Final Report
OASIS II Project Utilization-Focused Evaluation

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1. Introduction and Background

The OASIS II collaboration is unique and challenging in the breadth of the work in different countries in Africa and across different health focus and disease areas, and in the depth of the work supporting the integration of eHealth components into health care systems in limited resource settings - from high level enterprise architecture (EA) for national health system plans through electronic medical record systems (EMR) and other tools at the health center and smaller hospital levels to mobile phone based tools for community health workers (CHWs) and their supervisors at the community level. The primary groups involved engaged in a Utilization-Focused Evaluation (UFE) process to help answer their question of, "*How well are we leveraging this unique range of expertise?*"

1.1 OASIS II Projects – Background

The OASIS II project aims to build on aspects of the Open Architectures, Standards and Information Systems for Healthcare in Africa (OASIS) project. OASIS I – begun in 2007 - was an International Development and Research Centre of Canada (IDRC) funded project that applied a mixed research methodology to investigate, establish and evaluate methods, tools and techniques required to develop and implement sustainable open architectures, standards and information systems supporting healthcare in three Southern African countries (South Africa, Mozambique and Zimbabwe).
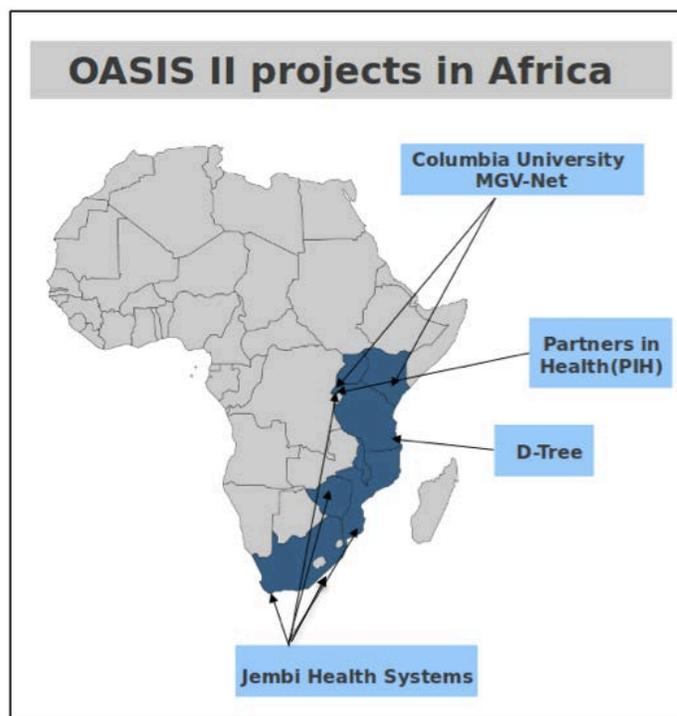
OASIS II, also funded by IDRC, expanded to include additional countries (Rwanda and Tanzania) and remains a unique multi-institutional collaboration between several partners, each with specific objectives (see Appendix A), but all attempting to address the following overarching research questions:

1. How can electronic information systems be integrated into African healthcare delivery?
2. How can local capacity and local ownership be strengthened?
3. Do electronic information systems improve healthcare delivery and health outcomes?
4. How can interoperability among these systems be improved?
5. How can coordination and collaboration among those developing electronic health systems be improved?

The OASIS II activities and the 4 project partner roles are summarized here:

1. OASIS Core (Jembi Health Systems, lead PI: Dr. Chris Seebregts)

   The OASIS core project has mainly investigated the development of a sustainable model for health systems strengthening by in-country capacity building support for Ministries of Health. Ongoing research looks at ways of creating and supporting OASIS nodes in multiple countries in Africa (South Africa, Rwanda, Mozambique, and Zimbabwe) with a particular focus on how health information systems are managed at country level.

2. Open Architectures (Jembi Health Systems, lead PI: Dr. Chris Seebregts)

   The Open Architectures project has investigated the concept of using open enterprise architecture to guide the technical Health Information System (HIS) strengthening activities of OASIS, applied in low and middle-income countries.

3. Millennium Villages Project (MVP, Lead PI: Dr. Andrew Kanter)

   The MVP's role in OASIS II project is to support development of MGV-Net and the interoperable multinational, multilingual eHealth infrastructure and research tools. Research is focused on 1) comparing of methods of supporting eHealth interventions across a multinational enterprise, 2) assessment of whether ICT for Health systems have an impact on the Millennium Development Goals (MDGs) and how much compared to other interventions, and 3) assessment of what components are required to operate a common enterprise-wide health information system across multiple countries in multiple languages.

4. OpenROSA / JavaROSA (D-Tree International, Lead PI: Dr. Neal Lesh)

   The ROSA project within the OASIS II project focuses on the promotion of a "Coded in Country" (CIC) approach, and identifying what kinds of in-country capacity building efforts related to open source mobile technologies (mHealth) for health work best in different contexts. Likewise, the ROSA project research also focuses on how the standardization among mHealth projects can improve links to other eHealth systems. Related to health outcomes directly, the ROSA project has focused efforts on a rigorous assessment of whether CommCare – a specific open source mobile technology software for community health worker decision support – can improve community health worker and client behavior.

5. Rwanda OpenMRS and Informatics Training Program (Partners in Health, Lead PI: Dr. Hamish Fraser)

Partners in Health (PIH) is involved in the OASIS II projects in multiple ways, but most importantly in their efforts to develop and support the longer term institutionalization of a Health Informatics and OpenMRS training programs in Rwanda, graduating students as well as integrating the course into the Kigali Institute of Science and Technology's curriculum.

1.2 Rationale for UFE

The Utilization-Focused Evaluation (UFE)[3,4] process was applied in this project. UFE works off of the premise that evaluations should give careful consideration to selecting the most appropriate content and methods for the primary stakeholders and their intended uses of the evaluation findings. A UFE can include one or several evaluative purposes based on multiple kinds of data (quantitative, qualitative, mixed), by applying one or several methodologies (observational, experimental, etc.). Generally, UFEs follow the 12 step "checklist" proposed by Patton[1] (see section 3.1). For this evaluation, a modified version was applied based on 1) the timing of the evaluation team involvement in the project progress (towards the end of the project period instead of from the beginning), and 2) the tight timeline of the evaluation itself (April – September 2011).

For this evaluation, intended uses by the primary project leads (as described by focus area below) were prioritized and all project phases included input and feedback from major stakeholders. Evaluation methods that promoted and facilitated the involvement of the primary project leads - Drs. Chris Seebregts of Jembi, Andrew Kanter of the Millennium Villages Project, Hamish Fraser of Partners in Health, and Neal Lesh of OpenROSA - were applied in order to support the application of the evaluation findings to their work 1) within the respective OASIS II projects, and 2) to identify direction setting steps for possible future collaborative work.

1.3 Focus Areas

The following focus areas were identified as the highest priorities for evaluation at this stage by the primary OASIS II project leads.

Capacity Building / eHealth Workforce Strengthening

Capacity building and eHealth workforce strengthening received a great deal of attention at the 2-day OASIS meeting in Cape Town, South Africa in 2010. All primary groups involved in OASIS II are committed to and have worked on this issue as a critical success factor for eHealth sector strengthening in limited resource settings.

This evaluation attempted to address the larger question of how changes in the way eHealth services are delivered in Africa have changed as a result of capacity building efforts under OASIS II projects. The overall goals of the investigation relative to Capacity Building / eHealth Workforce Strengthening efforts were (1) to clearly articulate the greater objectives of OASIS II in building local capacity for eHealth technology

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[3] Patton, M. *Utilization-Focused Evaluation* in *Evaluation Models: Evaluation in Education and Human Services*, 2002, Volume 49, V, 425-438.
[4] Patton, M. *Utilization-Focused Evaluation*, 4th Edition. 2008. SAGE Publications Inc. Los Angeles, California.

development and implementation in Africa, and (2) to understand to what end the work through the OASIS II projects can contribute to approaching these objectives.

Specific goals of this component of the evaluation include (1) describing the current efforts by the primary OASIS II project groups as well as related "secondary" networks through the Jembi, OpenMRS, OpenROSA, and Millennium Village Project communities, (2) identifying gaps and overlaps in these efforts, and (3) compiling lessons-learned to share experiences about what efforts have worked and which have not been as successful as hoped.

Interviews with OASIS II project leads were complemented by in-person and skype-based interviews conducted with trainers, trainees and relevant eHealth workforce stakeholders during field investigations at project sites in Africa (Rwanda, Tanzania, Mozambique, and South Africa). In addition, key informant interviews with project personnel or OASIS II partners were conducted with individuals based in the United States (for PIH, MVP and OpenROSA projects).

Interoperability

Another important theme of the OASIS II meeting in 2010 was that of interoperability. Several important collaborative efforts emerged between members for promoting interoperability – from social and professional networking to coordination between groups on data concept exchange to collaboration on the definition and application of open architecture approaches. Two new substantial and complementary efforts are: the Health Enterprise Architecture Framework (HEAF) and the Maternal Concept Lab (MCL). These efforts take two fairly different approaches to collaborations, and we conducted an investigation of how these efforts came about and what positive (or negative) impacts they have had.

2. Methodology and Approach

2.1 12 steps of UFE

The Evaluation Center at Western Michigan University has developed a checklist to guide UFE evaluators and users through the process of implementing a UFE[5]. Their goal is to provide a general framework and guidelines for designing, managing, assessing, analyzing, reporting and determining the utility of evaluations.

For a UFE, the following is a list of the steps in the implementation process:

1. Program/Organizational Readiness Assessment
2. Evaluator Readiness and Capability Assessment
3. Identification of Primary Intended Users
4. Situational Analysis
5. Identification of Primary Intended Uses
6. Focusing the Evaluation
7. Evaluation Design
8. Simulation of Use
9. Data Collection

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[5] www.wmich.edu/evalctr/checklists/index.html

10. Data Analysis
11. Facilitation of Use
12. Meta-evaluation: Evaluating Use

Two points are important to note relative to why this UFE of the OASIS II projects only engaged in steps 2 – 10.

First, this evaluation functionally began at step 2 when the PI team (along with collaborators and project support personnel at IDRC) deemed this evaluation team a good fit for the project.

Second, based on the timeline of this evaluation (roughly 6 months for data collection and initial analysis) and the timing of the evaluation relative to the OASIS II project implementation (March 2010 – March 2012), all PIs and the evaluation team deemed that getting through step 10 was the most we could realistically accomplish. Steps 11 and 12 – facilitation of use of evaluation findings and evaluation of the use of the evaluation findings – were determined to be beyond the scope of this UFE at this time. Ideally this could be followed up with in the coming months as the OASIS II projects wind down in 2013.

2.2 Mixed Methods Approach

A combination of research methodologies was employed in this evaluation. Primarily, the evaluation team proposed and ultimately applies a forward-looking lessons-learned approach, similar to that used by MoTECH in their report "MoTECH in Ghana: Early Lessons Learned[6] (March 2011). This methodology and corresponding report is elegantly simple but very effective in addressing all major focus areas by breaking down both their analysis as well as the report output into 4 sections: "overview," "issues & considerations," "lessons learned," and "implications for future work." It is both intentionally prescriptive for next steps and immediate future work while capturing a retrospective set of lessons learned by focusing on specific in-depth case studies to highlight both qualitative and quantitative indicators of primary significance to the project's goals. Given the OASIS II Evaluation project's strong focus on the UFE process, the range of research strategies available, and the tight timeline, this kind of straightforward approach is very applicable in this case as well, and strikes a nice balance between the intended uses provided by the PIs.

Similar to the evaluation of "Strengthening ICTD Research Capacity in Asia" (SIRCA) Programme[7], another IDRC initiative, this evaluation used a modified "theory of change" model to link inputs, processes and outputs to impacts in drafting initial log-frame models for teasing out critical and unique factors in both focus areas for the OASIS II projects. However, unlike SIRCA, we did not focus on measuring outcomes against the original project plan (although this is still an important data source), but rather against the specific interests highlighted in the intended uses by the 4 PIs (see below).

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[6] http://www.mobileactive.org/files/MOTECH-Early-Lessons-Learned-March-2011-FINAL.pdf.
[7] Mizumoto, A. 2010. Evaluation of "Strengthening ICTD Research Capacity in Asia" (SIRCA) Programme. Commissioned by the Singapore Internet Research Centre (SiRC) and International Development Research Centre (IDRC).

For the capacity building focus area in particular, some guidelines from the MEASURE Evaluation Project[8] (2003) were be applied in order to help understand relationships (or assumed relationships) among the many factors that contribute to or detract from capacity and, ultimately, potential for future performance in the eHealth sector in Africa. Mapping exercises were used both with the 4 PIs as well as by the evaluation team to identify untapped, constrained, or missing elements of capacity building efforts (when possible) to provide insight into gap-analysis for future efforts amongst the OASIS II projects and their respective stakeholder groups.

2.3 Research Design: Evaluation Methodologies

Evaluation design, step 7 of the UFE process, was undertaken in tandem with refinement of the intended uses and focusing the evaluation (steps 5 and 6)[9]. The design process was as follows:

1. Following initial conversations with the OASIS II PIs and a review of relevant project documentation, the evaluation team proposed a research plan with semi-structured interviews as the primary research activity, augmented by a web survey and the development of visual network maps and an inventory of people, organizations and projects related to OASIS II.

2. Each of the four PIs was asked to suggest interviewees for the Interoperability and Capacity Building / eHealth Workforce Strengthening pieces of the evaluation, as well as additional documents for review.

3. Based on the interview lists and documentation, a case study approach was proposed for both focus areas, with findings reported in the format of the recently released MoTeCH in Ghana report[10].

   For eHealth workforce strengthening, the four different approaches taken by different OASIS II partner organizations were easily conceptualized as four somewhat comparable cases, from which lessons and recommendations for future work could be derived. For interoperability, cases were harder to define because much of the work is at an early stage, and a major intended use of the findings (particularly in the case of MCL) was to shape future work on interoperability as well as to learn from what has already been done. Initially, four case studies were proposed:

   a. MCL as used by D-tree and MoTeCH for a project with CARE in Bihar, India
   b. OASIS Rwanda mapping of government maternal health forms to MCL
   c. MVP/PIH dictionary mapping
   d. Development of the SDMX-HD OpenMRS module connecting PIH's OpenMRS installations to TracNet in Rwanda

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[8] LaFond, A. and L. Brown. 2003. A Guide to Monitoring and Evaluation of Capacity-Building Interventions in the Health Sector in Developing Countries. MEASURE Evaluation Manual Series, No. 7. USAID.
[9] Patton, Michael Quinn (2008). Utilization-Focused Evaluation (4th ed.). London: Sage Publications, Inc.
[10] Grameen Foundation (2011). Mobile Technology for Community Health in Ghana: What it is and what we have learned so far. Available at: http://www.grameenfoundation.org/what-we-do/technology/mobile-health

4. Individual calls were held with each of the 4 PIs (as well as Jonathan Payne for MCL) to discuss the research framework and verify that it matched the intended uses. Specific interviewees for each case study were identified, as were particular areas of sensitivity to be aware of in interviews.

