routing to enable client or legacy applications to communicate with disparate health information systems. All configuration is done through a Java client which can connect remotely. Channels (HL7 interfaces) are easily configured, imported and exported. Mirth can be configured to listen and send HL7 messages and connect to a variety of protocols: TCP/MLLP, Database (ODBC), File; with planned support for JMS, HTTP, and SOAP. Mirth supports all major operating systems (requires Sun Java 1.5). Mirth provides built in transformers or the creation of creation of new ones to enable transformation and mapping of HL7 data. Mirth provides the following types of transformations:

- Mapping transformer: map data from incoming message to variables
- Script transformer: execute custom script on message (Ex. JavaScript, Python, Tcl)

- HL7 message generator: construct HL7 messages from data source
- XSLT transformer: run XLS Transformations on incoming HL7 v3 or XML encoded message

ELINCS – Laboratory Results Reporting Standard
http://www.chcf.org/topics/chronicdisease/index.cfm?itemID=108868

ELINCS is a detailed specification for the formatting and coding of lab results messages from laboratory information systems to ambulatory electronic health records. The specification is based on the HL7 version 2.4 ORU message type and uses standardized LOINC coding for common lab tests. ELINCS is designed to standardize the electronic transmission of lab test results from laboratories to electronic health record systems used in the ambulatory setting. Hence, the specification should be used by commercial labs and hospital labs that perform outpatient testing and want to send results electronically to ambulatory-care providers in the community. The specification should also be used by the developers and vendors of electronic health record systems that are deployed in the ambulatory setting and can receive laboratory test results electronically. The goal of ELINCS is to simplify and facilitate the interface of these systems for the exchange of outpatient lab results.

6.2.4Decision Support

BIRT – Business Intelligence and Reporting Tool
http://www.eclipse.org/birt/phoenix/intro/

BIRT is an Eclipse-based open source reporting system for web applications, especially those based on Java and J2EE. BIRT has two main components: a report designer based on Eclipse, and a runtime component that can be added to an application server. BIRT also offers a charting engine that enables adding charts to an application. The tool enables the creation of a rich variety of reports which include: lists, charts, cross-tabulations or matrices, and compound reports. BIRT reports consist of four main parts: data, data transforms, business logic and presentation.

Pentaho – Business Intelligence Tool
http://www.pentaho.com/

The Pentaho BI Project provides enterprise-class reporting, analysis, dashboard, data mining and workflow capabilities that help organizations operate more efficiently and effectively. The software offers flexible deployment options that enable use as embeddable components, customized BI application solutions, and as a complete out-of-the-box, integrated BI platform. Pentaho's reporting capabilities include:

- Flexible deployment from standalone desktop reporting, to interactive web-based reporting to enterprise business intelligence
- Broad data source support including relational, OLAP, or XML-based data sources
- Flexible output options including Adobe PDF, HTML, Microsoft Excel, Rich Text Format, or plain text

Pentaho provides data analysis, dashboard and data mining capabilities.

6.2.5Collaboration Platforms

Numerous, mature open source web based collaboration platforms such as Wiki's and workgroup support systems exist today. A key trend is that they are increasingly being applied to support healthcare and health ICT activities. A description of the range of tools and applications can be found here: http://en.wikipedia.org/wiki/Computer-supported_collaboration. The following are examples of these types of applications.

Plone – Content Management and Workgroup Collaboration Support
http://plone.org/about/plone

Plone is a content management framework that works hand-in-hand and sits on top of Zope, a widely-used Open Source web application server and development system. Plone is an object oriented a web content publishing and management system that allows normal content originators to create, submit, and publish their content directly within a web application/site without any development tools or knowledge of HTML.

Media Wiki – Collaborative Web Authoring Tool
http://www.mediawiki.org/wiki/MediaWiki

A wiki is a type of Web site that allows the visitors themselves to easily add, remove, and otherwise edit and change some available content, sometimes without the need for registration. This ease of interaction and operation makes a wiki an effective tool for collaborative authoring.

Moodle – Collaborative E-learning Platform
http://moodle.org/

Moodle is a course management system (CMS) - a free, Open Source software package designed using sound pedagogical principles, to help educators create effective online learning communities. The system can scale from a single-teacher site to a 50,000-student University. Moodle has a large and diverse user community with over 150,000 registered users on this site alone, speaking over 75 languages in over 160 countries.

6.2.6Consumer Health Monitoring Devices

Both Intel and Apple/Nike are pioneering consumer targeted health monitoring devices that include capabilities to capture vital signs and other health data.

Intel - Connected Health Products
http://www.intel.com/healthcare/personalhealth/products.htm

This site lists a wide range of products, available through retail stores or online, designed to help manage fitness, general wellness, and health conditions. These specific products offer a complete solution for connecting with a PC including a USB or better connection interface, and software or web service.

Apple/Nike - iPod Fitness Monitoring
http://www.apple.com/ipod/nike/sync.html

The Nike + iPod sensor and receiver, collects exercise performance data for later transmission to the Internet or a computer. It enables analysis of performance measures such as speed, distance, and calories burned by run, by week, or by month. Creation of other types of sensors would enable this

type of technology platform to capture many other types of health data such as blood pressure, temperature and heart rate.