Software and Global Health: Understanding the Vaccine Cold Chain

Richard Anderson
Department of Computer Science and Engineering
University of Washington

PATH

What this talk is about

- The development and deployment of software for evaluating the vaccine cold chains developing countries
  - Software has been used in four African countries to analyze recently completed cold chain inventories
- Bigger issues
  - Use of information in supporting health systems
  - Introduction and sustainability of technology

Three themes

1. Implications of inventory based cold chain planning to global health
2. Adoption and use of software at the Ministry of Health
3. Software technologies for national health systems

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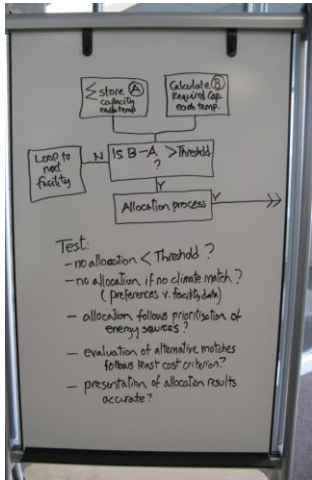
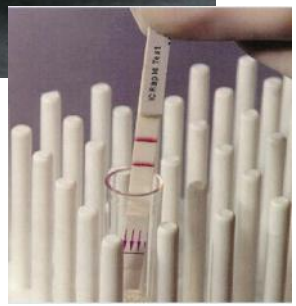
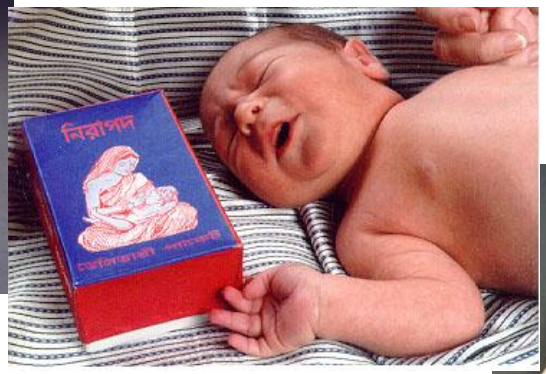


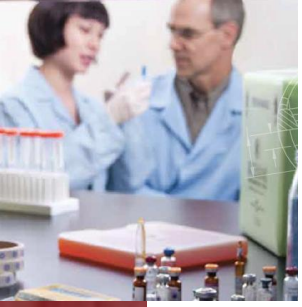
Background on PATH

- Seattle based NGO working in health technologies
- Founded 1977
  - Now working in 70 countries
- Program for Appropriate Technology in Health
- Approximately 1000 employees world wide, 400 in Seattle