5. The research framework was finalized during the mid-evaluation check-in meeting held in NYC on 3 and 4 June 2011 with the 4 PIs, Jonathan Payne (of MCL) and the lead evaluator, H.Zornetzer. Changes made during this final review included:

   a. Reducing the scope of the interoperability work to cover only MCL, and OASIS II-related initiatives in Rwanda. These two areas are treated as separate case studies, and between them incorporate all the previously proposed interoperability case studies.
   b. Incorporating the network maps research activity into the OASIS II Rwanda case study
   c. Removing the inventory development research task, on the basis that it was not clear how such information would be used or how it would contribute to the finalized intended uses.
   d. Specifying two short web surveys - one of PIH Rwanda trainees, the other of users of the MVP/CIEL concept database - as the only web survey research tasks.

The finalized refined goals and intended uses as agreed to by all PIs and the evaluation team include:

FOCUS AREA: Capacity Building / eHealth Workforce Strengthening	FOCUS AREA: Interoperability
GENERAL GOALS	
This evaluation will address the larger question of how changes in the way eHealth services are delivered in Africa has changed as a result of capacity building efforts under OASIS II projects. (1) To clearly articulate the greater objectives of OASIS II in building local capacity for eHealth technology development and implementation in Africa, (2) To understand to what end the work through the OASIS II projects reached or approached these objectives.	Several important collaborative efforts emerged between members for promoting interoperability – from social and professional networking to coordination between groups on data concept exchange to collaboration on the definition and application of open architecture approaches. Two new substantial and complementary efforts are: the Health Enterprise Architecture Framework (HEAF) and the Maternal Concept Lab (MCL). (1) To document the two different approaches to collaborations in the HEAF and MCL projects, investigating how these efforts came about and what positive (or negative) impacts they have had, and to derive lessons from these projects for future interoperability efforts. (2) To document and learn from other interoperability efforts pursued by OASIS projects (in addition to the MCL and HEAF efforts), including the OpenMRS Concept Cooperative (OCC) and the efforts of the open architecture group.
SPECIFIC GOALS	
1. To document current efforts by the primary OASIS II project groups as well as related "secondary" networks through the Jembi, OpenMRS, OpenROSA, and Millennium Village Project communities, 2. To identify gaps and overlaps in these efforts, 3. To compile lessons-learned to document what efforts have worked and which have not been as successful as hoped.	1. To create a broad inventory of all the groups involved in various interoperability efforts, including how they became involved/what makes involvement valuable to them, as well how they perceive opportunities and barriers going forward. 2. To document lessons learned/future directions of umbrella efforts like MCL and HEAF, but also to generate more insight into on-the-ground adoption - how to bring people/groups in to interoperability efforts and how to sustain momentum *3.* To create a structured conceptual statement about interoperability as a development intervention – a theory of change that serves as a research framework as well as a design tool for future projects
INTENDED USES OF FINDINGS	

To motivate and inform capacity building efforts within the larger eHealth community by providing relevant policy-brief format information re:		To Inform current and future interoperability efforts in low-resource settings, both led by network members and more generally.
1.	"upstream" inputs and activities internal to each group (as well as with important boundary partners for each project) that led to successful local capacity building for developers, implementers and decision makers	2. To make a case for continuation of interoperability efforts as projects/systems move towards local ownership, and for the development of new initiatives in under-examined areas.
2.	lessons learned during OASIS II projects around both successful and less successful capacity building efforts	

2.3.1 Evaluating action research

In addition to being guided by the intended uses of the evaluation as specified in UFE, the research plan reflects the structure of OASIS II as an action research project. Because of its emergent nature, action research is hard to evaluate in terms of changes against a defined baseline. In positivist terms it corresponds better to hypothesis generation than hypothesis testing - starting by describing outcomes, and working back to tease out contributing factors. Action research in eHealth faces particular challenges because it cannot (and does not aim to) 'prove' the effects of an intervention in the same way as much other medical or health systems research. At the same time, it is well-suited to exploring complex real-world problems in areas where there is little previous research.

Particular features of the resulting research plan include:

- A focus on documentation/description as well as analysis. Documentation is difficult to prioritize because of the emergent nature of action research, and the real urgency of the issues many of the OASIS II activities address, and this was a gap it was felt could usefully be filled by the evaluation.

- A flexible mixed-methods approach combining documentary sources, semi-structured interviews and web surveys.

- Case studies as an organizing structure, both for analysis and to clearly communicate findings, lessons learned and recommendations derived from diverse sources. Case studies allow the context of the intervention to emerge through description, dovetailing with the action research principle of locating knowledge production within a particular social, organizational and institutional context.

- As is usual in action research[11,12], researchers are understood not as detached observers, but as stakeholders in their own right - in our case, the evaluation team are also stakeholders in the global eHealth community more broadly. Interviews are seen not as a one-way process of information gathering, but rather a conversation in which description and analysis are created as a shared effort between interviewer and interviewee[13].

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[11] Blake, E. & Tucker, W. (2006). Socially Aware Software Engineering for the Developing World. IST-Africa 2006 Conference Proceedings, P. Cunningham and M. Cunningham (Eds), IIMC International Information Management Corporation.

[12] Byrne, E. & Sahay, S. (2007). Participatory design for social development: A South African case study on community-based health information systems. Information Technology for Development, 13(1), 71-94.

[13] Fontana, A., & Frey, J. H. (2005). The interview: From neutral stance to political involvement. (N. Denzin & Y. Lincoln, Eds.)The Sage handbook of qualitative research, 3, 695–727.

2.3.2 Case studies

The development of descriptive and explanatory case studies was a major research activity of the evaluation. Case studies foreground the context of the projects studied and the importance of contextual factors. Case studies also allow diverse methods (documentary sources, interviews and web surveys) and diverse informants (training program students, trainers, employers, developers, implementers and funders of interoperability projects) to contribute to a unified set of findings. Given the emphasis in UFE on research products that will be used directly, the use of case studies also helped us present the findings in a coherent and applicable way.

Data collection

Data for the case studies was collected primarily during semi-structured interviews. Topic guides for the interviews were developed by the evaluation team, then reviewed and edited by the PIs. The topic interview guides for both focus areas appear in Appendices D1-4.

Because the interviews included a range of informants with varying relationships to the projects being studied, the version of the topic guide used for each interview typically included a subset of all questions. Some interviewees were asked additional questions to probe particular points that arose during the interview, or had arisen during previous interviews.

For the Capacity Building and eHealth Workforce Strengthening focus area, primary stakeholder input was included from a total of 53 individuals with relatively equal representation across the 4 primary OASIS II projects in Rwanda (MVP, Jembi and PIH stakeholders), Tanzania (MVP and OpenROSA stakeholders), Mozambique and South Africa (Jembi stakeholders). 38 interviews were conducted, including stakeholders representing various roles across the eHealth workforce. Individual interviews were carried out in person or via skype and ranged from 20 minutes to 2 hours. 3 separate focus group interviews were carried out in person, 1 with CHWs in the Dodoma, Tanzania DTree/OpenROSA project site, 1 with MVP data clerks at the Nyamata, Rwanda MVP site, and 1 with MOASIS developers in the Jembi project site in Maputo, Mozambique. In addition, 13 responses to the PIH program trainee web-survey were received (of the 22 trainees invited to participate in the online anonymous questionnaire). A strength of the study is the large number of African interviewees (25 of the 38) for this focus area as well as the wide range of types of stakeholders "captured" with the mixed methods interview process applied here – including funders/donors, researchers, program staff, trainers, trainees, community health workers, representatives of Ministries of Health, and OASIS project partners and collaborators.

For the interoperability focus area, 24 interviews were conducted - 2 in person, and 22 via Skype. Interviews ranged from 20 minutes to 1 hour. Interviewees included people who had been involved in MCL - either as direct contractors or volunteers, or through particular projects where MCL was used - as well as key informants in organizations that might adopt MCL or promote adoption in future. For the case study of OASIS II in Rwanda, a smaller group of interviewees included people who had been involved in specific interoperability projects (SDMX-HD and two dictionary mapping projects, one between the PIH and MVP dictionaries and other mapping Rwanda's maternal health

forms to MCL) or who had worked extensively in Rwanda (primarily the PIs). A general weakness of the study is the small number of African interviewees for the interoperability focus area. For the OASIS-Rwanda landscape case study in particular, direct interviews with representatives of Ministry of Health were determined inappropriate for the scope of this evaluation in order not to risk the perception of a conflict of interest for ongoing OASIS II projects.

Compliance with Human Subjects Research Standards

To comply with international ethical human subjects research standards (and specifically with IDRC's requirements for ethical conduct of human subject research), verbal consent was obtained at the beginning of each interview. The interview protocol is included as Appendix C. Interviewees were informed of the purpose of the study and anonymity provisions, and asked whether they were willing to allow us to record the interview, as well as given the opportunity to comment off the record if they felt more comfortable doing so. Interview data (recordings, notes and transcripts) is stored securely using SpiderOak[14], a zero-knowledge online backup system, and Dedoose[15], a HIPAA-compliant online research tool. Only the evaluation team had access to the primary interview data, as many of the interviewees are direct ongoing project partners (or participants in ongoing projects) within the OASIS II project portfolio. All efforts were made by the evaluation team to provide an impartial atmosphere and tone during the interview process. Likewise all efforts were made by the evaluation team to fairly and accurately represent interviewees' opinions while protecting their identity from other stakeholders in the preparation and publication of this report.

Data analysis

Interviewers used Dedoose to associate codes ('tags') with excerpts from interview transcripts and notes. *Coding* is an established method of qualitative data analysis, usually used to derive quantitative results for content analysis or to complement qualitative data in a mixed-methods approach[16]. In this case, interviews varied widely in content and in the role of the informant, and we found tagging most useful in identifying emerging themes throughout the data. As part of this process, we continually updated our code book (initially based on the topic guides) during the data analysis phase.

2.3.3 Web surveys

Two web surveys were conducted as a complement to the case studies. For the Capacity Building / eHealth Workforce Strengthening focus area, 22 current and former trainees from the PIH OpenMRS developer training program in Rwanda were contacted to participate in an anonymous online survey (using Google forms) about their experience during and after the program. The survey questions are included in Appendices F1 and F2. 13 participants completed the survey, which is reported as part of the PIH Rwanda eHealth Workforce Strengthening case study (Section 4.1.5 below).

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[14] https://spideroak.com/

[15] http://www.dedoose.com/

[16] Buber, R., Gadner, J., & Richards, L. (Eds.). (2007). Issues in mixing qualitative and quantitative approaches to research. Applying qualitative methods to marketing management research (pp. 141-156). UK: Palgrave Macmillan. Retrieved from http://www.dedoose.com/PDF/Bazeley_2002_Mixed_Methods_in_Market_Research.aspx

For interoperability, a web survey (anonymous unless the respondent chose to provide their name) of MVP/CIEL dictionary users was conducted, with questions about how they use the dictionary and particular features. The survey also asked about their knowledge of MCL as a related initiative, and which planned features of MCL they might use in future. The response rate for this survey was poor - 13 responses of 46 people contacted - even after one initial contact email and two reminders. This may simply be the result of attempting a web survey of very busy people. It is also possible that the list includes many people who expressed interest in using the dictionary but are not currently invested to the extent that they felt a survey addressed to 'MVP/CIEL dictionary users' applied to them.

3. Findings

3.1 Interoperability: MCL work to date and next steps

The Maternal Concepts Lab (MCL) is interesting as a case study on how interoperability work has developed to date in OASIS II projects because, although not part of the initial plan, the MCL arose during the funding period and has involved all the partners in various ways. It is also ongoing, and providing directional guidance towards the MCL's future development is one of the explicit intended uses of the evaluation. Finally, the 'concept lab model' represents a novel way of collaborating for technology solution reusability and interoperability, and one that it was felt could usefully be documented by this evaluation.

3.1.1 Overview

History and origins

MCL originated in conversations between several people involved in mobile phone projects for maternal health. Initially named 'Mobile Maternal Health', it had a focus on sharing tools that were being built for the same clinical protocols and with some of the same software components (particularly OpenMRS) by people who knew each other and were involved in various collaborations in the eHealth space. OASIS II was one of these collaborations, and at the time of writing all 4 OASIS II grantees were involved in MCL in some capacity. Jonathan Payne, as part of work for D-tree and PIH (who funded a 20% time allocation for a year in part to advance MCL) but also worked significantly unpaid, took on a coordinating role, and has been instrumental in establishing MCL over the course of its first year.

The need for a common standard data set became clear when the technical requirements for shared tools began to be discussed. Specifically, sharing of tools necessitated the development of a common set of medical and programmatic concepts ('influenza virus vaccine', 'number of goats') that could represent data collected using the tools. Andrew Kanter, coordinator of health information systems and medical informatics for the Millennium Villages Project (MVP) and maintainer of the MVP/CIEL concept dictionary, was approached at this point. The MVP/CIEL dictionary is one of several default options for new OpenMRS installations, and aims to provide a complete concept dictionary mapped to terminology standards. It was agreed that the subset of the MVP/CIEL concept dictionary relevant to maternal, newborn, and child health

(MNCH) would provide the initial set of core concepts for MCL, referred to as the MCL:Core.

MCL was launched formally in November 2010 with a poster presentation at the 2nd annual *mHealth Summit* meeting in Washington, DC. In addition to MCL:Core, the maternal health core concepts, the launch proposed a set of tools for concept exploration and management (currently a search tool - MCL:Search, and a proposed concept mapping tool, MCL:Mapper) and a repository of reusable tools based on the core concepts (MCL:Repository). At the time of writing, progress on the components is as follows:

- MCL:Core has been established based on the MVP/CIEL dictionary. MVP and PIH have worked together to map the PIH concept dictionary - used in all PIH sites except Malawi - to the MVP dictionary. MoTeCH's tools for health promotion messaging and decision support have been mapped to the MCL:Core concepts, as have several of D-tree's m-Health protocols and, as part of Jembi's work in Rwanda, the Rwandan government's maternal health forms.

- MCL:Search[17] has gone through several development iterations, and was widely recognized in interviews as the best available tool for searching standard concept dictionaries. In addition to searching the MCL core concept list, the search allows users to select results from standard dictionaries (from MVP/CIEL, PIH and AMPATH as well as the OpenMRS default dictionary) and terminology standards (SNOMED, ICD, HL-7 CVX, LOINC etc).

- A concept mapping process for tools has been established, and refined through use. Excel spreadsheets are used to record the mappings. The process and the spreadsheet format, although not yet publicly documented, together form the current state of MCL:Mapper.

- As part of the early development of MCL, the various groups involved have shared some of their existing maternal health tools. A subset of tools - notably D-tree's Android-based maternal health protocols and the forms, the Rwandan MoH maternal health forms and reports and notification messaging settings associated with MoTeCH's planned implementation for CARE in Bihar, have been mapped to the core dictionary. These efforts form the basis of MCL: Repository; however, this does not yet have a public face.

In addition to material achievements, MCL has provided valuable learning about the process of mapping tools to a common concept dictionary, as well as general lessons about shared concepts as a way to collaborate for reusability. To date, this has been done without dedicated funding and without a formal structure. The future evolution of MCL is actively under discussion, and to that end, the results of this evaluation continue to inform that discussion.

3.1.2 Issues & Considerations

What is MCL?

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[17] http://www.maternalconceptlab.com/search.php

In its first year, the scope and concept of MCL has expanded considerably. There is also significant diversity among the groups involved. The result, as described by one interviewee, is akin to the Indian story of the blind men and the elephant. Each man feels one part of the elephant, but the shape of the whole is elusive. The interviewee added that Jonathan Payne has the enviable position of being the one in the elephant suit!

