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Health informatics — Survey of mHealth projects in low and middle income countries (LMIC)

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National foreword

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TECHNICAL REPORT

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Health informatics — Survey of mHealth projects in low and middle income countries (LMIC)

Informatique de santé — Étude de projets de santé mobile dans les pays à revenu bas et moyen

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Foreword

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The committee responsible for this document is ISO/TC 215, *Health Informatics*.

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Introduction

Mobile Health (mHealth) is a hot topic in the health information technology (IT) industry because it can make a big difference in healthcare services. The United Nations (UN) and World Health Organization (WHO) are interested in mHealth technology to help overcome the current low quality healthcare services in low and middle income countries (LMIC).

The UN describes use cases that are applicable to mHealth in LMIC: Education and Awareness; Remote Data Collection; Remote Monitoring; Communication and Training for Healthcare Workers; Disease and Epidemic Outbreak Tracking; and Diagnostics and Treatment Support. WHO also describes use cases: Health call centres/Healthcare telephone help line; Emergency toll-free telephone services; Treatment compliance; Appointment reminders; Community mobilization and health promotion; Raising awareness; Mobile telemedicine; Public health emergencies; Health surveys and surveillance; Patient monitoring; Information Initiatives; Decision support systems; and Patient records. For more use cases, see References [1] and [2].

There are several eHealth frameworks already developed by a number of organizations such as Health Level Seven (HL7), ISO/TC215, CEN/TC251, and Standards Australia (SA). Before suggesting an interoperable mHealth framework, currently available eHealth frameworks are surveyed and investigated to recognize how suitable each eHealth framework is for mHealth.

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TECHNICAL REPORT **ISO/TR 19231:2014(E)**

Health informatics — Survey of mHealth projects in low and middle income countries (LMIC)

1 Scope

This Technical Report surveys ongoing national mHealth projects in LMIC, to which some emerging technologies such as zero configuration and proximity computing are applicable, especially when the information and communication technology (ICT) infrastructure is not established in those countries.

The scope is constrained to mHealth use cases and technologies for information and communication infrastructures that are useful for LMICs. In addition, the purpose of this Technical Report is to survey not only national mHealth projects in LMICs, but also possible mHealth frameworks that might be used.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
clinician
health professional who delivers health services directly to a patient/client

3.2
patient
individual person that is a subject of care

3.3
HIV/AIDS
human immunodeficiency virus infection
acquired immunodeficiency syndrome
disease of the human immune immunodeficiency virus

3.4
SIM card
subscriber identity module
subscriber identification module
(SIM)
integrated circuit that securely stores the international mobile subscriber identity (IMSI) and the related key used to identify and authenticate subscribers on mobile telephony devices (such as mobile phones and computers)

3.5
infrastructure
basic physical and organizational structures needed for the operation of a society or enterprise, or the services and facilities necessary for an economy to function

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3.6
confidentiality
property that information is not made available or disclosed to unauthorised individuals, entities, or processes

[SOURCE: ISO 7498-2:1989]

3.7
standard
document, established by consensus and approved by a recognised body that provides, for common and repeated use, rules, guidelines or characteristics for activities or their results, aimed at achievement of the optimum degree of order in a given context

[SOURCE: ISO/IEC Guide 2:2004]

3.8
solution
successful resolution to a medical problem

3.9
service
ability of a system to provide a set of output information based on a defined set of input information

[SOURCE: ISO 12967-1:2009]

3.10
healthcare
activities, services, or supplies related to the health of an individual

3.11
healthcare worker
healthcare professional involved in the direct provision of healthcare

3.12
organization
unique framework of authority within which a person or persons act, or are designated to act, towards some purpose

[SOURCE: ISO 6523-1:1998]

3.13
subject of care
person scheduled to receive, receiving, or having healthcare

[SOURCE: ISO/EN 13606-1:2008]