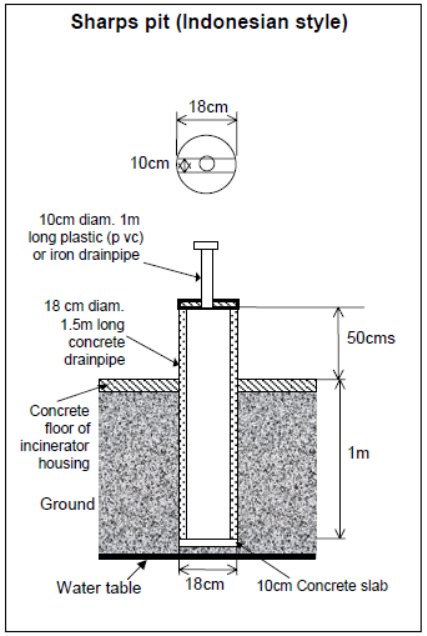
PATH Technologies





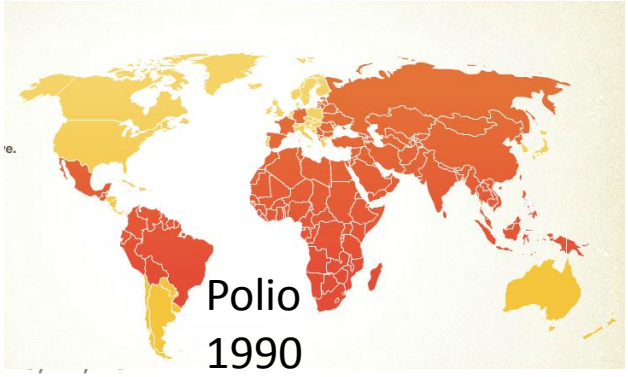


Cold Chain and Immunization Technologies at PATH

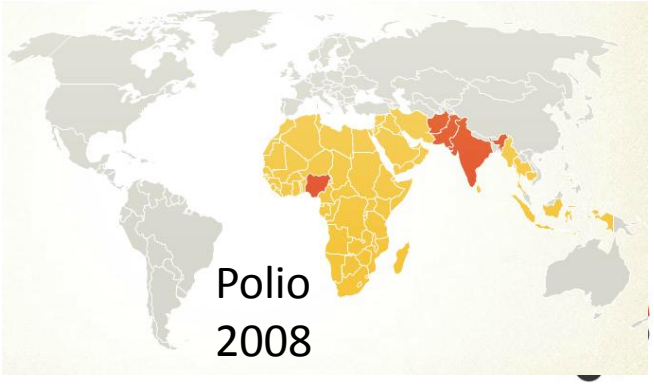


Vaccines and Immunization

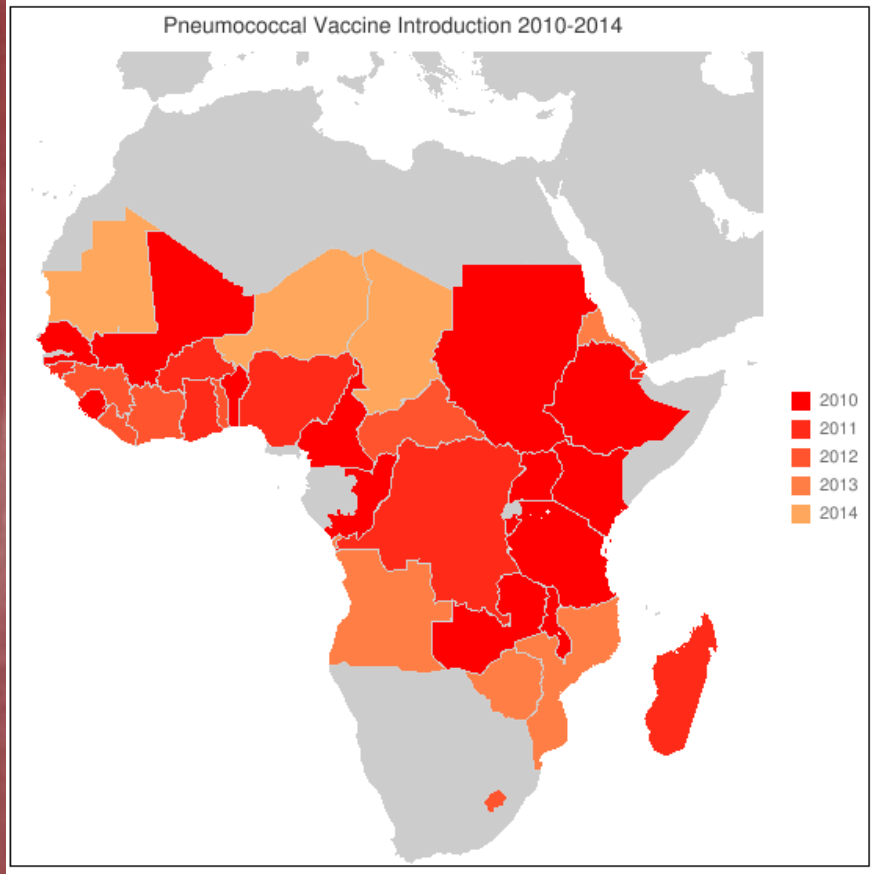
- One of the worlds most effective health interventions
  - Wide coverage of basic vaccines
    - Diphtheria, Pertussis, Tetanus: 77% in poorest countries
    - Tremendous reduction in deaths
    - Some diseases close to elimination
- Large scale global programs
  - Decade of Vaccines
- Introduction of new vaccines
  - Pneumococcal and Rotavirus vaccines