Word cloud generated by the Dedoose data analysis program based on key descriptors identified by stakeholders interviewed about the value of MCL to their work.

Interviewees were asked to describe how they would define MCL, and what they understand of its intentions. The MCL concept and its relationship to organizational priorities was also discussed at the OASIS II mid-evaluation check-in meeting in New York. The results included definitions of MCL as:

- A **standardized platform** for (or collection of) maternal health concepts. Its primary use is helping people to decide the right concepts to use for their own applications.

- A **set of concepts that map to standards** (e.g. WHO standards) for maternal health.

- A **way of creating semantic interoperability** between systems by agreeing on shared set of concepts.

- A **collection of reusable concepts and forms** ("metacontent") related to maternal health.

- A **way to develop an evidence-based approach to maternal health** - the best concepts and the best forms. Agreeing on what these are allows some re-use, but agreeing at the level of concepts allows re-use of much more.

- A **library of concepts and tools** that use those concepts, and both could be taken and used, out of the box or tweaked to their needs, by groups starting a new maternal health project

- A central library of concepts that **allows people working in maternal health to share data** based on those concepts, or at least share reporting capabilities

While the definitions are similar in many ways, they confirm that MCL exists as different things to different people. This was true both for interviewees who have been heavily involved in MCL, and for those who have only encountered it peripherally. Key areas of difference include:

- **Whether the primary goal is reusable tools, or semantic interoperability.** While obviously not mutually incompatible, interviewees with greater focus on tools, software and specific programs differed from those whose coming from the perspective of health systems/enterprise architectures.

- **The extent to which concepts are central to MCL**. None of the interviewees believed concepts were not a part of the solution. However, some defined MCL only in terms of concepts, while others defined it in terms of promoting reusability or interoperability at a higher level. This could include reusable forms or form components (e.g. a maternal danger signs checklist) and reusable reports, or maternal health -specific distributions of full software systems (e.g. OpenMRS).

- **How closely MCL aims to tie concepts and tools to international standards**. For some interviewees, this was a key aim. For others, collecting concepts or tools that were widely used was enough.
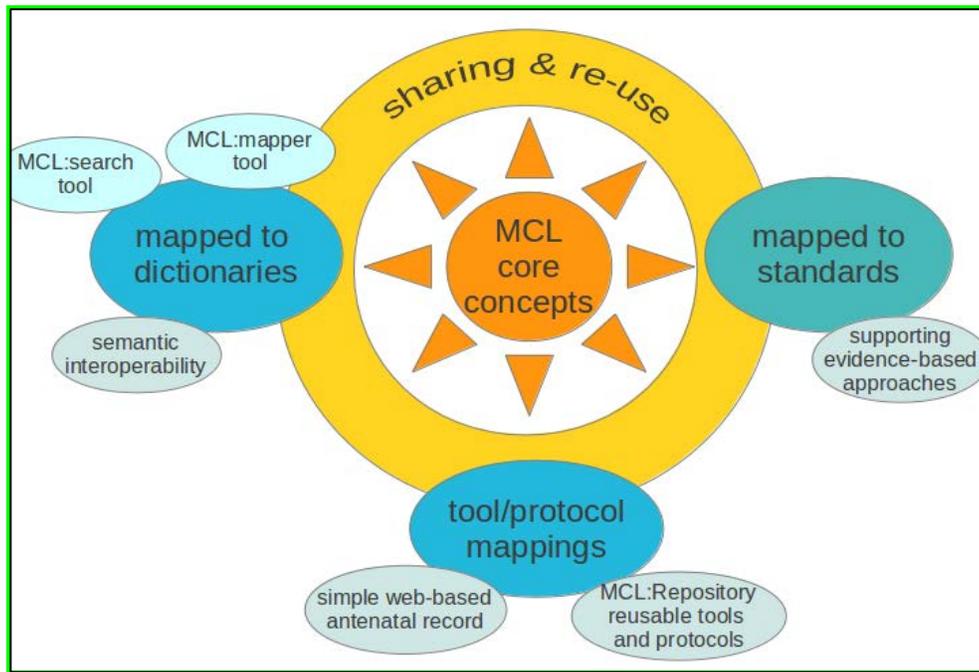
Shared MCL Components, including the "core concepts" approach.

Value proposition and drivers of adoption

Interviewees were asked about the value proposition of MCL in one of two ways. For interviewees in organizations or projects that might be expected to use MCL, how it

might be used by their own organization. For others, we asked how they would expect it to be used by other organizations in eHealth. Most respondents fell into the second group, either because their organization does not directly implement maternal health projects or because they have an existing system and stated that they would be unlikely to use MCL in its place. This gap could be addressed by reaching out to new entrants into maternal health (a difficult group to identify because they are often less connected to others in the space) or to donors or governments funding new programs in maternal health.

- For new projects, some respondents felt that **being able to start with a standard concept dictionary rather than develop one from scratch** was reason enough for groups to adopt MCL. The concepts should be well-structured and complete (for maternal health). Relationship to clinical standards was a secondary concern for most but important to some.

- In addition to providing well-structured concepts, MCL could **drive adoption by providing advice** to people mapping their own tools to the concept dictionary. Concept mapping is tricky, and MCL is valuable for its specialized (and domain-specific) knowledge.

- Other respondents felt that MCL's status as a **standard for semantic interoperability** would drive adoption, particularly if that standard were to become a requirement at national level.

- Relatedly, several groups **building new systems with the intention of making them reusable** felt that building on top of a complete dictionary rather than a custom one would save time in future when the system might be used a different context.

- Still others emphasized the need for **reusable tools that build on the standard concepts** - as one interviewee says, "I think it'll get adopted if people get something for free".

- Even if groups did not use either concepts or tools directly in their own system, the existence of a public, centralized repository would be useful as a **reference for designing tools and comparing existing tools to best practice**.

- MCL originates from groups who work **primarily in the developing world at community level**, and has the potential to develop a **context-specificity** that is sometime lacking in other medical terminologies or collections of standard tools.

MCL adoption - by groups developing a new system - is expected to be driven by the potential time and cost savings. This applies both to MCL:core on its own, and to the combination of core concepts and reusable tools. For implementers with an existing system, the effort involved in switching is greater and the value proposition less clear. Specification of MCL as a standard for interoperability at country or organizational level is one potential driver for this group. Groups who are mainly technology providers fall somewhere in between, with adoption likely to be driven by MCL's status as a standard as well as by the existence of reusable tools that could be provided to clients.

BOX 1: MoTeCH/D-tree collaboration for CARE in Bihar

One of MCL's first 'implementations' took place in early 2011 as part of an m-health pilot project in Bihar, India, in which D-tree and MoTeCH collaborated on a system to support pre-natal care, delivery and antenatal care. Both organizations use OpenMRS and XForm-based data collection on mobile phones, but the focus of their tools is different. As described in the project proposal18, the systems are complementary:

• MoTeCH uses data collected from women's antenatal visits to drive many useful alerts, reminders, reports, and IVR sessions. The data is collected from paper records after the clinical encounter. The benefits come after the data is submitted to the MoTeCH server.

• D-tree's focus is on putting clinical protocols on phones for use during clinical encounters. The primary benefit comes during the encounter. There is a small client record maintained on the phone that includes all data needed for future encounters. After each session, data is sent to a backend server.

To integrate the two systems, it was necessary to agree on a common concept dictionary. MCL:Core provided this. During development, Indian maternal and child health protocols were mapped to MCL:Core, with concepts added as necessary. The resulting system llows data collected with D-tree's mobile forms to be used in reminders and reports generated by MoTeCH. In future, anyone else who chooses to use MCL:Core in OpenMRS will be able to reuse both tools.

Barriers to adoption

The barriers to adoption suggested by interviewees fall into to two groups. First, there are various barriers that exist for any attempt to achieve reusability through shared concepts. Second, MCL currently lacks certain features that may be critical for wider adoption.

For groups with an existing system, the work involved in moving to MCL is a clear barrier. As one interviewee explains:

> "It's a real challenge if you've already collected data, and you're switching and trying to adopt MCL. It's not just a matter of mapping the ID of my concept or one I already have to what's in MCL. They may be modelled differently, so it might be incompatible data, or there's a translation step that would be required. And that's not just challenging, it's also time-consuming and resource-intensive."

This is a fundamental feature of attempting to collaborate around shared concepts. It may be particularly acute in eHealth projects in the developing world, which are typically funded for specific implementations. Combined with the inherent unpredictability of software projects, this means that time and resources to are always scarce. For this interviewee, MCL fills a gap that is seldom part of his groups' initial planning:

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[18] Draft MoTeCH - D-tree collaboration plan, 5 September 2010.

> "We're always under the gun to just have the prototypes out there and be able to collect some kind of results that we can then present at the end of the contract. It's been a bit of a rush for us, so what we have done has always been a little bit after the fact."

Even within organizations, systems that work across different country health systems and different health domains experience tension between standardization and customization. This interviewee maintains a concept dictionary for an organization:

> "There are always pros and cons when an implementation site wants to adopt shared concepts. You can take advantage to a certain point, but then because it's so country-specific or disease-specific, you still end up.... it may look like you have less work at first but then you might end up having more work because you might need to create your own concepts or try to map what is existing there so it's more localized - terminologies or dictionary terms"

Although many interviewees responded positively to the strategy of focusing on maternal health as a single health domain, others noted that this can also be a challenge:

> "It's almost impossible to develop a clinical application that's specific to maternal health and have it be broadly used. They have to almost always live within the milieu of a more sophisticated general purpose medical record application, and I think that where the more interesting general challenges for MCL will come from."

In any attempt to achieve reusability, country ministries play a role in ensuring that national data collection and reporting requirements are clearly defined, and aligned as far as possible to standards. MCL may be a good way to start a conversation around standardization, between implementers but most importantly with decision-makers at national level. However, several interviewees mentioned that in the countries where they work, the Ministry of Health was currently concentrating on basic reporting and other urgent priorities and would be unlikely to fully engage with standardization for some time.

In terms of features, MCL doesn't yet have a publicly accessible repository of tools. For some interviewees, this is a critical incentive for adopting the core concepts, and one without which wide adoption is unlikely.

> "There is always the tradeoff between short-term and long-term benefit, and short-term benefit for MCL is low right now, for most groups. That may change in the future but right now it's just how it is."

> "To my knowledge there are no value-added technology solutions out there, so the way I think it'll get adopted is if people get something for free by trying to collaborate with MCL. I don't know that there's anything you get for free."

MCL's current dependency on OpenMRS was an area of concern for interviewees who have chosen not to use OpenMRS, or who work in countries where another system is mandated. In their current form, the most established pieces of MCL - the core concepts and the concept search - are useful primarily to OpenMRS users. While tools built on top of the concept dictionary could still be a useful reference for those not using OpenMRS,

they would need to implement other standards (e.g. xforms) or be browse-able in a generic, human-readable form.

Finally, lack of clarity about MCL's role and structure, or what these are envisioned to be in future, may also be a barrier to adoption.

Tools

One of the early realizations in MCL was that tools for managing concepts - and particularly tools for comparing across different concept dictionaries - were nearly non-existent. To support the goal of reusability, it was necessary to also become provider of tools. This has been a significant contribution both in itself and as a way to raise the profile of MCL. MCL's search tool in particular was widely praised, and had been used by many of the interviewees.

> "The inability to find things is driving a lot of adoption. The search portal into it is probably the most important thing at this early stage."

> "Some percentage of people who like the Maternal Concept Lab like the look of the website and those tools, that's what [..] hooks them in"

> "MCL search was seen as a means to an end initially, where the tools to search the dictionary were not powerful enough so we just needed help to make it so we could do mapping, but as it turns out MCL search has been a contribution to the community on its own"

> "Back in 2008 I was trying to work with OpenMRS, but it was a little complicated. I didn't really know where to find information about concepts, how to build concepts, if I was right or wrong if I built my own concepts without caring about standardization or anything like that. It is a lot easier with the MCL search site. [..] You don't have to recreate what's already done."

A number of interviewees suggested improvements or new tools, reinforcing the importance of tools in the project as a whole. Suggested improvements included:

- Add the ability to combine results from repeated searches using the search tool into a metadata sharing package for download directly into OpenMRS

- Find a way to track which concepts users download, and solicit feedback on which concepts they did not find in the MCL dictionary.

- Provide basic documentation (a one-page guide) on how to use the search tool

Suggestions for new tools included:

- **MCL support system**. Develop a system where people working with MCL's concepts could ask questions and receive assistance. Something like StackOverflow or Google Moderator could work well, or just a mailing list with more of a support focus than the general MCL list.

- **Search tool for other reusable components**. Develop a tool to search for reusable questions, checklists, forms or protocols, and download them as well as the required concepts.

- **Preliminary concepts**. Provide a way for implementers to request a concept from MCL, and use the preliminary concept while it is added to the main dictionary. When the new concept ID is available, update the preliminary concept in the implementer's database.

- **Simple web-based antenatal record**. Develop a very limited antenatal record system based on MCL that can be used with minimal setup to collect basic data such as due date, delivery plan and risk factors.

In terms of the concept lab as a model for reusability/interoperability, it is significant that tools have become a key component of MCL's work. Together with the existence of a supportive community, they provide an infrastructure for finding, adapting and implementing reusable components. Various open source projects in eHealth and mHealth have demonstrated the value of developing a community, but MCL may be the first to demonstrate the importance of supporting tools.

BOX 2: MVP/CIEL Concept Dictionary Web Survey

15 respondents from 13 different organizations answered questions about their use of the MVP/CIEL concept dictionary in a web survey administered via Qualtrics. Of these, seven reported using the concepts in OpenMRS, with others stating that they are in an early stage of their project or that they use the concept dictionary as a reference source.

Key findings from the survey were as follows:

- Although five respondents reported not finding the concepts they needed in the MVP/CIEL dictionary, only one had requested concepts from MVP/CIEL. Reasons given for not requesting concepts included lack of time, preferring to use a separate concept dictionary and refer to the MVP/CIEL concepts only, and lack of understanding of concepts generally.

- When asked to suggest improvements respondents requested further language translation of concepts, documentation about how to use concepts, and integration into and testing for new versions of OpenMRS. More technically complex requests indcluded a way to choose concept granularity, common UUIDs across different dictionaries for frequently used concepts. Finally, like MCL, the MVP/CIEL dictionary needs a formal process for requesting new concepts to be added to the dictionary.

- Respondents were enthusiastic about tools related to MCL. Of ten respondents who answered a question about what components they might use in their work, nine stated that they would use MCL:Search, seven would use concept mappings between dictionaries, and six would use each of the MCL core concepts and eHealth and mHealth tools build around them.

Perceptions of MCL's work to date

Interviewees perceived MCL as a novel approach, with impressive achievements in its first year despite having no funding or formal structure. Among these are:

- **Developing a working group and wider community**. "MCL has been [...] incredibly successful at bringing people together - it's been good at I guess community. It's got a good name, it struck a chord with people, it somehow accommodated different visions"

- **Mobilizing resources around a concrete goal**. "[Compared to other efforts in eHealth and mHealth] this is much more concrete, much more realistic, much more tangible."

- **Establishing a common repository for maternal health tools**. "I think what has been done well is to establish a common place to link together examples and tools and best cases of the way that people are using data. And to make it easier for people to access that data and think about it in a semantic way."