3.14
use case
textual and graphical depiction of the actors and operations that address information exchange in the context of a set of specific tasks performed by different systems or devices

4 Symbols and abbreviated terms

mHealth	Mobile Health
LMIC	Low and Middle Income Countries
SMS	Short Message Services
PDA	Personal Digital Assistant

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UHI	Universal Health Identifier Service
NASH	National Authentication Service for Health
NPC	National Product Catalogue
CADA	Chinese Aged Diabetic Assistant
AESSIMS	Acute Encephalitis Syndrome Surveillance Information System
SARS	Severe Acute Respiratory Syndrome
TCD	Trinity College Dublin
ATNF	Apollo Telemedicine Networking Foundation

5 mHealth survey around the world

Mobile devices have been reaching more people in many developing countries than power grids, road systems, water works, or fibre optic networks. Mobile services offer a way for the public and private sectors to reach these communities, and one of the most important spheres for this interactive contact is health.[3] As a result, this report survey mHealth projects which are conducted nationwide around the world. Furthermore, several use cases of mHealth are illustrated in the next chapter in order to classify the possible mHealth services.

5.1 Africa

5.1.1 Project: Masiluleke

Country: South Africa

Participants: Pop! Tech Accelerator, Parakeet Foundation, iTeach, frog design, MTN, Nokia-Siemens Networks, National AIDS Helpline, National Geographic Society, Ghetto Ruff Records, Children of South African Legacies, Aricent

Application Area: Education and Awareness

Description: Project Masiluleke was proposed and this project is in progress to harness the power of mobile technology as a high-impact, low-cost tool in the fight against HIV/AIDS. The project provides a suite of interventions targeting the entire HIV/AIDS care continuum under the guidance of an international, multidisciplinary team. The project contributes to HIV/AIDS care by promoting testing, treatment connection/adherence, and, ultimately, improved access to testing through an innovative home HIV test kit supported by mobile counselling. Project Masiluleke is encouraging people who are scheduled to be tested and treated for HIV/AIDS in South Africa by sending one million text messages per day. Capitalizing on the ubiquity of mobile devices in even the most resource constrained areas makes the potential for this project to revolutionize the public health response to HIV/AIDS in South Africa and other parts of the globe. The model is designed for scale and replication and can be modified to address a variety of public health and social challenges. Local languages are used for these messages and messages are used to direct recipients to the National AIDS Helpline. Representatives of the hotline provide information about testing services and locations when patients call.

5.1.2 Project: The Dokoza system

Country: South Africa

Participant: Dokoza, State Information Technology Agency (SITA), Centre for Public Service Innovation (CPSI), Centre for Scientific and Industrial Research (CSIR) and the Meraka Institute, with the cooperation of South Africa's National Department of Health

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Application Area: Remote Data Collection

Description: The goal of Dokoza system in South Africa is to provide solutions for integrating mobile data collection with existing health information systems which is essential for advancing patient care. In other words, this solution is SMS-based mobile system designed to fast-track and it improves critical services to HIV/AIDS and TB (tuberculosis) patients. In this solution, SIM cards, which can be used across the networks, interact with a more complex back-end system that integrates with existing hospital information systems. Integrating with existing infrastructure offers the possibility of dramatic improvements to existing patient health information records. Also, in the 2004 pilot, both doctors and patients found the system to be user-friendly. During the pilot test, some problems have been detected including the duplication of data entry in instances where paper-based systems already exist and staff shortages which hampered information collection. Despite the availability of this technology, there are little new data on its impact until the end of the pilot.

