Development Engineering

CSEP 590 B
Engineering the Immunization Cold Chain
Richard Anderson

Today

• Announcements
• Some general themes
• Mapping the immunization cold chain
• Discussion of Uganda deployment

Announcements

• Discussion Sections – Zoom – Attend one
  • Wednesday: 3:00-4:00 pm
  • Wednesday: 5:00-6:00 pm

• Homework 1, Due April 13.
  • Submit by email
  • Course grade based on 7 of 9 assignments
  • Defer questions on HW1 until end of class


Course Schedule

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<td>April 6</td>
<td>Engineering the Vaccine Cold Chain</td>
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<td>April 13</td>
<td>Community Cellular Networks</td>
<td>Kurtis Helmert</td>
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<td>April 20</td>
<td>Remote Temperature Monitoring</td>
<td>Martin Lukac, Nedelef</td>
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<td>April 27</td>
<td>Election Monitoring</td>
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<td>May 4</td>
<td>Social Based Social Networks</td>
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Development Engineering

Technological interventions to improve human and economic conditions in low-resource settings

An engineering discipline aimed at addressing global inequity

Develop principles for design, introduction, scaling, and sustainability of Global Good technology

Engineering

• Domain Understanding

• General Principles
Case study approach

- Engage with individual examples
- Extract transferable knowledge

Today – The immunization cold chain

General Issues

- Top down management of global development
- Global Goods software
- Designing for users

Global Development

- Global organizations set policy
- Donors
- Country ministries

Global Goods Software

- Software systems for global development
  - Health data reporting, medical records, human resource management, health insurance, logistics
  - Goal of Global Goods software is to have a positive impact
  - Generally, Open Source, but different models
  - Many projects depend on donor support
  - Projects often have a fairly long history
  - Barriers to entry

Designing for the user

- Common conflict between “purchaser of system” and user of the system
- Information systems may make overall system more efficient, but the actual users do more work
- In development setting, Global Organizations and Country Ministries set policy and are the “customers”
Mapping the Global Immunization Cold Chain

Richard Anderson
University of Washington

Problem: How do we count every vaccine refrigerator in the world?
- Mapping the global immunization cold chain
- Construct an accurate cold chain equipment inventory for all low- and medium-income countries

Why is this an interesting Development Engineering problem?
- Address the problem of taking DevEngr interventions to scale
  - How does the field have impact
  - Difference between pilots and sustainability
  - Examples: 99 Dots, Digital Green, DHIS2
- Understanding “Global Good” Software
  - Creating, deploying, and sustaining low-cost software platforms
  - Open source software in global health eco-system

Why this is important: Immunization
- One of the world's most effective health interventions
  - Wide coverage of basic vaccines
    - Diphtheria, Pertussis, Tetanus: 77% in poorest countries
    - Tremendous reduction in deaths
    - Some diseases close to elimination

Why this is important: Immunization Logistics
- Vaccines need to be kept in a given temperature range
  - Spoil if vaccines freeze
  - Spoil if above 8 degrees for extended period of time
  - Facilities must store between 1 to 3 months of stock

Why this is important
- This information is critical for decision making for managing the global immunization cold chain
Immunization Domain Background

- Vaccines are the same around the world
- For many countries – immunization is managed and funded globally

Immunization Cold Chain Challenges

- Ensure that all countries have high quality vaccine cold chains
- Working equipment at all points in vaccine supply chain
- Sufficient capacity for vaccines
- Refrigerators need power
- Grid power, Solar power, Gas, Kerosene
- Many areas suffer from regular power outages
- Desire to replace Kerosene / Gas equipment with Solar
- Equipment upgrades
  - Identify needs and determine order size
  - Remove obsolete equipment
  - Ensure proper installation
  - Establish repair infrastructure
  - Monitoring of equipment condition

My background in immunization logistics

- Sabbatical with PATH (2008-2009)
- CCEM Project
- Country projects: Nicaragua, Kenya, Zimbabwe, Malawi, Nigeria, Ghana, Uganda, India, Pakistan, Laos
- Multiple projects on cold chain information systems
- DHS2 for Cold Chain Inventories
- SMS Temperature Reporting
- Promoted Cold Chain Equipment Inventory Data Standards

Problem Statement

- Count every refrigerator
- Global data base of refrigerator and health facility info
- Analytics to make this information useful

Caveats

- Focus on low and middle income countries
- Multiple levels of dashboards and distinction between global and country data bases
- 2010 data

Cold Chain Equipment Inventories

- No accurate global equipment inventories
- Inconsistent at the country level
- Inventories often become out of date
- Not updated for equipment changes
- Health facility information is also a challenge
- Periodic efforts to collect inventory information for reporting
  - Often restricted to sampling
- Fragmented data sources
- Different health systems inside a country
  - Public, Private, NGO, Faith-based
Part I: Visualizing the Cold Chain

- Map based visualization
- GIS Coords
- Regions
- Global Management Questions
  - Country summaries
  - Equipment trends
  - Integrated analysis tools and models
- Country Cold Chain Management
  - Equipment management
  - Allocation
  - Reporting