- **Providing usable outputs - both tools and concepts - at an early stage**. "what I really liked with MCL was that there was actually priority given to it, and initially it really made progress quickly [..]. It was productive and it moved quickly and there was an actual concrete output, which I thought was great."

Everyone interviewed was generally supportive of MCL. However, as interviews took place at a relatively early stage in the project, some interviewees were less familiar with the work undertaken to date. Those with more involvement were more generally more critical.

Less successful aspects included:

- **Lack of an on-the-ground implementation of the MCL core concepts**. While various groups have started or completed the work of mapping tools to the MCL core concepts, none have yet started from scratch with the concept dictionary and finalized an implementation.

- **Limited involvement of groups active in eHealth and mHealth**. There are few contributions of tools from groups not actively working on MCL.

- **Uneven progress on the different components of MCL**. Work has been done on the platform and tools for concept searching, some on the core dictionary and evaluations of existing tools, but little on mapping best practices, and formalizing the concept lab model.

- **Limited public relations work**. Although the initial working group was established relatively quickly, little has been done to develop the 'public face' of MCL. Publication of a position paper on the concept lab model is one component of this, raising awareness of MCL tools is another, and soliciting input to the tool repository and concept dictionary is a third.

Only a few interviewees felt they were familiar enough with MCL to discuss things that could have been done differently.

- **While acknowledging that progress could have been accelerated by an earlier funding push, interviewees also saw value in getting off the ground before looking for funding**. This strategy certainly contributed to the emergent nature of the collaboration, which has evolved its focus some way beyond the initial idea of reusable mHealth tools.

- **On the other hand, the volunteer nature of the work done to date has made it harder to complete concrete projects**. It may have been helpful to seek funding in parallel to ongoing work by volunteers.

- **The single health domain focus of MCL was generally seen as a good thing, as was the choice of maternal health**. Several interviewees suggested expanding into other, related domains, such as HIV and TB care, and family planning.

Overall, MCL was perceived very positively. Criticisms were often phrased in the form of next steps, reflecting interviewees' ongoing interest in the project. The gap between appreciation of the idea and actual adoption and implementation, as exemplified by the earlier discussion of barriers, remains; however many of these apply to any attempt at reusability. MCL has some new ideas and a solid foundation, and interviewees were hopeful it might succeed where other attempts have failed.

3.1.3 Lessons Learned

Concept mapping process lessons

Several of MCL's activities have involved mapping a tool - a data collection form, a protocol, a required report - to the core concepts. Doing this in a systematic way has provided lessons that interviewees were keen to document.

- **The process of concept mapping is extremely time-consuming.** "To map a form using the current MCL search tool, each pass takes ~1 hour for every 20 concepts. On average, we needed 3 passes and multiple consultations with the client and concept dictionary experts. A simple antenatal form may have just 20 questions, but that could mean as many as 150 concepts, which is a 25+ hour process! "[19]

- **Even relatively simple forms can require specialist medical, health systems and informatics knowledge.** Concept mapping has a non-trivial learning curve, even for people who are otherwise familiar with the tools, programs and protocols involved. Expert advice remains important even for those who are proficient.

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[19] Payne, Jonathan. (2011, March 9). Re: [ict4chw] MCL [Electronic mailing list message]. Retrieved from
https://groups.google.com/forum/#!msg/ict4chw/O1lytD-_vqU/NmmV45Go3pEJ

- **Good tools are vital**. MCL:Search was developed to streamline the concept search part of the process. Work in progress is recorded in excel spreadsheets, which have evolved into a relatively standard format that specifies the source and similarity of existing concepts, comments, and any new concepts created. There are plans to formalize the spreadsheets in future, possibly into a web-based tool.

Going forward, MCL can use these findings in two ways. First, the time and expertise required to map existing tools to the MCL core concepts is a very good reason for potential adopters to reuse tools from the MCL repository. Second, interviewees supported formalizing and streamlining both the concept search (already done to an extent) and the process of obtaining expert advice, and MCL could do both.

Lessons about collaboration

MCL's structure as an eHealth collaboration is informed by - and on a practical level, organized through - participants' involvement other collaborative projects. OASIS is one such collaboration, bringing together several established eHealth programs that have provided expertise and resources for MCL. OpenMRS is another, and is significant for its strong and supportive community. Here, the OpenMRS community is described as a intervention for interoperability - of both technology and people:

> "What became increasingly clear was that this concept of collaboration was more than just building the software, and it was more than just using the data in the clinic. It was also a notion of both machines and people becoming interoperable in a planned approach, in a methodologically sound approach"

MCL has certainly benefited from 'interoperability between people' in the eHealth space. As one interviewee describes it, the seed was that "four of us, who are all friends, should be able to just among ourselves, collaborate in a unified way."

For the same person, however, MCL has also been a lesson in the challenges of creating a successful collaboration. This was a common theme in many of the interviews, with lessons that apply as much to similar initiatives as to the future of MCL.

- **Collaboration is generally hard**. The more commitment you require from participants - from sharing ideas on a mailing list, to using and contributing to shared software, to sharing forms, reports and protocols - the more difficult it becomes to gain a critical mass of participation.

- **Time is always short to start with, and collaboration takes additional, unplanned time**. "We're always under the gun to just have the prototypes out there and be able to collect some kind of results that we can then present at the end of the contract. [..] so what we have done has always been a little bit after the fact. We've gotten things out in the field and begun the refinement process, and then looked at the concept mapping."

- **Ambitious goals need to be broken down into small pieces**. "Think carefully about small scope, choose your targets for collaboration [knowing that it] generally doesn't work. [Choose] something that seems really small to you and unambitious, because it's hard to get time"

- **The 'big names' that tie a collaboration together may not be the best people to actually do the work**. In addition what one interviewee described as "salespeople", MCL has benefited from concrete work done by volunteers and paid contractors, either working on MCL directly or doing mapping as part of another project.

- **Funders can promote collaboration**. In the case of the MoTeCH/D-tree collaboration, the Gates Foundation encouraged grantees working on complimentary software systems to do an implementation together - with the MCL core concepts providing the common core.

- **Funders can hinder collaboration**. "Everybody wants to get their project done and the investment in time for the next project is oftentimes not completely supported or appreciated"

- **National requirements can support reusability if they are clearly documented (and aligned to standards)**. In particular, Jembi has been working on national-level enterprise architectures for e-Health, within which MCL might be a standard for maternal health data collected by primary care facilities. This could be a significant driver of adoption.

Finally, the issue of applying for funding at the start (versus allowing things to develop organically and without initial, directed funding) and being agile in the early stages recurs in any discussion of collaboration. MCL has gained breadth and conceptual sophistication from adopting the latter strategy, as well as a much greater understanding of potential barriers to collaboration around reuse. Next steps include documenting these (partly through this evaluation!) and incorporating the lessons learnt into a funding proposal.

The concept lab as a model for interoperability/reusability

In addition to providing tools and bringing together a collaborative community, the development of the concept lab as a model for interoperability/reusability initiatives has been one of MCL's key tasks in its first year. At the core of this approach is an acknowledgement that the field is littered with failed or stalled projects. Interoperability and reusability are challenging, and part of the challenge is at the level of institutions.

> "The way the system is structured, people tend to work independently, they tend to be funded for a particular project which involves just building a system locally. Generally they have other goals - their goal is to roll out antiretroviral treatment or to do something about TB and then the data collection is just a side thing, so that creates this big leaning towards data reporting as opposed to data for local use and also silo approaches, so you don't get a lot of interoperability - there's no real incentive to connect."

The concept lab model introduces some specific challenges, but resolves others, and affords new opportunities to address the problem of interoperability/reusability.

Challenges	Opportunities
• **Semantic interoperability is generally not well understood, even less so at the level of actual implementation**. "When people talk about it in a loose way and say you know, semantic interoperability across the health care system, that implies many of degrees of sophistication further than I think most people are perceiving it." • **The extent to which semantic interoperability between systems is possible depends on the granularity of the data being captured.** "For MCL to provide shared reports, anyone adopting the report needs to be collecting data with at least as much granularity as the MCL core concepts." • **Concepts for a specific health domain are only one part of a larger system**. "It's almost impossible to develop a clinical application that's specific to maternal health and have it be broadly used. They have to almost always live within the milieu of a more sophisticated general purpose medical record application, and I think that where the more interesting general challenges for MCL will come from"	• **There is a groundswell of recognition for semantic interoperability**. "I think there's a natural evolution where interoperability was first looked at as electronic data exchange, they were simply getting systems to talk to one another, and then once they did that of course they realized that the stuff they were talking wasn't understandable. It's the same evolution going on in the United States where we're emphasizing the use of standardized terminologies, where as up to this point controlled medical terminologies, standard terminologies, reference terminologies were a pain in the ass to most people. But I think they're now recognizing that without it is actually much more difficult." • **Clearly defined standard concepts go some way towards documenting the data being collected**. "Poor documentation hobbles interoperability." • **Unlike previous systems, MCL is created with limited-connectivity environments in mind.** "I think there are also a lot of issues around what people's expectations around connectivity. A lot of the issues around semantic interoperability are resolved when you have good connectivity in your environment because you can create central authorities for the content to be normalized" • **Everyone involved in MCL is actively implementing systems, and is also concerned with reusability within their own organization**. "Current approaches to reusability are not that effective. [..] OCC's idea that reusability and standards develop organically is absolutely correct. These much more top-down standards involving people who don't know what actually needs to happen for reusablity to occur, understandably isn't necessarily the right approach."

At its core, the concept lab model represents a compromise between bottom-up and top-down approaches, neither of which can achieve reusability of mHealth / eHealth tools alone.

> "MCL is a nice hybrid approach, that has a good amount of expertise for the top helping design the model, design the structure of concepts - I mean mostly CIEL and Andy [Kanter] - but along with a group that is more bottom-up, that is mapping existing instruments. So I think this is shaped by both common usage and by expertise, and I think that joint approach is going to end up being extremely valuable."

Roles for funders and health systems decision-makers

MCL is a technical and informatics intervention that lives within the larger context of country health systems and (predominantly) donor-funded projects. Interviewees expressed a need to communicate the role of MCL to these kinds of health systems decision-makers, and to seek their support.

> • **In general, national governments in the countries where OASIS partners work are still working on getting basic data reporting in place. They lack**

the financial and technical resources to enforce informatics standards, and it will be a long time before these are given priority.

- ○ "I don't think governments have that sophistication right now to understand what is the difference between an MCL concept dictionary and a not MCL concept dictionary. I think governments right now are just at the level of are EMRs actually useful or not, because they're finding it expensive rather than effective".

- ○ "Everyone is just struggling so mightily just to get data reporting at any level, and in any time, the idea of systems design, the idea of data exchange and standards, anything like this, is just, I think just a step removed"

- **The USA has a long and fraught history of efforts at semantic interoperability, and countries like Rwanda have the advantage of being able to demonstrate a "greenfields" approach**.

  - ○ "One of the biggest problems that we face is that there aren't so many great examples of interoperability working well within established health systems. We talk a lot about it and it's probably a major health policy goal for the US government in the Obama administration. But the examples of successful interoperability are not nearly as frequent as one would expect. So that's where pioneering something in a country like Rwanda and showing that actually this can be an effective strategy [can] make it easier for countries to adopt a mixture of systems - that really needs to be shown, we need good examples."

- **Without a larger framework to guide implementation, eHealth projects suffer from short-term thinking that does not prioritize interoperability/reusability**.

  - ○ "I think that the biggest challenge is a lack of basic understanding among people who implement systems as to the implications of those systems being in place for a lifetime."

  - ○ "I think it could be pushed from the public health side but I doubt that will happen anytime soon because the projects have no accountability to worry about that"

- **Funders can support national health systems by supporting the development of frameworks and standards - either separately, or as part of existing projects**.

  - ○ "I think that's really where things need to push from, have donors saying hey, we're going to give you some money to do this, we understand it's extra work and we understand it slows you down but we know it's important and we know it will support the government in its work."

- **Where awareness exists, it needs to be transformed into concrete action.**

  - ○ "At the mHealth Summit in Cape Town, talking to some of the larger donors, [..] people are conceptually on board with it but it needs to be written into RFPs and RFAs, it needs to be out there. Donors need to appreciate that it's the right thing to do. And it's difficult, because [..] all the usual politics that are involved in people needing to come together

and do the right thing rather than each being able to wave their own flag on having created the ultimate system"

3.1.4 Implications for Future Work

Organizational structure, roles and relationships

One of the intended uses of this report is to inform a potential funding push for MCL. The findings reinforce the initiative's promising achievements to date, and the importance of obtaining funding to further develop it. For this to happen, it will be necessary to make formal statements on the structure, goals and scope of MCL, and the roles of the various groups involved.

In terms of **structure**, MCL is currently a loose collaboration that works through contributions by volunteers or small, focused funding where the needs of an organization or funded project overlap those of MCL. A standalone funding application would need to define one or more organizations as recipients. In conjunction with this, their relationship with the wider community, and responsibility to implementers of MCL, should be formalized beyond the current ad-hoc arrangement.

Relatedly, some interviewees suggested that MCL may wish to consider locating itself within an existing collaboration - such as OpenMRS - to reduce administrative overhead. With OpenMRS in particular, this should be balanced with tying MCL to OpenMRS, which was seen as a barrier by some respondents.

MCL's **goals** and **scope** have evolved over the first year, gaining sophistication (and arguably a better chance of success) but also complexity. The findings on definitional issues and value proposition demonstrate this well. Decisions about focus require further discussion, but should take into account the short-term need to expand implementation and the development of usable tools to drive adoption.

Finally, **roles and responsibilities** need to be clarified, both within MCL and to potential implementers. Within MCL, ownership of the dictionary, which currently lies with CIEL, should be clearly stated along with a commitment to potential adopters about the process for requesting new concepts, and for decisions about what is and is not part of MCL. As far as MCL itself, the creation of a formal structure (which may or may not be the same entity applying for funding) with clearly defined goals will make it easier to promote MCL publicly, and reassure potential implementers of its longevity and commitment.

Next steps

In addition to larger questions about strategy, the findings suggest some immediate next steps for MCL. During the face-to-face OASIS meeting in June 2011, participants agreed on a list of 'game-changers' for the immediate future.

1. **Publicly launch MCL**, probably through a panel at a high-profile conference.
2. Reinforce the concept lab model by e**xpanding to another health domain**/community of practice

3. **Get best practices/health standards - for example, from WHO - mapped in to the dictionary**.
4. Do **an implementation that proves applicability to a system other than OpenMRS**
5. Get to a stage where **a specific MCL-enabled tool being used by several groups in the field.**
6. Develop a **comparison tool** which allows you to map a tool in to the dictionary, and produce and automated comparison to (for example) WHO guidelines
7. Develop a **concept mapping tool** with a lower barrier to entry than the current process.

Of these, point 5 was most commonly mentioned in interviews. While some work has been done (particularly on MoTeCH and on D-tree's tools), interviewees were not uniformly aware of it. This also supports to the need to launch MCL publicly and promote a consistent public face – beyond the primary user group.

In addition to tools - a significant contribution in their own right - MCL should consider providing formal guidance on the concept mapping process. To the extent that this already happens, interviewees were very appreciative. Concept mapping is non-trivial, and part of the 'infrastructure' for reusability may be providing knowledge services, including advice (on a mailing list for public conversations, or over Skype) as well as documentation and/or training.