5.1.3 Project: Mobile HIV/AIDS Support

Country: Uganda

Participant: Trinity College Dublin

Application Area: Communication and Training for Healthcare Workers

Description: In the developing world, 'training the trainers' (providing healthcare workers in the field with accessible and reliable medical information) is essential for improved health service delivery. To explore the potential advantages of using PDAs in HIV/AIDS care and treatment, Trinity College Dublin (TCD) is collaborating with the medical school at Maker ere Hospital in Kampala, Uganda. The aim of this project is providing high-quality medical information and advising healthcare workers in Uganda and throughout sub-Saharan Africa. The project leaders (a group of academic clinicians from TCD, the Dublin Institute of Technology, and North American universities) developed a prototype of a training program on the clinical care, research, and prevention of HIV/AIDS, after an initial needs assessment. By selecting a group of healthcare workers in the field, this program was scheduled to be evaluated, however, testing and evaluation results have not yet been published.

5.1.4 Project: Cell Phone Apps for Clinical Diagnostic Therapeutic and Public Health Use by Front Line Healthcare Workers

Country: Mozambique

Participant: Microsoft Research and Department of Information Systems, University of Melbourne

Application Area: Diagnostics and Treatment Support

Description: Mozambique has extensive cellular network coverage and a high percentage of health workers who own mobile phones although this country is one of the world's poorest. Microsoft Research supports this project which aims to take advantage of Mozambique's 'wired' reality. A suite of applications that can run on standard mobile phones have been created by the project principals, researchers from the University of Melbourne. Mozambican health workers use this application and get services with diagnostic and analytical tools, including reference material in the phone's memory, a calculator for determining drug dosage, and a program for analysing inputs from medical sensors (e.g. low-cost pulse oximetry probes or a simple electrocardiogram). The project duration was from March 2008 to March 2009 and researchers concluded project result by evaluating the impact and efficacy of the applications suite.

5.2 Asia

5.2.1 Project: Chinese Aged Diabetic Assistant (CADA)

Country: China

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Participant: Microsoft Research, researchers from St Louis University, Old Dominion University, Beijing Medical University and Peking University First Hospital

Application Area: Remote Monitoring

Description: Diabetes is becoming an important issue for developed countries such as China because of economic developments and the resultant lifestyle. To deal with this problem, 'Smartphone-based self-management and support system for elderly diabetics in China' project is in progress by Microsoft Research and a group of researchers from several universities and Chinese medical centres. This project provides several functions such as sending elderly diabetics recommendations and guidelines related to physical activity, glucose and blood pressure monitoring, weight measurement, and diet with smartphone. The product gathers and sends data on glucose levels and it is helpful for doctors by tracking patient data and graphically displaying data for patients. The system has been implemented by the user-centred design approach to develop software that improves the preferences and capabilities of the targeted population to achieve maximum usability. This software has been provided free of charge on PDAs and smart phones that run the Windows Mobile operating system.

5.2.2 Project: HealthLine

Country: Pakistan

Participant: Microsoft Research, Carnegie Melon University (CMU), Aga Khan University (Karachi) and Health and Nutrition Development Society (HANDS)—a Pakistani NGO

Application Area: Communication and Training for Healthcare Workers

Description: To provide mHealth solutions, sufficient literacy should be guaranteed. Low and middle income countries such as Pakistan don't have a high literacy rate; therefore, Microsoft and others are developing HealthLine, a speech recognition-based information system based on Microsoft Speech Server2007 beta software. This program supports both landline access and mobile phone access. Callers meet their needs by specifying a topic (or disease) and searching a set of menus until they reach the required information. This information is then provided by pre-recorded message, using their local language. In mid-2007, a test of HealthLine was performed by a group of low-literate maternal and child health community health workers in Pakistan. The test has continued in the field while improving the program through the addition of new features, functionality, and enhancements.