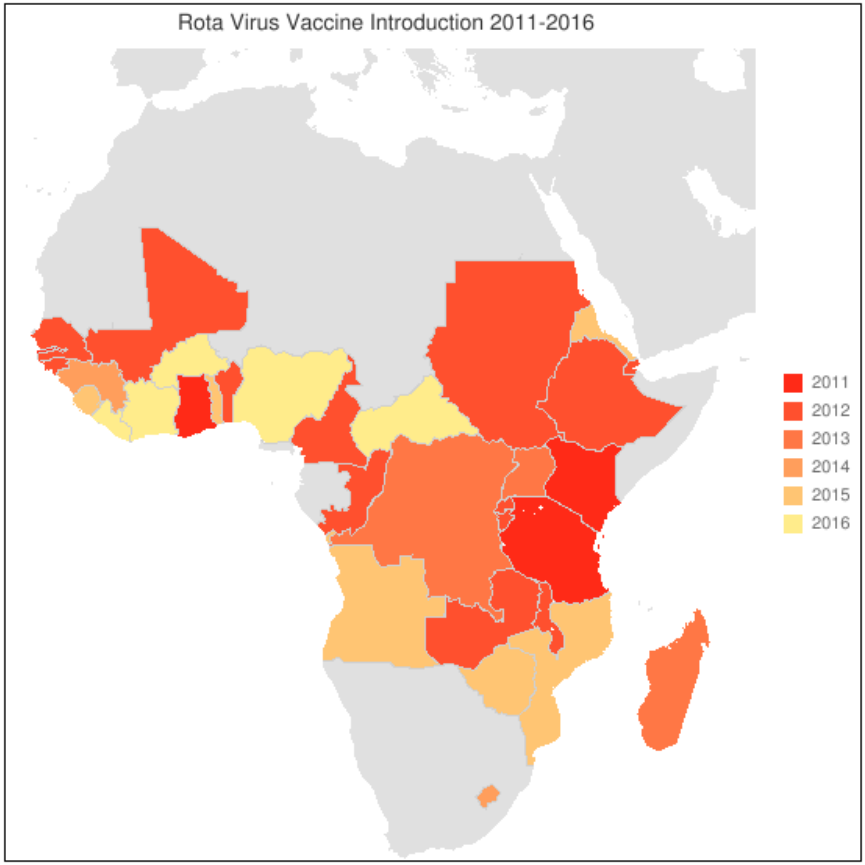


University of Michigan



New Vaccine Introduction Timeline





IVAC VIMS report, March 2010

Old vs. New Vaccines

4,100 doses
Polio and Measles
$635

625 doses
Rotavirus
$4687

NPR Interview of Bill and Melinda Gates (10-28-09)

Q: I'm just curious - and this must be very hard as very practical, successful people to admit - but has there been an occasion where you've let some foundation money out the door and after a couple of years you would say, oh, that was pretty much a failure; that was wasted money; didn't work?