Finally, the value proposition of MCL is highly dependent on a critical mass of adoption - it needs to "gain traction", as one interviewee said. Without this, it is considerably less attractive both groups developing new systems and those who might switch existing systems to use MCL. Next steps should be decided with this in mind.

3.2 Interoperability: OASIS II Rwanda interoperability work

The second interoperability case study looks at work by OASIS II partners - specifically PIH, MVP and Jembi - in Rwanda. The Rwandan eHealth sector has some special features, notably the strong leadership of the Ministry of Health (MoH) as well as ongoing sector support through the OASIS and OASIS II, RHEIN and RHEA projects. This case study was designed with primary intended users to document the interoperability work that is underway, as well as preliminary lessons learnt.

3.2.1 Overview

PIH, MVP and Jembi have distinct eHealth projects in Rwanda, between them covering about 10% of the country's approximately 450 primary care facilities. Although outside the scope of the evaluation, it is also notable that the MoH is currently rolling out their own version of OpenMRS for primary care, based on the PIH version with some additional modules. Many of the MoH developers have been through PIH's 11-month postgraduate program, and have gained hands-on experience developing OpenMRS modules as a result. The MoH rollout intends to reach between 120 and 150 additional sites over the nest two years.

The table below summarizes the PIH, MVP and Jembi eHealth implementations in Rwanda under the OASIS, OASIS II and other projects.

	PIH	MVP	Jembi
Context	PIH has been working in Rwanda since 2005. Their focus is on health systems strengthening in partnership with the MoH. There are currently 25 PIH-supported health facility sites in operation, with plans to have around 30 by the end of 2011.	MVP has one village site in Rwanda, out of a total of 14 sites in several African countries. The overarching goal of the program is "the coordinated delivery of a package of scientifically-proven health and development interventions which are aimed at accelerating progress towards achieving MDG targets"	Jembi's implementation of RHEA, the Rwanda Health Enterprise Architecture, will begin in late 2011. The pilot implementation focuses on maternal health in 12 health facility sites within a single district
Systems	PIH's primary system is a customized OpenMRS distribution with additional modules, some of which the Rwanda version has in common with PIH sites in other countries.	The full MVP system 'stack' includes: - Childcount+, a RapidSMS-based data collection application for community health workers - Customized OpenMRS for clinic-based data collection - Aggregate reporting to MVP-IS for project-wide statistics - Data warehousing using I2-V2, a commercial product.	Jembi's implementation is intended as a pilot of a multi-level enterprise architecture, including OpenMRS at clinic level and communication with provider, client and facility registries and shared health record provided by ezVida, the enterprise system chosen by the Rwanda MoH.
Interoperability	PIH is in the process of implementing the OpenMRS SDMX-HD module to provide reporting of aggregate statistics from OpenMRS to TracNet, Voxiva's HIV statistics system	MVP is planning to use SDMX-HD to connect to DHIS, the District Health Information system.	Jembi's work on enterprise architectures defines standards for diverse systems to communicate and provides infrastructure to facilitate this. Jembi also developed the SDMX-HD module for OpenMRS on contract to PIH.
Status	PIH's OpenMRS implementations are well established. SDMX-HD integration is nearly complete, pending Voxiva implementing data consumption in TracNet	OpenMRS, MVP-IS and I2-V2 are implemented; SDMX-HD link to DHIS is not. Childcount+ in Rwanda is on hold pending MoH rollout of their own RapidSMS system for home visits.	Initial integration between OpenMRS and ezVida is beginning, with the intent to implement on the ground by late 2011.

Despite differences in approach, maturity and scale, all three groups have basic components in common - specifically all three groups are working actively with the OpenMRS platform, as well as with RapidSMS (also being rolled out by the Rwandan MoH), and all three groups have plans to use the SDMX-HD OpenMRS module. In addition, all three have taken steps towards semantic interoperability for their maternal health data. PIH has mapped their concept dictionary to the MVP/CIEL dictionary, which forms the basis of the Maternal Concept Lab, MCL, and Jembi has done the same with the Rwanda MoH maternal health forms prior to their implementation.
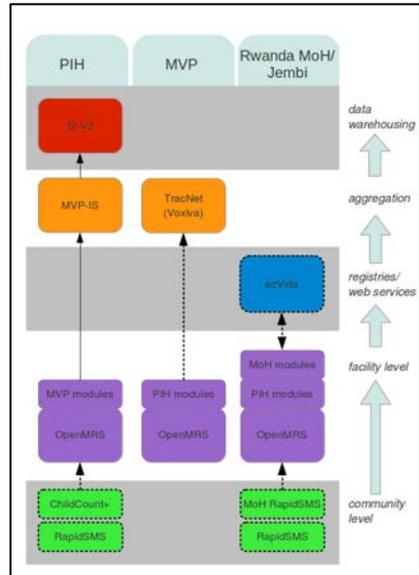
Different approaches to working within the Rwandan eHealth Landscape for PIH, MVP and Jembi.

3.2.2 Issues & Considerations

Approaches to interoperability

Even within OASIS II, approaches to interoperability are diverse.

- **SDMX-HD** is a targeted, pragmatic intervention to provide one-way data aggregation between two systems. As an OpenMRS module that implements a WHO standard, it has nevertheless been implemented in a reusable, customizable way. That all three groups plan to use it despite having different versions of OpenMRS is evidence of the effectiveness of this approach, as is a recent implementation in Sierra Leone#.

- **The Rwanda Health Enterprise Architecture (RHEA)** is much more ambitious, with Jembi's forthcoming pilot implementation preceded by a significant period of discussion and high-level design. Scaling up the pilot to anenterprise architecture for eHealth in the entire country will require strong enforcement as well as sustained technical commitment.

- **MCL** occupies the middle ground. For maximum benefit, it needs to be mandated as a standard, and live within an enterprise architecture. In the interim, however, it can still provide short-term time-savings the possibility of shared reporting, and is able justify its adoption.

With the support of the MoH, the three groups have shown willingness to work towards both short-term, specific and long-term, generalized interoperability. The corresponding bottom-up and top-down approaches are mutually sustaining. Proven components like SDMX-HD find their way into the enterprise architecture, and the existence of the enterprise architecture blueprint allows groups working in eHealth to harmonize their efforts with each other and the MoH plan.

Coordination and Direction

The important role of the Rwanda MoH in promoting interoperability came up repeatedly in interviews. By providing both coordination and, where necessary, coercion, they have created a conducive environment for interoperability work.

> "I think what they've done better than other countries is to establish a framework and a set of institutions like the eHealth committee [..] it's still a work in progress, but at least by addressing these questions and by providing a framework and government support for the issue of interoperability, they've moved things a lot forward. So people have felt there's a partner to work with, and I think that's been important."

> "I think it's government leadership [driving interoperability in Rwanda]. To some extent there's this natural.... or I wouldn't say it's natural, but there's a collegial collaboration that's going on between PIH and Jembi and MVP, and that provides the ground on which these sorts of interoperability initiatives can be initiated. But clearly there has also been a leadership at the top that has both demanded it and has encouraged it, and maybe provided the right context for making it germinate and grow."

Ownership strategy

Working in active cooperation with the MoH is part of the local ownership philosophy of OASIS II. However, PIH, Jembi and MVP operationalize this active cooperation in different ways. Jembi has established *Jembi Rwanda* to act as a local satellite, and is working with the Rwandan company *Pivot Access* on the RHEA implementation; MVP's facility has only local staff members; PIH has a strong focus on providing eHealth training, both at sites - which are operated jointly with the MoH - and through the postgraduate training course.

Each approach is covered in much more detail in the section 4.1. For interoperability, the existence of a strong local eHealth workforce is significant because it reduces Rwanda's reliance on imported technology skills. The MoH is empowered in turn to strongly enforce standards and architecture requirements as fits best for the Rwandan eHealth landscape.

3.2.3 Lessons Learned

> "There are not really any concrete examples of fully operational interoperability initiatives at this point - I know that seems like a shock given all the talk about it"

All of the projects described so far (SDMX-HD, MCL, RHEA) are still at the pre-implementation stage. This in itself is a lesson. **Interoperability takes time, a significant proportion of which goes to building relationships and negotiating roles**.

The points below are reflections on this process, as well as on the technical challenges of components and context.

- **Communities of practice provide a foundation for interoperability.** Whether organized around tools (e.g. OpenMRS), or research questions and implementation goals (OASIS, OASIS II, RHEIN, RHEA), communities of practice build relationships and support the development of best practices that can be codified into common standards.

- **Standards and architecture processes must be locally led**. "The single biggest thing we've learnt is that you need to really believe in the fact that these projects can and should be locally led, and that you have to step outside of the paradigm of that things have to be led by the person with the most knowledge or the most political power or whatever, but you have to find - pragmatically - you have to find people that are willing and able to take projects on, and try and grow in small steps."

- **Standards aren't prioritized without incentives and enforcement**. The PIH SDMX-HD link to TracNet is not yet implemented in part because of lack of prioritization by Voxiva. The MoH has begun to provide enforcement, but there needs to be more thinking about incentives for interoperability work by private companies. MCL, on the other hand, has no enforcement but clear reusability incentives, at least for for OpenMRS users.

- **For interoperability to be prioritized, other parts of the implementation need to be working well**. More than one project reported delays due to difficulty in attracting and retaining skilled technical staff in remote areas, and Internet connectivity is an ongoing challenge.

- **Design for unreliable Internet connectivity**. Interoperability components should be designed to retry failed data transmissions, and not to rely on being continuously online. Enterprise architectures that use a web services model need to be modified to deal will low connectivity environments.

3.2.4 Implications for Future Work

All three OASIS II partners working in Rwanda have been involved in work on interoperability, with plans to implement soon for both the SDMX-HD/TracNet link and the enterprise architecture pilot. In parallel, development, community-building and implementation work MCL is ongoing, and Jembi continues to develop on enterprise architecture projects in other countries, as well as through the Health Enterprise Architectures Laboratory at the University of KwaZulu-Natal.

From the early lessons captured here, two things emerge. First, interoperability can be approached at many levels, from data sharing between systems to standards setting and architecture provisions for national health systems. In Rwanda, the MoH has largely been able to sustain conversation between different projects, and has bridged the different levels by communicating an emerging blueprint for eHealth in the country. Structures such as the weekly eHealth meetings and the publication of an eHealth

strategy should be supported, could be usefully adopted by other countries wanting to promote interoperability.

Second, support for communities of practice - both within and between countries - can create a conducive environment for interoperability. By developing relationships and awareness of best practice, communities of practice overcome some of the organizational barriers to interoperability. Shared, reusable tools can similarly contribute to overcoming technical barriers. Nevertheless, additional incentives may be required to convert ideas into implementation. Both donors and governments can provide incentives by requiring compliance with standards and reuse where feasible, and by being willing to pay for dedicated work on interoperability.

3.3 eHealth Workforce Strengthening Case Studies

Primary stakeholder input was included from a total of 52 individuals with relatively equal representation across the 4 primary OASIS II projects in 4 countries: Rwanda (MVP, Jembi and PIH stakeholders), Tanzania (MVP and OpenROSA stakeholders), Mozambique and South Africa (Jembi stakeholders). 38 in depth interviews were conducted, including stakeholders representing various roles across the eHealth workforce. 3 separate focus group interviews were carried out in person, 1 with CHWs and their supervisors in the Dodoma, Tanzania DTree/OpenROSA project site, 1 with MVP data clerks at the Nyamata, Rwanda MVP site, and 1 with MOASIS developers in the Jembi project site in Maputo, Mozambique.

3.3.1 PIH

Overview

PIH focused on developing and institutionalizing **a formal academic training program in software development** for the OpenMRS platform in Kigali, Rwanda that included a heavy emphasis on classroom and hand-on programming skills curricula, and a basic introduction to health informatics. The formal part of PIH's OASIS II eHealth workforce strengthening project work is focused on a training program, *E-Health: Software Development and Implementation* (EHSDI), in Kigali, Rwanda, for Rwandan programmers to learn advanced Web and Java programming techniques, OpenMRS programming and the basics of medical informatics. 2011/2012 was the 3rd year of the course being offered in a collaboration with the eHealth Center at the Kigali Institute of Science and Technology (KIST). The training program curriculum, developed and refined by a collaborative team at PIH, Harvard, and with input from the OpenMRS core developer community around the world, is divided into two stages – functionally an instruction/training stage (7 months), followed by a hands-on production stage (2 months).

The training stage goals are 2-fold, 1) to teach junior-level programmers the required technologies for OpenMRS development, and 2) provide a basic introduction to medical informatics. The production stage requires the students to develop "production quality" modules for OpenMRS per the needs of the Rwandan MoH (and other partners). For developer skills training, both stages include several weeks of teaching, followed by a

written exam and a relevant student project component. Background in medical informatics is taught throughout the course based on weekly lectures or presentations on a range of topics. Full curriculum information and course content materials can be found on the OpenMRS wiki[20].

The informal part of PIH's OASIS II eHealth workforce strengthening project work is the collaboration with other OASIS II members around capacity building in general and training in particular for data managers and users, as well as supporting technical areas like data management and reporting. For example, PIH led the OpenMRS trainings at the OpenMRS meeting in Cape Town (2010) where participants from all over the continent (and other regions) were able to benefit from the OASIS II funded training program process, results and products. In addition to intensive workshops and short-term trainings and capacity building efforts, an important outcome of the EHSDI program is the employment of a graduate from the course by Jembi and MVP in 2011. This represents a success in terms of contributing to the size and quality of the eHealth workforce available in Rwanda.

For the UFE, 9 in depth key stakeholder interviews were conducted in person and via phone and skype calls and 13 trainees (of 22 total contacted) participated in an anonymous web survey about their experience during and after the program (see Appendices F1 and F2).

Issues and Considerations

To date, 34 African trainees have gone through the PIH EHDSI OpenMRS-focsed program. Critical factors identified in the UFE related to the content and impact of the training program include the fact that of the 5 content areas included in the curriculum, the programming focus was the initial priority and was the only one that the trainees felt was addressed in depth. **All trainee respondents to the web survey and all related interviewees commented on how helpful and relevant the OpenMRS programming component is, however that that more time and emphasis was needed on the other 4 areas -** Data Management, Project Management, Basics of Health Informatics, and other Professional Development skills. This was impressive to the evaluation team in it's consistency, however not surprising based on the evolution of transition to more fully developed local capacity within the MoH and local collaborators around OpenMRS planning and implementation at the national level.

Lessons Learned and Implications for Future Work

The evaluation team's specific recommendation for PIH and/or KIST partners going forward is to reevaluate the curriculum to focus on either 1) adding a "level II" course that addresses the context issues related to OpenMRS implementation (addressing the other 4 content areas), and/or 2) shift the balance of the current curriculum to include more equal attention to those other components. Based on feedback about format, scope and necessary resources for the program, it may be unrealistic to assume that one course can address all 5 necessary context and content information to prepare OpenMRS programmers *and* implementation support personnel (which by default is a combination trainee profile to some extent at present).

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[20] https://wiki.openmrs.org/display/RES/EHSDI+Training+Course

As the program itself is being transferred to the KIST entity in order to be more formally institutionalized into the Rwandan university system, the expectation is that this will help more clearly anchor the program at a local level. **The lack of a recognizable, respected form of accreditation was cited by almost all trainees and interview respondents as a significant barrier to more formal institutionalization of the training program.** Converting to a fee based degree program will raise the bar on university education and computer science and will significantly contribute to strengthening the health informatics sector as it's own unique interdisciplinary field within Rwanda's rapidly growing health and informatics communities.