5.2.3 Project: The Acute Encephalitis Syndrome Surveillance Information System (AESSIMS)

Country: India

Participant: Voxiva, Program for Appropriate Technology in Health (PATH) and the Government of Andhra Pradesh

Application Area: Disease and Epidemic Outbreak Tracking

Description: Every year, over two million children die from preventable diseases and over three million children are left impaired in the developing world. Japanese Encephalitis is one of the reasons for this tragedy, which is a devastating mosquito-borne illness. This illness can be prevented by a vaccination, but it is not always provided due to its high cost and a lack of awareness on the disease's true prevalence and impact. To solve this problem, the Government of Andhra Pradesh, where the disease is endemic, performed a pilot test of an Acute Encephalitis Syndrome Surveillance Information Management System (AESSIMS) in one of its districts. Local health providers and clinicians reported incidences of the disease to the AESSIMS system by using mobile phones (or web-based technologies). This service also helped decision makers access and analyse data in real time through a variety of tools which include GIS-based maps. It was predicted that if the pilot test were a success, the AESSIMS system can be applied across India and into other Asian countries.

5.2.4 Project: Ericsson and Apollo Hospitals Initiative

Country: India

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Participant: Voxiva

Application Area: Diagnostics and Treatment Support

Description: In the summer of 2008, Ericsson and Apollo Telemedicine Networking Foundation (ATNF) began a project in India, "Memorandum of Understanding to implement telemedicine applications over broadband-enabled mobile networks". During the initial phase, this project was predicted to contribute towards decreased costs and improved healthcare outcomes, particularly for rural populations. Although the specifics of project were not announced, it is expected to be based upon mHealth technology. Chairman of Apollo Hospitals Group says: "With the availability of wireless technology, mobile health will be integrated into the healthcare delivery system". The new mantra could well be "Healthcare for anyone, anywhere, anytime".

5.3 South America

5.3.1 Project: Cell-PREVEN

Country: Peru

Participant: Universidad Peruana Cayetano Heredia (Peru), Imperial College (London), University of Washington (Seattle), and Peru's Ministry of Health

Application Area: Remote Data Collection

Description: When it comes to effective data collection in remote areas of the developing world, there is less chance that it will occur. Cell-PREVEN was created to allow access to real-time data to members of the healthcare ecosystem in Peru. This interactive voice response system enables health workers in the field to collect and transmit data through basic mobile phones. The data are collected in a centralized database and made available to medical professionals, and the system is designed to send SMS or e-mail alerts if certain symptoms are recorded. During the three month pilot test, it collected 797 reports and recorded 374 adverse events enough to trigger an SMS alert to a team leader. The pilot researchers believe that Cell-PREVEN demonstrates that "cell phones are a feasible means of collecting and reporting data in real-time in remote communities, it's not necessary to have the latest Palm Pilot or Tablet PC to create a sophisticated public health surveillance system."

5.3.2 Project MediNet Healthcare Management System

Country: Trinidad and Tobago

Participant: Microsoft Research and University of the West Indies

Application Area: Remote Monitoring

Description: The Caribbean is a region with very poor healthcare facilities but a comparatively strong cellular phone infrastructure. Microsoft Research has provided a grant to professors at the University of the West Indies to create a mobile phone-based healthcare management system, to be deployed first in Trinidad and Tobago, followed by a broader regional rollout. The long-term goal is to build a network that integrates medical resources and promotes the sharing of medical information and expertise. The healthcare management system, 'MediNet,' is targeting diabetes and cardiovascular disease. The system is designed to relay information from patient monitoring devices to a central server through a cellular network. At the server, a data reasoning engine extracts all relevant information and alerts medical officers about severe cases. It also recommends appropriate responses such as a follow-up visit or phone call. The system can also send suggestions directly to patients through SMS message or pre-recorded voicemail.