Part II: Data Management

- Cold Chain Equipment Inventory
  - Basic equipment and facility information
  - Tracking of performance and maintenance
- Remote data updates
  - Keeping data up to date is the critical challenge
  - District cold chain supervisor responsible for managing equipment
  - Mobile App is feasible for district supervisors
- Integrate with other Health Information Systems
- Ownership by the country

ODK-X

- Mobile data collection on Android Phones. Project started at University of Washington by Professor Gaetano Borriello
- Open Data Kit 1.0 aka ODK
  - Submission of forms
- Open Data Kit 2.0 aka ODK-X
  - Synchronization with a database
- Open source tools. Strong commitment to contributing to global good software

Cold Chain App

- App built on top of the ODK-X platform
  - Combination of ODK Survey and ODK Tables
  - Written in Java Script
- Manage a database of health facilities and refrigerators associated with facilities

Architecture
Project Status

- Cold Chain Visualization project
- Cold Chain App prototype
- WHO Deployment
  - Haiti, Pakistan, DRC, Bangladesh
  - Sentinel Surveillance officers
- GAVI Deployment – Uganda
  - Two regions - Kampala and Wakiso (13 Districts)
  - Possible expansion to national scale

Challenges

- Data Challenges
  - Initial collection and cleaning
  - Name resolution
  - Country administrative regions
- Mobile App
  - Data connection, on-line/off-line
  - Usability
  - Android Phones
- Country Deployment
  - IT support and training
- Project Scoping
  - Software can do anything ...
  - Boundaries with other health information systems
- Hosting and Data Ownership
- Country specific versus general
- Sustainability
  - Planning for partnership with Makerere

Can this be made global scale?

- Technologically, yes
- Architectural choices are straight forward
- This is not big data
  - Estimate 200,000 Health Facilities and 300,000 Refrigerators
- Data management
  - Administrative and geographic data across 70 countries will be a significant challenge
- App deployment
  - Diverse deployment settings
  - Challenge of producing multiple versions of App on per country basis
- Split global and country management
  - Determination of global versus country data

Does it provide sufficient value to cover the cost

- Global immunization has substantial resources
- Cost of developing and maintaining this is modest
- But – this only makes sense if has quantifiable benefits

Value at the Global Level

- Ensure adequate immunization cold chain
- Equipment purchase and distribution
- Implementation and management of equipment
- Market shaping

Value at the Country Level

- Immunization System Management
- Equipment Allocation
- Equipment Management
- Strategic decisions
- Reporting
- Interactions with Global Level
Research Questions

- Multiple country deployments underway
  - Thirteen Districts in Uganda
- Potential long term deployment in Uganda
- What can we learn at this stage of the project?

Technical questions

- Performance and usability of ODK-X application
- Global administrative data pipeline
- Data cleaning pipeline for country data
- Multi country App and system deployment

Country Questions

- Does the project yield a usable and up to date cold chain equipment inventory
- Updating inventory – last good inventory in Uganda was 2011 with a partial update in 2014
  - Can Uganda’s cold chain equipment be inventoried by district cold chain technicians using the mobile application
- Does the system help or hinder district cold chain workers
- In which processes is the data used
- What is the country costs of maintaining and managing the system

Global Questions

- How do country and global level systems interact
- How does the global cold chain mapper fit with other systems and information sources
- How can more accurate and complete country data be used for improved global support for immunization

Taking the project live

- Training – January 28-30
  - 4 UW people + 2 PATH
  - 15 cold chain technicians
  - 15 other people from ministry
- Methodology
  - Powerpoint presentation
  - Instruction
  - Walk through
  - Exercises
  - Hands on training with the application

Training

- 14 of 15 technicians were already familiar with Android phones
- MoH Android phones were distributed to all
- Quick understanding of the cold chain application
- Hard parts of training were
  - Configuring the application
  - Managing synchronization and the possibility of data conflicts
ODK-X

- Behind the scenes concerns
- App installation a slow process as the entire database is installed
- 30 users simultaneously hitting the server on an unknown networking environment
- Stress test on conflict resolution
- Necessary to collect and reconfigure all devices each night
- Move from a test server to the live server the last day
- Technology worked very well throughout
  - Good performance and few issues

User reactions

- Surprise at list of health facilities for each district
  - Differences between national view and district view
- Discussions on user permissions for operations
  - Handling of dangerous operation
    - Some workflow issues
      - Who has permission to delete, move refrigerators
      - Who handles administrative updates (e.g., adding health facilities)

Training summary

- Capacity development for Development Engineering interventions is critically important
- A practice run with training materials in Seattle was very helpful
- Carefully constructed time schedules had to be discarded
- Last minute changes in the application added to the stress of implementing training
- Lots of work for trainers outside of training sessions
- Considered to have been successful

Deployment: Feb 1 to April 30

- Scale: Approx 400 health facilities and 600 refrigerators
- Data update (through March 15): Approx 80%
- Information collected on need for refrigerator maintenance and temperature alarms
  - Leading to various actions on refrigerator repair / replacement
  - Existing system where additional information allows new actions
  - Demonstrates feasibility of collecting performance data
- A small number of erroneous entries
  - Usability / training issue
- One escalated issue on synchronization

Questions and Discussion