3.3.2 MVP

Overview

MGV-Net is designed as a comprehensive open source electronic health service delivery platform to function at MVP sites where health services are provided. MVP currently has nearly 180,000 patients (46,000 under 5 year olds, 87,000 15-49 year olds) and nearly 320,000 encounters recorded in the four OASIS databases. The MVG-Net also ideally generates data that can be used to track progress and inform decision-making and management throughout MVPs health intervention strategies. While leveraging both computer and mobile technology based applications that provide support at the point-of-care for community health workers (CHWs) and facility-based staff, MGV-Net ideally enables facility-based data capture of individual-level information, community-based data capture of individual-level information, data storage of individual patient health records, and provides an automated mechanism for aggregating data and generating reports and feedback to healthcare providers and managers.

Related to the capacity building focus area, the MVP / MVG-Net group met this challenge in this project period via **semi-formal workshops and on-the-job training** for the various primary users of the version of OpenMRS being implemented in the MVP sites (in addition to other tools, including the mobile tool Child Count+ which interfaces with OpenMRS). In addition to intensive training for a few individual programmers and data managers through the PIH training program in Rwanda (mentioned above), various degrees of continuing capacity building trainings for data entry staff as well as clinical care providers were designed as part of the MVP workforce strengthening approach in several sites in East Africa (although only Tanzania and Rwanda sites were included in this evaluation).

For the UFE, 5 in depth key stakeholder interviews were conducted in person and via phone and skype calls. The evaluation team was able to visit the MVP sites in both Mbola, Tanzania and Myange, Rwanda and interviews were conducted with a range of stakeholders – from data clerks to data managers, eHealth specialists with data management and technical support responsibilities, and site coordinators. One focus group with data clerks was conducted at the Myange, Rwanda site.

Issues and Considerations

There were some common challenges and gaps identified across the interview responses. Most importantly, **more human resources are needed to help cover the large implementations rolling out.** The few specialists that exist related to specific tools (OpenMRS and ChildCount+ are stretched very thin in terms of their work responsibilities**. In addition, nurses and clinicians who were envisioned to be primary users of eHealth and mHealth tools were not adequately trained in their use or incentivized to do so reliably in both sites.** This has resulted in the perception by the interviewees of patchy use of the systems by the appropriate end users and a disproportionate responsibility falling on the technical support staff to both promote the use of OpenMRS and mobile tools as well as actually engage the users for data entry and data management.

Compounding this, a simultaneous strength and weakness of the job training approach by MVP was to recruit, support and hire recent computer science university graduates to be primary OpenMRS and IT support personnel. This was a benefit as these individuals tended to be young, actively interested in learning about new technologies and their application in the field of health, and excited to take on new responsibilities within the MVP projects. However in some cases proved a liability in terms of hiring a cohort that had little (if any) project management experience and very little (if any) health sector training. **This finding reinforced the lesson learned mentioned above in the PIH training program section that topics beyond programming are critical to include in preparing an eHealth workforce that, at least for now, must be able to cover a range of support issues related to health services work flow and information flow.**

A major strength mentioned by the data clerks and eHealth specialists interviewed was related to the perceived increase in job and continuing education opportunities available to them to engage at a local level with an international community (both through OpenMRS and MVP's networks themselves).

Lessons Learned and Implications for Future Work

Additional critical factors to challenges identified at a MVP-wide level had to do with the perceived compartmentalization of eHealth tools as only part of the MVP and Columbia research projects and not really "owned" by MoH or local clinic staff in any way (in both Tanzania and Rwanda sites at least).

At the clinic level, nurses had been treating the eHealth program, especially OpenMRS, as a threat, and not as something that could/should facilitate their work flow. This had to do with major hurdles in the first few years of the MVP eHealth platform implementations where the MoH and MVP in Rwanda were essentially duplicating efforts in terms of data collection and reporting. Nurses have the historical experience of being tasked with a double workload when it came to information collection and management since they were required to continue to manage paper form systems for the MoH while at the same time transitioning to OpenMRS. There was very little buy in early on (or incentives) by the nurses to support the eHealth implementation. Over the course of the OASIS II project period some of these problems were solved at the political level between the MVP project teams and the MoH in terms of harmonizing reporting tools, however there was a general consensus among interview respondents at the local level that nurses were still not adequately trained in OpenMRS use or maintenance and perhaps more importantly, the nurses – potential primary users of

OpenMRS system outputs – were not really able to articulate if and how the eHealth tool implementations could improve information use, access, etc. **Buy-in was still somewhat minimal on the part of several important primary user groups and long-term sustainability of the MVG-Net was doubted by several key interviewees because of this.**

3.3.3 CommCare/D-Tree

Overview

The OpenROSA/D-Tree project was unique in the mix of the 4 OASIS II project partners in that it focused on **field-based primary eHealth tool user training** (rather than MoH centralized human resource training) in one implementation site in Dodoma, Tanzania where CHWs and their supervisors and site directors were trained in the implementation of CommCare – an application for use on mobile phones to support work performance for CHWs - for community based work in maternal and child health.

OpenROSA also employed the **"Coded In Country" (CIC) model of using local software developers in Tanzania to work on the site-specific version** of CommCare being used in Dodoma. These two complementary approaches were intended to cover the process of implementing an mHealth project in Dodoma throughout the design-development-modification-implementation-monitoring-maintenance lifecycle.

For the UFE, 6 key stakeholder interviews were conducted with developers and project staff at D-Tree and Dimagi (the group on the back end of the core CommCare application development). In addition, a 6 person focus group was conducted with CHWs and their supervisors in Dodoma by the evaluation team.

Issues and Considerations

The summary results indicate that focusing on community level end users (and the support staff at several levesl necessary to manage the overall project) was incredibly empowering for the CHWs themselves as well as their supervisors, in terms of initiating local interest in and ability to maintain community focused health projects, which in this case happen to have an "mHealth" component.

The complement to the community based capacity building on project management, information collection and basically critical thinking skills around project problem solving was complemented by a more directed technology capacity building focus with ITIDO, a Tanzanian NGO, that was supported in part by the OpenROSA OASIS II project.

Via directed trainings on CommCare module development and adaptation and via remote support from Dimagi and other JAVARosa community computer programmers, ITIDO was reasonably able to provide the local technology support necessary for the Dodoma implementation.

Lessons Learned and Implications for Future Work

Two critical elements were identified across the interviews and focus group results, including:

- **the importance of individual "champions"** of maintaining momentum around local ownership over the CommCare CHW project.

- **the flexibility that the OpenROSA group afforded to "slow down" and allow local empowerment to be a primary focus** of the project (when not necessarily linked to health outcomes or technology development goals)

This last point was articulated again and again by the CHWs and their supervisors and was key to leaving local partners feeling like they were engaged, involved and leading project directions by the end of the OASIS II project period.

3.3.4 Jembi Health Systems/MOASIS

Overview

Jembi Health Systems has focused their efforts on **developing and supporting in-country eHealth specialist 'nodes' in several countries in collaboration with a local university partner to directly support the Ministry of Health (MoH)**. Four nodes have been developed to date:

1. Jembi Health Systems and the School of Computer Science at the University of KwaZulu-Natal (UKZN-SCS) in South Africa
2. The Rwanda Health Enterprise Architecture (RHEA) project
3. The Mozambique Open Architectures, Standards and Information Systems (MOASIS) project and the University of Eduardo Mondlane (UEM) in Mozambique
4. The Center for Public Health Interventions (CEPHI) and the University of Zimbabwe

At the time of the UFE, full implementation was underway in Mozambique (MOASIS) and South Africa. The goal is that this model will strengthen the eHealth capacity of the MoH and by extension the national eHealth landscape. The MoH in both countries have generally struggled to retain skilled computer and information systems staff and this effort provides a unique solution to support ongoing consulting, development and implementation support services for the MoH with a public-private partnership model. Related, Jembi also focuses on the Health Enterprise Architecture Framework (HEAF) model to consolidate implementation experiences and 'patterns' into a methodology and set of artifacts that can be used to assist in generating country-specific architectures and promote reuse.

For the UFE, 5 in depth key stakeholder interviews were conducted in person and via phone and skype calls. The evaluation team visited the MOASIS offices in Maputo, Mozambique and conducted a focus group discussion with 3 members of the local developer team.

Issues and Considerations

Jembi's approach is unique in its' scope – targeting a national level support capacity from the beginning - and in the public-private partnership approach model. Rather than

try to support MoH internal capacity building or establish temporary completely external outside support from a non-national entity (international business, contractor or NGO), Jembi works with local partners (universities, local research groups and the non-government sector) to establish a specialized provider for MoH eHealth development and implementation services.

Several key interviews are summarized here that shed light on the critical upstream factors that have led to Jembi's success so far in both providing implementation support to the respective MoH while at the same time attracting significant project and system level donor funding for eHealth system strengthening:

- **strong relationships** with experts in the health information system space in each country (whether nationals or expatriates)

- **strong interest on the part of the MoH counterparts** with clear definitions of roles of collaborating partners (who does what and with what funding/support)

- **political agreements that document those relationships and protect developing programs and projects** through personnel changes in the MoH.

The last point – strength of agreement between Jembi, local partners and the MoH - was specifically identified by respondents as a key factor in maintaining forward momentum and proving for institutional memory of advances made in MoH eHealth systems progress milestones, even when MoH personnel changed one or several times over the course of a project phase.

Lessons Learned and Implications for Future Work

Interviewees, both internal and external to the Jembi team, mentioned that the "back to basics" approach by the OASIS node teams in both South Africa and Mozambique was a critical success factor so far. This is to say that when identifying capacity building and training targets within the OASIS node teams and MoH partners, **a key step was beginning with an orientation of the most basic health system work flows, basic information system management principals (including data management fundamentals) etc. for teams of technology implementers and their MoH end user counterparts.**

Another comment was echoed several times by respondents that in part Jembi's success with their increasing capacity at the local nodes to meet the MoH eHealth system support needs is based on **not being afraid to tackle the simple problems well, even when donors are pushing for certain eHealth or mHealth elements "of the moment**."

3.3.5 Critical Factors

All 4 principal groups involved in the implementation of OASIS II projects are committed to and have worked on the issue of local capacity building and eHealth workforce strengthening in East Africa. Each group has a different focus, approach and scope to operationalizing capacity building efforts.

Several Gaps were identified that point to suggestions for future training and capacity building focus topics:

- **More content focus (formally and informally) on the interdisciplinary nature of health informatics is needed.** Essentially technical experts and developers need to understand more about health care services, work flows and information flows (including data management and decision making contexts) in order to be able to fully engage in a support capacity for improving health service provision. Likewise, health care services providers – from MoH decision makers to doctors, nurses and community health workers – need to have a basic understanding of what the ICT tools and eHealth solutions landscape looks like (and where it's headed) in order to more fully engage as informed end-users of these tools throughout the design, development, adaptation and modification processes of eHealth system introduction and use in Africa;

- **More project management, professional development skills and agile problem solving approaches to eHealth tool / system use and maintenance is needed.** Respondents to interviews across all four projects consistently referred to a lack of codified focus on problem solving skills in local East and Southern African education systems (and universities and computer science programs in particular). Several key interviewees directly referred to how most of the eHealth and mHealth efforts (theirs respectively included) don't put enough time into capacity building in general and in specifically promoting and cultivating critical thinking on the parts of their trainees or project participants. Resources are not necessarily the bottleneck at this point in most projects - there are enough computers and cell phones available in all 4 project contexts that health informatics training programs as well as less formal capacity building efforts should focus more on shifting mentalities towards more adaptive, agile problem solving in basic eHealth intervention design, development and maintenance.

- **More focus on both "ends" of the partnership process is necessary - target both top down and bottom up capacity building efforts to include decision makers, implementers and programmers at upstream and end-user points.** Without all three kinds of stakeholders involved in actual implementations at scale (both as indirect support teams and at the clinic or field worker level), there is limited sustainability, regardless of funding available and local health priorities.

3 "upstream" inputs and activities across all 4 projects were identified as critical factors in each project's impact:

- **Engagement and involvement of local stakeholders early and often around content and format decisions** in design of workforce strengthening and capacity building efforts was crucial – when this element was weak or absent (and not corrected for adequately along the project lifetime), intended outcomes and impact was negatively affected

- **Investment in local "champions," coordinators, content designers, and support staff for implementation of programs** was key to maintaining

momentum and facilitating course corrections throughout both formal and less formal eHealth workforce strengthening activities over the life of the projects.

- **The individual "champions" amongst the OASIS II project leaders and the level of dedication in their teams to fundamentally changing the way that local eHealth workforces *should* be conceptualized in the future was a make-or-break factor in impact.** This is a more abstract factor to document, but the patterns seen in the in depth interviews across all 4 projects clearly indicate that where there were charismatic champions for local capacity building "from top to bottom" (ie. not just in developers or not just in policy makers) within the local institutional structures were present, beneficiaries/participants/end-users had much more confidence that lasting impact would result from those efforts.

- **Project oversight, management and monitoring frequency** was noted by several key interviewees in all 4 projects as an important factor affecting "course correction" throughout the projects' lifetimes. The scale at which oversight and capacity building efforts were monitored and managed made a difference – when it was perceived that there was limited actual interest and resources dedicated to oversight and implementation modifications for capacity building efforts (as an "afterthought" for example), both local participants/beneficiaries as well as project team members and trainers felt undervalued and even resentful of those efforts.

4. Output Utilization Plan

In addition to the UFE findings hopefully being useful for 1) each core project group to reflect on relative to their particular next steps with ongoing initiatives, and 2) to share with local collaborators and partners, one of the specific intended uses of this UFE's findings was to generate data, research and analysis methodologies and results for discreet peer reviewed publications in the ICT4D, eHealth, and health system strengthening literature.

Potential Publications

In identifying unique and concrete components of the OASIS projects to target for publications, it is important to keep in mind that the OASIS projects for the most part are action research and reporting on action research is different than more traditional health intervention research and information systems research.

Three points are important to keep in mind relative to publication strategies for action research:

- This kind of research does not lend itself to hypothesis testing because the shape the research takes is emergent rather than prearranged form (start with outcomes and work backwards to tease out key factors).

- The majority of the extant ICT4D and eHealth sector papers are single case studies. With the OASIS projects, there is a unique opportunity to compare across multiple countries and 2 focus areas (in this UFE).

- In addition, in most extant publications, building local capacity and creating interoperability frameworks are two elements that, if mentioned at all, are almost always done as "next steps" or "future directions" rather than being the subject of existing interventions – the OASIS projects are innovative in this way alone.

Following a facilitated brainstorming session with the 4 PIs mid-evaluation (June 2011), the following 3 publications were identified as initial targets for UFE findings utilization, always with the goal of sharing lessons learned with the wider eHealth and ICT4D communities.

1. "Concept paper on the MCL: A new approach to collaborative development of [well architected] maternal health information systems in developing countries"

This paper will focus in large part on policy issues around the processes and methodologies for adopting shared concept dictionaries as an approach to any health domain area where there's currently a duplication of efforts.

Initial journal target for this publication is the *Journal of the American Medical Informatics Association.*

2. "Rawanda Health Enterprise Architecture (RHEA): Lessons learned in the eHealth interoperability landscape in Rwanda"

Telling the Rwanda OASIS interoperability landscape development story, capturing the experiences of the 3 OASIS partners involved there (PIH, MVP and Jembi) and identifying critical factors that may help inform similar national-level eHealth system interoperability decisions and initiatives in other countries.