5.3.3 Project: Alerta DISMAR

Country: Peru

Participant: The US Navy, the Peruvian Navy and Voxiva

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Application Area: Disease and Epidemic Outbreak Tracking

Description: When disease outbreaks occur, timely transfer of information is important. Alerta DISAMAR is a disease surveillance system based on Voxiva technology, deployed by the Peruvian Navy with support from the US Navy. The system's strength lies in its 'multi-platform flexibility,' which allows users to transmit or access data through multiple technologies, including mobile phones and the Internet. Alerts of disease outbreaks are also sent through multiple mechanisms (text messages, voice mail, and e-mail). An evaluation of the project conducted in 2003 found that within the first year of deployment, Alert a DISAMAR "rapidly improved disease reporting, allowed officials to obtain quality data in real time, and, most importantly, facilitated improved response to disease outbreaks in a remote region." Since its launch, the system has reported more than 80,500 health events over a wide range of medical problems, including diphtheria, yellow fever, snake bites, diarrhoea, and acute respiratory infections.

5.3.4 Project: Digital Inclusion Kit in Health and Higher Education

Country: Argentina

Participant: University of Buenos Aires, Fundapers (an Argentinean NGO) and the Microsoft Research Digital Inclusion Program

Application Area: Diagnostics and Treatment Support

Description: Patients in neglected areas in both urban and rural Argentina lack access to specialized medical centres, which are often the only sites where vital diagnostic tools are available. Researchers at the University of Buenos Aires are creating a Digital Inclusion Kit in Health and Higher Education (DIKHAE), which allows smartphones to wirelessly connect to diagnostic tools like electrocardiograms, enabling sophisticated diagnoses to be conducted remotely. The test results can be stored on the smartphone until it is in range of a cellular signal, and then uploaded to a patient records system. A pilot conducted in 2006 received high marks from medical professionals for the system's usability. Project sponsors also envision that the DIKHAE is able to connect to X-ray, MRI, and other tools in the future.

6 mHealth use cases in LMIC

6.1 Education and awareness

Description: Short message service (SMS) messages now offer a cost-effective, efficient, and scalable method of providing outreach services for a wide array of health issues. This service is popularized by teenagers in western countries, such as Korea, China, and Japan, who wanted a low-cost means of communicating with friends. SMS messages can be used to send direct messages to users' phones in education and awareness applications, to offer information about testing and treatment methods, availability of health services, and disease management. The effect of SMS alerts has demonstrated that they have a measurable impact on, and a greater ability to influence, behaviour than radio and television campaigns by formal studies and anecdotal evidence. Further advantage of being relatively unobtrusive, offering recipients confidentiality in environments where disease (especially HIV/AIDS) is often taboo, is presented by SMS messages. SMS alerts have proven particularly effective in targeting hard-to-reach populations and rural areas, where the absence of clinics, lack of healthcare workers, and limited access to health-related information all too often prevent people from making informed decisions about their health in the developing world.

Please refer to 5.1.1.

6.2 Remote data collection

Description: One of the crucial components of public health programs is data collection. Accurate data are necessary for Policymakers and health providers at the national, district, and community level, in order to gauge the effectiveness of existing policies and programs and to shape new ones. Collecting field information is particularly important in the developing world, since many segments of the population are rarely able to visit a hospital, even in the case of severe illness. Gathering data where patients live is

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vital, and information should ideally be updated and accessible on a real-time basis. By conducting data collection through smartphones, PDAs, or mobile phones, data collection process will be more efficient and reliable, rather than data collection is conducted by paper-based surveys that must be submitted in person and manually entered into the central health database. Multiple developing countries started to develop data collection programs, mainly as pilot projects. The most successful programs are scaling up and beginning to be deployed in multiple countries or regions. Through these initiatives, the information gap which currently exists in developing countries is becoming smaller. This enables public officials to gauge the effectiveness of healthcare programs, allocate resources more efficiently, and adjust programs and policies accordingly.

Please also refer to 5.1.2 and 5.3.1.