Initial journal target for this publication could be the journal of *Health Affairs* and or the *International Journal of Medical Informatics.*

3. "eHealth workforce strengthening in limited resource settings: approaches across OASIS projects in East and Southern Africa"

Comparing approaches across projects and identifying unique elements as well as common themes, challenges and opportunities. Deeper review and analysis of the code logs within the Dedoose database (built and maintained by the evaluation team) will be necessary for the in-depth interviews.

Target journal could be *Health Affairs, International Journal of Medical Informatics* or *PLoS Medicine.*

Research tools applicable for other eHealth evaluations

Although by definition a UFE engages relevant stakeholders throughout the evaluation process – including the design and validation of research tools – we suggest that the interview guides developed for both focus areas here could be relevant to future related eHealth initiatives. Although the content specific to the "MCL" and "Rwanda Oasis Landscape" case studies is unique to the particular tools being developed in the OASIS II projects (and related initiatives), the general interview guide questions related to how interoperability is conceptualized from various stakeholders in the eHealth community

should be relevant to other ongoing or future projects. Likewise, the interview guides for the various kinds of actors involved in eHealth workforce strengthening could easily be used in other projects to evaluate efforts with similar goals to those of the OASIS II projects.

Acknowledgements

Appendix A: OASIS II Project Objectives

I. OVERALL OASIS II PROJECT OBJECTIVES:

ICT/Health integration:
To evaluate various technical and operational effects of deploying eHealth solutions within the health care systems at the different reference implementation sites

Local capacity:
To build the capacity of health practitioners (community health workers, nurses, midwives, doctors, etc), software developers and policy makers through training programs, evidence-based advocacy campaigns and targeted research communication activities.

Health outcomes:
To develop a theory of change and general research methodology framework based on the research question: Do open and interoperable Health Information Systems (HIS) improve the quality, timeliness and use of data toward the achievement of better health outcomes in low resource health systems? If so, what technical and operational factors contribute to the improvement?

Interoperability/Architecture:
To develop and publish the specifications of a robust, scalable and interoperable open eHealth enterprise architectural framework, based on reference implementations, to allow for the construction and deployment of interoperable eHealth systems for developing countries –with an initial focus on African countries.

Process Learning/Collaboration:
To strengthen collaboration within and between different FOSS-based communities such as OpenMRS and OpenROSA.

II. SPECIFIC OBJECTIVES

Objectives for OASIS Core Project
(Managed by Jembi Health Systems, South Africa)

Continue to investigate the implementation of a sustainable network of OASIS FOSSIL (Free and Open Source Software Implementation Labs) nodes in South Africa, Mozambique and Zimbabwe, developing relevant health information systems using open technologies and supporting Ministries of Health (MoH) and other in-country partners and harmonizing with other members of the OASIS II network;

Support the OpenMRS implementers and developer's network and expanding support into other African countries through activities such as the annual OpenMRS Implementers meeting and the OpenMRS Internship Program (OIP), and;

With inputs from other project leaders, coordinate the OASIS II project, including development of the research methodology, regular meetings, research outputs and overall evaluation and communication plans for the project.

Objectives for Open Architecture Project
(Managed by Jembi Health Systems, South Africa)

Developing and evaluating a first version of an eHealth Framework Architecture consisting of (i) a general methodology for architectural framework development and customization for eHealth, and; (ii) a library of software modules that can be used to assemble health information systems, including relevant health informatics standards, reviews of current successful experiences and an eHealth Toolkit that can be used to assess the country readiness to deploy an integrated eHealth system;

Investigate the benefits of an application of an enterprise architecture approach to designing well-formed eHealth and health information systems for developing countries, with an initial focus on selected reference implementations in one or more African countries, and;

Investigate the feasibility of developing a global collaborative of contributors to the development of enterprise architecture as well as relevant building blocks and artifacts in African countries.

Objectives for Millennium Villages Project (MVP)
(Managed by MVP)

Build capacity of OpenMRS data managers and eHealth specialists at pre-identified MVP sites;

Assess the deployment of OpenMRS and eHealth specialists to pre-identified MVP sites Create a common multi-lingual, multi-national data dictionary with maps to reference terminologies, based on open source tools;

Create a multi-lingual, multi-national, patient-level data warehouse for research purposes.

Objectives for OpenROSA and CommCare
(Managed by D-Tree International)

Promote the Coded in Country initiative, and evaluate a variation of the OpenMRS internship model in which junior African developers are hired for longer, full-time internships to work on projects relevant to OpenROSA with paid mentors;

Conduct a study comparing community health workers (CHWs) with and without the CommCare system to assess whether CommCare can improve CHW and client behavior;

Better documentation of the XForms standard and strengthen the integration of OpenROSA and OpenMRS in order to leverage the success of the OpenMRS network as well as to provide useful tools to both communities;

Continue to support and expand the OpenROSA network, and document the growth of the network (eg consolidating the code of JavaROSA under ownership of a single open source license) as well as what tools and techniques were most effective at promoting collaboration among mobile health (mHealth) projects.

Objectives for Partners in Health (Rwanda) Training
(Managed by PIH)

Develop a cyclical technical training and mentoring program for Rwandan junior programmers and students to build up the capacity required to roll out OpenMRS in Rwanda for improved healthcare, linking this to universities and the eHealth center;

To identify health management needs in partnership with the Government of Rwanda, and to develop and deploy customized OpenMRS software modules for application within the health sector in Rwanda to support the electronic medical record (EMR) rollout and the eHealth architecture project;

To undertake the documentation and evaluation of the technical training program and the software tools developed in order to assess the effectiveness of the program and the ways in which it impacts the technical and policy goals in Rwanda and internationally.

Appendix B1: eHealth Workforce Strengthening Interview Guide -- Funders

This interview guide was developed for intended uses with stakeholder targets including **funders, managers, program advocates, decision makers**

__Interview guide notes --__ Interview guides are to be loosely followed during semi-structured interviews and for each interviewee not all questions are relevant.

I. general "who are you" intro questions or data to collect:

DEMOGRAPHICS:
- name (optional)
- citizenship
- country where you work
- age
- gender
- what's your educational background?
- country(ies) where you received your education

II. questions about the program/CB effort:

GENERAL eHEALTH WORKFORCE STRENGTHENING THOUGHTS:
- How do you and your organization view the need for eHealth worksforce strengthening in Africa?
- What kinds of specific skills and skill sets are missing from the landscape at present in your opinion?

HISTORY OF INVOLVEMENT WITH OASIS II PROJECT(S):
- How did the focus on eHealth workforce strengthehing work arise and develop in your projects?
- How did you become aware of [relevant OASIS project] and what was your role relative to it?

FOCUS ON BENEFICIARIES:
- Who were the primary targets (and please list all if there were several) for eHealth workforce strengthening efforts in this case as you understand it?

CONTENT:
- What were the original major goals / content targets for capacity building efforts -- what specifically were the content objectives with changing/improving human resources (for example, data management, eHealth decision making, eHealth project design/development/implementation, programming)?
- Have any of these goals or objectives changed as the project / program has been implemented? How so?
- What were the strengths and weaknesses of this approach in your opinion?

- Was there a focus on project management in general or professional development skills? why or why not? How important is this element in eHealth capacity building in your experience?

IMPACTS:
- In your opinion, what were the major accomplishments and achievements relative to this case?
- What aspects are you particularly proud of or think are unique and worth elaborating on?
- What are the most important impacts in your opinion of this effort?

UTILIZATION OF LOCAL eHEALTH WORKFORCE RESOURCES:
- How successful do you feel that this program / these efforts have been at reducing dependence on foreign staff and experts?
- Has the program / effort helped to raise awareness about the need for eHealth specialists?
- What is the supply/demand landscape for health informatics specialists in your country and how do you think this program has addressed that -- created demand? created supply? both?

SUSTAINABILITY, FUTURE DIRECTIONS AND NEXT STEPS:
- How do you think the training program/effort can become sustainable to the extent that there is local support/funding to maintain this kind of effort?
- Where do you see the future of this program going?
- What are the critical factors in your opinion that will affect future directions or next steps?
- What are the critical local context factors that will affect the future success of these kinds of efforts here / where you are? (for example, political, economic and cultural factors)

Appendix B2: eHealth Workforce Strengthening Interview Guide -- Trainees

This interview guide was developed for intended uses with stakeholder targets including **trainees, beneficiaries, program participants**

*Interview guide notes -- Interview guides are to be loosely followed during semi-structured interviews and for each interviewee not all questions are relevant.

I. general "who are you" intro questions or data to collect:

DEMOGRAPHICS:
-   name (optional)
-   citizenship
-   country where you work
-   age
-   gender
-   what's your educational background?
-   country(ies) where you received your education
-   what languages do you speak and what languages can you train in / participate in trainings in?

eHEALTH INVOLVEMENT:
-   What projects/organizations have you worked for?
-   Where do you work now?
-   What other eHealth or health informatics-focused groups (companies, groups, etc.) exist in your country?

eHEALTH EXPERIENCE:
-   How many years have you worked on eHealth or health informatics projects?

eHEALTH TRAINING:
-   Have you participated in any formal eHealth or health informatics training?
-   Which program/course/workshop? when?
-   What was the overall goal of the training?
-   Was it relevant to the work you do?
-   Relative to the work that you do, what other topics or skills would be useful to you?

II. questions about the program/CB effort:

HISTORY:
-   How did the focus on [capacity building/training program/eHealth workforce strengthening work] arise and develop in your projects?
-   When, who was involved, who funded and initiated the focus on capacity building?

BENEFICIARY FOCUS:

- Who were the primary targets (and please list all if there were several) for capacity building efforts in this case?
- How were individuals selected or involved in these efforts?

CONTENT FOCUS:
- What were the original major goals / content targets for capacity building efforts -- what specifically were the content objectives with changing/improving human resources (for example, data management, eHealth decision making, eHealth project design/development/implementation, programming)? have any of these goals or objectives changed as the program has been implemented? why?
- What is the primary training or CB program mechanism -- in person classes, remote mentorship, etc? what were the strengths and weaknesses of this format in your opinion?
- What tools or programming environments did your program focus on? why these?
- Was there a focus on project management in general or professional development skills? why or why not? how important is this element in eHealth capacity building in your experience?

ACTIVITIES, HISTORY, CONTENT FOCUS:
- How was the training or capacity building program developed - who had input on curriculum?
- How were topics/content decided on? how was the program or curriculum tested/vetted? was this based on any evaluation or assessment of capacity and/or need prior to the program?
*TYRING TO GET AT WHETHER THERE WAS ANY SORT OF GAP ANALYSIS DONE TO INFORM THE EFFORT'S CONTENT BEFORE/DURING IMPLEMENTATION

IMPACTS:
- What were the major accomplishments and achievements in your opinion relative to this case?
- What were the strengths of this particular program?
- What aspects are you particularly proud of or think are unique and worth elaborating on?
- What are the most important impacts (positive, negative, both) in your opinion of this effort?

UTILIZATION of LOCAL RESOURCES / TRANSFER of RESPONSIBILITY:
- How successful do you feel that this program / these efforts have been at reducing dependence on foreign staff and experts?
- How well did you think the beneficiaries of the effort/program have been able to apply their skills in subsequent work?
- Has the program / effort helped to raise awareness about the need for eHealth specialists?

- What is the supply/demand landscape for health informatics specialists in your country and how do you think this program has addressed that -- created demand? created supply? both?
- How do you think the training program/effort can become sustainable to the extent that there is local support/funding to maintain this kind of effort?

CHALLENGES:
- What were the major challenges with the program -- at what stages?
- With what kinds of inputs (funding, trainers, logistics, continuing mentorship, etc.)?

LESSONS LEARNED:
- What are the lessons that you learned in your role relative to the program / case?
- What would you do differently next time or in the future?
- What would you caution others about beginning a new program / cap. building effort?

FUTURE DIRECTIONS / NEXT STEPS:
- Where do you see the future of this program going?
- What are the critical factors in your opinion that will affect future directions or next steps?
- What are the critical local context factors that will affect the future success of these kinds of efforts here / where you are? (for example, political, economic and cultural factors -- be sensitive given the role/institution of person)

Appendix B3: Interoperability Interview Guide – MCL

Interview guide notes -- Interview guides are to be loosely followed during semi-structured interviews and for each interviewee not all questions are relevant.

I. general "who are you" intro questions or data to collect:

DEMOGRAPHICS:
- name (optional)
- citizenship
- country where you work
- age
- gender
- what's your educational background?
- country(ies) where you received your education

eHEALTH INVOLVEMENT:
- What projects/organizations have you worked for?
- Where do you work now?
- What other eHealth or health informatics-focused groups (companies, groups, etc.) exist in your country?

eHEALTH EXPERIENCE:
- How many years have you worked on eHealth or health informatics projects?

CURRENT PROJECTS:
ask interviewee to describe what they are currently working on, if applicable. try to get information on:
- the tools/IT systems involved, where they are implemented, the scale of the implementation and what they are used for
- what is the model for local ownership/ ongoing development/ support? who the original developers where, which organization(s) are the developers now, which organization(s) provide support. is there a local group?
- any involvement in interoperability/reusability projects? current status of the project and who was involved.

II. specific questions relevant to the MCL case study

INVOLVEMENT IN MCL TO DATE:
- How have you been involved in MCL project?
- When and how did you first learn about MCL? How was it described to you?
- When and how did you first become involved and what was your involvement?
- *[if vounteer]* Working on this project as a volunteer, why do you think it is a valuable use of your time (or not if you decided to opt out)?
- *[if NOT vounteer]* Why have you chosen to spend some of your time on MCL? what is the value of it relative to your work?

INTEREST IN AND UNDERSTANDING OF MCL:
- What do you understand about how the MCL started and what it's goals are?
    - o [*if involved for a while*] has this changed/evolved since you first became aware of MCL? If so, why?
- In what ways are you using MCL now?
    - o How do you see it being useful in the future?
- How do you think interoperability/re-usability is understood in the MCL?
- Why do you think a group like this is important?
    - o [*If you are using it*] why is important to your group?
    - o [*If you are not using it*], why might it be important to other groups?

BENEFITS AND CHALLENGES:
- Can you explain benefits that using MCL has provided to you/your group or that you think it will provide in the future?
- What are the key factors that will allow you/your group to adopt MCL?
- In your opinion, what are the key drivers of the adoption of MCL for your group?
    - o are they local or external?
    - o decision-makers or developers?
    - o if individuals or the whole group are particularly strong supporters, why do you think this is?
    - o if individuals or the whole group are somewhat resistant, why do you think this is?
- What are the factors that will impede you/your group's use of MCL to you/your group adopting MCL?
    - o are there technical barriers?
    - o are there implementation barriers?
    - o are there organizational capacity barriers?
    - o what are the large barriers?
    - o what are the smaller barriers?
- Often it is easy to see long-term benefits to something, but hard to justify adoption without knowing there are short-term benefits as well.
    - o How could MCL make your life easier now / provide a short term benefit (how could we increase short-term drivers of adoption)
    - o How could we make adopting MCL easier? (how could we decrease barriers to adoption/ risks associated with adoption?)
    - o What would have to be added to get to this point?
- What other interoperability/reusability efforts are you aware of?
    - o How do these compare
        - ▪ in terms of the problem they address?
        - ▪ in terms of their organizational structure or approach?
    - o Are you/ your group involved in other interoperability/reusability efforts?
    - o What are the relative advantages and disadvantages of MCL compared to other interoperability/reusability efforts?
- Do you see the MCL approach influencing the eHealth space overall? How?