6.3 Remote monitoring

Description: Regarding mobile health technology, remote monitoring of patients is becoming a critical issue. By using remote monitoring, it helps treat patients in an outpatient setting and address a crucial capability in developing countries where access to hospital beds and clinics is limited. Remote monitoring provides one or two of the following services: one or two-way communications to monitor health conditions, maintaining caregiver appointments, or ensuring medication regimen adherence. This service can also work with inpatient and out-patient sensors for monitoring multiple conditions. When this service begins, strict adherence to a medication regime is essential for service becoming effective and there is much evidence for it such as AIDS, diabetes and, so on. Remote monitoring also contributes to improved survival rates of chronic patients by monitoring patients at home. Although developing countries adopted remote monitoring applications on limited basis, they are interested in remote monitoring services, particularly for chronic diseases. Remote monitoring is expected to become widespread and significantly improve health outcomes for a wide range of communicable and chronic diseases. This is a result of improved remote monitoring environments such as documentation and its funding model evolution in developing countries.

Please also refer to 5.2.1 and 5.3.2.

6.4 Communication and training for healthcare workers

Description: One of the major challenges facing developing country health sectors is a severe shortage of healthcare workers. To satisfy human capital needs for workers increasing job satisfaction and reducing attrition are necessary for training new cadres of health professionals and empowering current workers. Using sources of information through mobile technology and providing it to health workers contributes to a strong basis for empowerment and provides support for health workers to perform their duty effectively and self-sufficiently. Also, they need some progress, for example, improving communication among different health units to facilitate more efficient patient care. Due to the lack of landline phones and Internet-enabled computers, the ability to quickly communicate bed availability to patients is a common problem. Patients will therefore arrive at a hospital where no beds are available and should be turned away. To solve these communications gaps, which can often mean the difference between lives lost and lives saved in the health context, mobile phone technology can be used.

Please also refer to 5.1.3 and 5.2.2.

6.5 Disease and epidemic outbreak tracking

Description: When communicable diseases are left without detection, it can be developed into epidemics. From cholera and TB to dengue fever and severe acute respiratory syndrome (SARS), there are many examples of devastating outbreaks. One of the decisive points in the prevention and containment of outbreaks is deployment of mobile devices, with their ability to quickly capture and transmit data on disease incidence. In developing countries such as Peru, Rwanda, and India, they adopted disease and epidemic outbreak tracking mHealth applications. This early warning system allows public health officials to monitor the spread of infectious diseases. For such emergency tracking, written, satellite, and radio communication to adopt, mobile networks are needed. Using these functions in mobile systems, they simultaneously improve data quality and reduce costs.

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Please also refer to 5.2.3 and 5.3.3.

6.6 Diagnostics and treatment support

Description: Diagnostics and treatment support are vitally important in healthcare misdiagnosis or the inability to diagnose a condition that could have serious, even fatal, ramifications. mHealth applications in this area are designed to provide diagnosis and treatment advice to remote healthcare workers through wireless access to medical information databases or medical staff. With mHealth-enabled diagnostics and treatment support, patients are able to receive treatment in their villages and homes, replacing the need for expensive hospital visits, which are beyond reach for many. Diagnostic and treatment applications use a phone as a point-of-care device. Health workers' phones are typically equipped with specialized tools, such as built-in software that leads the worker through a step by step diagnostic process. Once data are entered into the system (e.g. symptoms and an image of a patient's injury captured on the mobile phone), remote medical professionals can diagnose the illness and prescribe treatment. By eliminating the need for patient travel, these applications have the potential to impressively increase accessibility to care.

Please also refer to 5.1.4, 5.2.4, and 5.3.4.

6.7 Sharing a medical image annotated with a region of interest

Description: Sharing a visual image of a region of interest (ROI), which contains a medical image of a certain symptom and comments of it, with a remotely located specialist for consultation is a good practice. It can, however, require a special purpose (and most likely expensive) application or system to send and view them, which is not a feasible solution in developing countries. So, in this use case, we need a method to achieve the interoperability of sharing clinical information and medical image with comments visually with regions of interest (ROIs) without a special viewer. The method by Nguyen Hai Minh is based on Health Level Seven Clinical Document Architecture (HL7 CDA) and eXtensible Stylesheet Language Transformation (XSLT) standards for the purpose of seamlessly exchanging and visually presenting the shapes of ROIs using readily common web and mobile browsers.

By this method, a number of unnecessary imaging-related works could be reduced, and a diagnosis might be completed with images captured before, even in situations where imaging solutions such as PACS are not available.[4]

7 Interoperable mHealth frameworks survey for LMIC

7.1 ISO 14639 (all parts)

7.1.1 Purpose

The goal of this ISO/TR 14639 (all parts) is the development of HIS in LMIC.

ISO/TR 14639 (all parts) arises from the recognition that, currently, there is considerable diversity internationally in the approach and scope of development and implementation of national health information systems (HIS). Growing interest in strengthening health systems in low-income countries (LIC) in the international community has led to increasing interest in and support of this activity.

ISO/TR 14639 (all parts) is a first response to this need and aims to identify the business requirements of eHealth architecture plus provide a generic and comprehensive context description to inform architectural structuring of HIS.[5,6]

7.1.2 Summary

Part 1: The variety in country HIS of ISO 14639-1 suggests the need for an eHealth Architecture Maturity Model (eHAMM) and methodology for describing country capacity to provide direction in health system

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strengthening. This architecture is basically structured with Health Process Domain Components, Foundation (eHealth and ICT Infrastructure), governance, and national ownership.

Part 2: ISO/TR 14639-2 provides a guide to best business requirements and principles for countries and their subordinate health authorities planning and implementing the use of information and communications technology (ICT) to support the delivery and development of healthcare. Business reference architecture is described in terms of components and capabilities that health authorities may use as a framework for building their own eHealth architectures and also for measuring the maturity of their health systems' use of ICT to support the delivery and development of healthcare.

The development of eHealth architectures based on the guidelines set out in this document will facilitate and optimize investments in Health Information Systems to achieve the following goals:

— information being used cost-effectively for improvement of health services;

— health information being concordant, consistent, accessible, and able to be used effectively;

— patients, health professionals and policy-makers having the exact data available to make decisions about health services, treatment, and delivery of care;

— appropriate information being available to support evidence-based practice, health services planning, health services quality, and safety, and to improve public health;

— improving accessibility to healthcare services;

— supporting harmonization of HIS and health information standards.[5,6]

7.1.3 Perspective for mHealth

ISO/TR 14639 (all parts) was created to support the development of eHealth system. ISO/TR 14639 (all parts) presents eHAMM, which could be used for evaluating eHealth systems of each country ranging from low to high in terms of income. Before suggesting eHAMM, this document researched how the countries like Brazil, Austrailia, Canada, India and Kenya implement eHealth systems with eHealth architecture, which includes fundamental components by criteria of policy, governance, and infrastructure.

In eHAMM, there are many items for accessing eHealth system. One of them is to determine how well eHealth system is ready for mobile health, which is a hot topic in healthcare ICT. It describes a few examples of mobile health in eHeatlh system; responding to emergencies, quality measurement of healthcare service through mobile device, treatment or diagnose payment with mobile.

Since the needs to make use of mobile devices in healthcare service are arising, evaluation items for mobile health are required to provide safe and reliable services. This means that eHAMM could be extended to provide authoritative criteria for mobile health to offer the quality-proven services in LMIC.

7.2 SA (Standards Australia) Handbook 137, 138

7.2.1 Purpose

The aim of principles introduced in this handbook is to facilitate consistency of national eHealth architecture approaches and to support the building and operating of consistent and interoperable eHealth systems.[7,8]

7.2.2 Summary

These principles are divided into two categories. One is general principle which reflects commonly used business and ICT best practices. These principles improve safety, quality, and efficiency of healthcare services. Furthermore, they ensure that solutions are fit for following purposes: supporting service-oriented approaches, complying with legislative and policy requirements, maintaining security, managing information quality, and expressing policy compliance as business rules. The other is a suite of principles which are specific to interoperability in eHealth and amplify the general eHealth

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architecture principles. These principles ensure that eHealth solutions support interoperability, engage with all relevant stakeholders, and express policy in technology-independent terms.[7,8]

7.2.3 Perspective for mHealth

General principle mentioned in this handbook explains about eHealth framework. Thus, mHealth framework is able to be built with considering those general principles. However, most of this document describes the business part of eHealth framework which has relevance to interoperable architecture. On the other hand, this handbook does not require any technical components.