LESSONS LEARNED:
- Based on your involvement with MCL, would you say the project has been successful?
    - o What has it been successful at?
    - o What has it been slow/unsuccessful at?
    - o Why do you think MCL has been able to get a relatively large number of people interested in it?
    - o Do you think focusing on a single health domain (or one at a time) is a good approach?
- What lessons have been learned from this particular case that you think are important to communicate?
- Anything you'd do differently?
- What would you tell someone in eHealth who is doing a similar project (or continuing work on this project)?
- What would you tell policy-makers or other health systems decision-makers about the importance and/or challenges of interoperability/reusability?
- Are there research findings you think should be reported - either from your/your group's work or from other work that you know about?

Appendix B4: Interoperability Interview Guide -- OASIS II Rwanda Roadmap

This interview guide will be used for people who are either:
- OASIS II PIs; or
- Were involved in the PIH/MVP concept dictionary mapping work; or
- Were involved in SDMX-HD development

The purpose of these interviews is to develop a descriptive case study and associated relationship maps of OASIS II interoperability work in Rwanda, focusing particularly on technical achievements (PIH/MVP concept dictionary mapping; SDMX-HD).

Interview guide notes -- Interview guides are to be loosely followed during semi-structured interviews and for each interviewee not all questions are relevant.

I. general "who are you" intro questions or data to collect:

DEMOGRAPHICS:
- name (optional)
- citizenship
- country where you work
- age
- gender
- what's your educational background?
- country(ies) where you received your education

eHEALTH INVOLVEMENT:
- What projects/organizations have you worked for?
- Where do you work now?
- What other eHealth or health informatics-focused groups (companies, groups, etc.) exist in your country?

eHEALTH EXPERIENCE:
- How many years have you worked on eHealth or health informatics projects?

CURRENT PROJECTS:
ask interviewee to describe what they are currently working on, if applicable. try to get information on:
- The tools/IT systems involved, where they are implemented, the scale of the implementation and what they are used for
- What is the model for local ownership/ ongoing development/ support? who the original developers where, which organization(s) are the developers now, which organization(s) provide support. is there a local group?
- Any involvement in interoperability/reusability projects? current status of the project and who was involved.

II. specific questions relevant to the OASIS Rwanda interoperability case study

INVOLVEMENT:
- How have you been involved in the project? How did you first become involved and and what is your role now?
- What are the job responsibilities you have for this project?
- If you are working on this project as a volunteer, why do you think it is a valuable use of your time?

ACTIVITIES:
- How did this interoperability work arise and develop? When, who was involved, who funded?
- How is interoperability/re-usability understood in this case?

TECHNOLOGIES:
- What tools/standards are being used? Why were these chosen?
- What technical challenges were involved in the development of this interoperability project? How were these overcome?
- What implementation/management challenges were involved in the development of the technical solution?

OWNERSHIP/LOCAL CAPACITY/STRATEGY
- Who were the original developers?
- Which organization(s) are the developers now, if any (is there a local group/is this planned)
- Which organizations provide support (is there a local group/is this planned)
- In your opinion, the key drivers of the inclusion of an interoperability/reusability component (if part of existing Bigger project) or of the project getting off the ground (if specific interoperability project)
  - are they local or external?
  - are they developers or decision-makers?

BENEFITS AND CHALLENGES:
- Would you say the project has been successful? what benefits has it had?
- Any challenges you are aware of in this project?

FUTURE WORK:
- What is the current status of the project? Future plans for this project or other interop work?
- How are tools/standards/processes being documented?
- Is there work being done to promote adoption by others?

LESSONS LEARNED:
- What lessons have been learned from this particular case that you think are important to communicate?
- Anything you'd do differently?
- What would you tell someone in eHealth who is doing a similar project (or continuing work on this project)?

- What would you tell policy-makers or other health systems decision-makers about the importance and/or challenges of interoperability/reusability?
- Are there research findings you think should be reported?
- What do you think is most important to do next in terms of developing interoperable/reusable tools/systems - in this project or in others?

GENERAL INTEROPERABILITY/eHEALTH LANDSCAPE QUESTIONS:
- What is your opinion on the general state of interoperability/reusability in eHealth in Rwanda?
- In what ways has the RHEA initiative helped move interoperability efforts forward?
- What are the drivers and barriers?
- What have the OASIS projects contributed?
- What should the next steps be?

Appendix C: Interview Protocol and Consent Form

Introduction
- Greeting and Name
- I am working with a research team for the OASIS II project
- We were given your contact details by [PI or other] from [organization or project]

Mission
We are doing a study to understand the work OASIS II and related projects have been doing in the areas of eHealth capacity-building and interoperability. I am part of a 3 person team working with the OASIS II project leaders between now and August to undertake this study. [Heather Zornetzer/Melissa Loudon/Justine Esquivel -- depending on who's doing the interview] are the other researchers that I work with.

We are involved in this study along with [relevant PI] but are not directly part of his team/group. We are hoping to have as many people as possible sharing their opinions in the study, and we appreciate your willingness to talk to us.

Participation in Research
- If you participate in the research, you will be asked a series of questions in the form of an interview.
- How long do you have available? The interview should take a maximum of one hour.
- You are not required to participate in this study. It will not affect your involvement with OASIS II or other projects.
- We do not anticipate that any benefit or harm will come to you from participating and answering these questions.
- You do not have to answer any questions you are not comfortable answering.

Confidentiality
- We will not share meeting notes, recordings or direct transcripts beyond the evaluator team. Summary notes and anonymous quotes may be shared in the final report.
- Qualitative interviews are the majority of our study and quotes are very important. However, we will only quote you by name with your permission.
- We would like to include your name, institution, projects you are involved with and contact details in an online directory to share with OASIS II project partners and collaborators. Is this ok?

☐ YES ☐ NO

- If documents are collected these documents will be shared within our study team. May we also share them back with [PIs / relevant OASIS project lead name]?

☐ YES ☐ NO

- Are there parts of the document that are confidential? [budgets, etc.]

☐ YES ☐ NO

If yes, please note: _____

Interview Procedure
- If you choose to participate, please answer the questions as best as you can. You can choose to skip any questions as you see fit.
- There are no right or wrong answers. We are most interested in your opinion.

Permission to Record Interview
- I would like to record the interview. Would it be OK if I used the voice recorder?

☐ YES ☐ NO

Permission to Take Notes During Interview
- I would like to take notes during the interview and direct observation, would that be OK?

☐ YES ☐ NO

Permission have someone else call in to listen and perhaps ask a few additional questions
- [Healther or Melissa] would like to call in and listen to the interview over the phone/over skype. Would that be OK?

☐ YES ☐ NO

Questions and Consent
- Do you have any questions regarding the research?

☐ YES ☐ NO

if yes, note questions and do your best to answer; if necessary, follow up with answers once you've had a chance to check in with Melissa/Heather/PIs as necessary/appropriate

_____

_____

_____

- Would you like to participate in this study?

☐ YES ☐ NO

Results
- We will make a final report available to all participants by email.
- Can we contact you to follow up on this interview if we need to? What is the best way to do this (email/phone)?

☐ YES ☐ NO

☐ email_____ ☐ phone:_____

▪▪▪

TO BE COMPLETED BY INTERVIEWER FOR EACH INTERVIEW
copy and paste this form at the end of each interview transcript or notes document

☐ Subject Verbally Consents to Participate in Research
☐ Subject Verbally Consents to Tape-Recording Interview
☐ If documents are collected, subject has been asked if they can be shared with PIs

Name of Subject:_____

Interview Date: _____

The participant verbally consents to partake in the study and is allowing the researchers above to use information shared in the interview for research purposes only. I have ensured that the participant understands that his/her name will not be shared and that he/she does not need to answer any questions he/she does not wish to.

Signature of Interviewer: _____

Name of Interviewer: _____

Appendix D1: WEB SURVEY eHWFS - PIH eHealth Training Program Participants

Hello!

You're receiving this email because you participated in a Partners In Health / Rwandan Ministry of Health joint eHealth training program. As part of an evaluation of this program we are conducting a very short web survey to learn about your experience in the training program, and how it could be improved in the future. Your participation would be greatly appreciated! The survey is anonymous unless you choose to provide your name. It should take no more than 10 - 15 minutes. Thanks in advance on behalf of the evaluation team and the PIH eHealth program team.
* Required

Demographic Information About You

These questions help us understand a bit about who you are.

Q1. Name (optional)

Q2. Citizenship *
- ◯ Rwanda
- ◯ Other:

Q3. Country where you currently work *
(Please select all that apply and use "other" to list others not on the list)

◯ Rwanda	◯ Tanzania
◯ Kenya	◯ USA
◯ Uganda	◯ Other:

Q4. Age *

◯ 15-20	◯ 36-40
◯ 21-25	◯ 41-45
◯ 26-30	◯ 46-50
◯ 31-35	◯ Other:

Q5. Gender *

◯ female	◯ male

Q6. What is the level of education you've reached up until this point? *
(Please use "other" to specify any other relevant information)

◯ high school	◯ at least 1 year of university study

○ completed university study   ○ post-graduate study

○ post-university graduate study   ○ Other:

Q7. Countries where you received your education *

(Please select all that apply and use "other" to list country names if outside of Rwanda)

○ Rwanda

○ Other:

Q8. Please tell us about any additional technical certifications/non-university training you've had *

(for example MCSE or CISCO academy or others)

Q9. What languages do you speak and feel comfortable participating in trainings in? *

(Please select all that apply and use "other" to list additional languages if necessary)

○ Kinyarwanda   ○ French

○ English   ○ Other:

eHealth Involvement

These questions help us understand a bit about what kinds of eHealth projects and work you've been involved with.

Q10. What organizations and/or projects have you worked for in the past? *

Q11. Where do you work now? *

(Please list the name of the organization and/or the project and what your role is)

Q12. What other eHealth or health informatics-focused groups do you know of in Rwanda? *

Q13. How many years have you worked on eHealth / health informatics projects? *

○ < 6 months   ○ 2 - 5 years

○ 6 months - 1 year   ○ >5 years

○ 1 - 2 years   ○ Other:

eHealth Training Program - CONTENT

These questions help us understand what your experience was like in the eHealth training program that PIH was involved with.

Q14. What format types of the program were most useful to you? *

(Please select all that apply and use "other" to include other elements as necessary)

☐ formal classroom lectures   ☐ individual or group projects

☐ hands-on learning sessions (on computers)   ☐ one-on-one time with instructors

☐ Other:

Q15. What course materials were useful to you both during and after the course? *
(Please check all that apply and use "other" to include ones we may not have on the list)
☐ slides or handouts used during the course
☐ tutorials and guides available on the OpenMRS wiki
☐ demo sessions and examples of modules, etc.
☐ Other:

Q16. How useful did you find the content in the PROGRAMMING section of the course? *
(Please use "other" to add any other opinions on this question)
○ helpful and relevant to my work
○ interesting, but not relevant to my work
○ interesting but needed more time/emphasis on this topic
○ not interesting or relevant to my work
○ Other:

Q17. How useful did you find the content in the DATA MANAGEMENT section of the course? *
(Please use "other" to add any other opinions on this question)
○ helpful and relevant to my work
○ interesting, but not relevant to my work
○ interesting but needed more time/emphasis on this topic
○ not interesting or relevant to my work
○ Other:

Q18. How useful did you find the content in the FUNDAMENTALS OF HEALTH INFORMATICS section of the course? *
(Please use "other" to add any other opinions on this question)
○ helpful and relevant to my work
○ interesting, but not relevant to my work
○ interesting but needed more time/emphasis on this topic
○ not interesting or relevant to my work
○ Other:

Q19. How useful did you find the content in the PROJECT MANAGEMENT section of the course? *
(Please use "other" to add any other opinions on this question)
○ helpful and relevant to my work

○ interesting, but not relevant to my work

○ interesting but needed more time/emphasis on this topic

○ not interesting or relevant to my work

○ Other:

eHealth Training Program - IMPACT

These questions help us understand what kinds of impact this program has. Remember that your answers are anonymous (even if you included your name, we won't identify you with your opinions in this section). Our goal is to help improve the program in the future, so your constructive input is very valuable to us.

Q20. What were the strengths of this training program in your opinion? *

Q21. What were the most important things you learned in this program? *

Q22. How well do you feel this program prepared you for the "real world" of working in eHealth in Rwanda or other countries? *

Q 23. Are there other course topics related to eHealth that you think should be included in this program or a complementary one? *
(Please elaborate)

Q24. What other PROFESSIONAL SKILLS DEVELOPMENT content areas would be useful to include in this course in the future? *
(Please elaborate)

Q25. What were the weaknesses of this training program in your opinion? *

Q 26. What suggestions do you have for the instructors on how to improve the program in the future? *(
Please think about factors like whether there was enough time to cover the material over the course of the program… Whether there were enough instructors and how well prepared they were... Whether other formats for the course could have been useful... etc.)

Appendix D2: WEB SURVEY Interoperability - MVP/CIEL Concept Dictionary User Survey

Q 1. Your name (optional)

Q 2. Your organization (optional)

Q 3. Which of the following describes your organization?
1. We develop medical informatics software
2. We implement medical informatics software for other organizations
3. We implement medical informatics software in-house/for our own use
4. We are an academic organization or only doing research
5. Other (please specify) _____

Q 4. In which country(s) do you work?

Q 5. Are you using the MVP concepts in OpenMRS?
1. Yes
2. No

Q 6. Which OpenMRS version?

Q 7. How are you using the MVP/CIEL concept database?

Q 8. Did you have any problems downloading the concepts and loading them into your system?
1. No problems!
2. Yes...

Q 9. Please tell us about any problems you have downloading the concepts and loading them into your system

Q 10. Did you find the concepts you needed?
1. Yes
2. No...

Q 11. Please tell us what concepts were missing, or provide a link to a spreadsheet (for e.g. in Google Docs)

Q 12. Have you requested any new concepts from MVP/CIEL?
1. Yes
2. No   (please tell us why not) _____

Q 13. Were you primarily looking for crossmaps (mappings between different concept dictionaries)?
1. Yes
2. No

Q 14. What do you need crossmaps to?
1. SNOMED
2. ICD-10
3. other (please specify) _____

Q 15. Tell us how you would use crossmaps

Q 16. What would you like to see to make the concept database work better?

Q 17. Are you familiar with the Maternal Concept Lab (MCL)?
1. Yes
2. No

MCL - the Maternal Concept Lab - is an initiative to develop a shared set of core concepts for maternal health, as well as concept mappings and e-Health and m-Health tools for the maternal health domain. MCL search also allows you to search the MVP/CIEL dictionary easily

Q 18. Are you are likely to use the following in your work? Please choose all that apply.
1. MCL core concepts
2. Concept mappings between dictionaries
3. eHealth and mHealth tools build around the MCL core concepts
4. MVP/CIEL dictionary search
5. None of the above (please tell us why not) _____

Q 19. Are there other health domain topics besides maternal and child health for which you think an initiative like MCL would be useful?
1. HIV
2. TB
3. Non-communicable diseases (which ones?) _____
4. Other (please specify) _____