7.3 HL7 Services-Aware Interoperability Framework (SAIF)

7.3.1 Purpose

The SAIF provides HL7 with an Interoperability Framework, i.e. a set of constructs, best practices, processes, etc. that enable HL7 specifications to achieve cross-specification consistency and coherency irrespective of the chosen interoperability paradigm (messages, documents, or services).[9]

7.3.2 Summary

SAIF consists of four core "frameworks".

— Information Framework (including RIM, data types, vocabulary bindings, etc.): IF defines the grammar for information and terminology models, metadata, value sets, and schemas that specify the static semantics of interactions.

— Behaviour Framework (subsuming the existing Dynamic Model): BF defines constructs to specify the dynamic semantics of interactions in an interoperability specification.

— Enterprise Conformance and Compliance Framework (including HL7's existing Implementation and Conformance standards): ECCF enables an organization implementing SAIF to organize and manage interoperability specifications.

— Governance Framework: GF grammar enables an organization implementing SAIF to manage rick by relating decisions and policies, to the IF and BF interoperability specifications within the ECCF.

The ECCF is the centrepiece of SAIF. It supports both technical interoperability (IF and BF) and the GF management of interoperability. The SAIF ECCF provides external stakeholders with a coherent picture of exactly what is required to interoperate with an organization's software components.[9]

7.3.3 Perspective for mHealth

HL7 SAIF might be useful for defining and establishing mHealth framework because its aim is to set up interoperable framework based on services oriented architecture (SOA). In addition, HL7 SAIF includes many feasible information with the view of technician or developer. Consequently, four technical frameworks which HL7 SAIF provides would be helpful for building interoperable mHealth framework.

7.4 HISA (Health Informatics Service Architecture) ISO 12967

7.4.1 Purpose

The HISA standard was developed by ISO in cooperation with CEN Technical Committee (TC) 251, the technical committee for Health Informatics within the federation of European national standards bodies (CEN).

HISA is a new standard defining "Service architecture" for the information services of a healthcare enterprise. It contains a methodology for the enterprise work and also models of the basic services

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required for healthcare. The HISA standard is based on the general principles to secure openness and vendor-independence.[10]

7.4.2 Summary

HISA consists of three parts.

Part One: Enterprise Viewpoint. Enterprise Viewpoint provides health services with guidance in describing, planning, and developing new IT systems, utilizing an open distributed processing approach.

Part Two: Information Viewpoint. Information Viewpoint sets forth the fundamental characteristics of the information model to be implemented by the middleware to provide comprehensive, integrated storage of the common enterprise data and to support the fundamental business processes of the healthcare organization, as defined in ISO 12967-1.

Part Three: Computational Viewpoint. The Computational Viewpoint component of ISO 12967 provides details on the fundamental characteristics of the computational model to be implemented by the middleware, to provide a comprehensive and integrated interface to the common, fundamental business processes of the health service.

All of which deal with different aspects of ensuring service architecture supports openness and vendor-independence [10].

7.4.3 Perspective for mHealth

HISA ISO 12967 is a standard for designing the service structure, not for system development. It could be a reference standard for designing mHealth services not only because it is independent from specific platform, but also because it describes a methodology to establish Health IT infrastructure and provides a guidance to represent basic healthcare services. Furthermore, HISA ISO 12967 would be a helpful document especially when the ICT infrastructure is not well set up in LMIC if it adds features for mobile health.

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