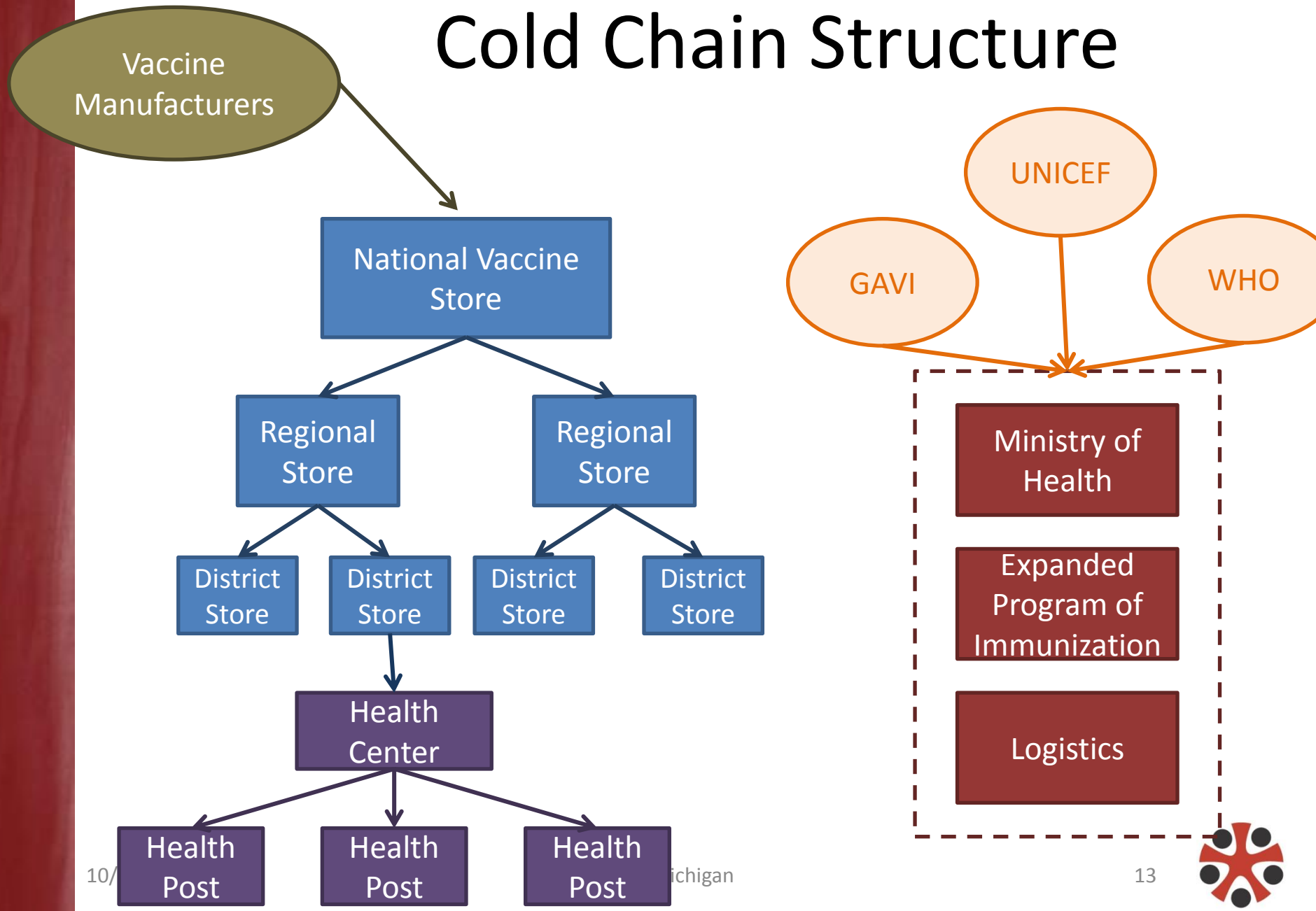
Melinda Gates: And sometimes you make a mistake where it's a fantastic investment but there's a little piece of it you didn't get right. So, a great example is rotavirus. We have, thank God, an amazing life-saving vaccine that's coming for kids. And it's actually being delivered now in Nicaragua; we're going to get it out in lots of places. It's a vaccine against diarrhea. . . . Well, unfortunately, the rotavirus packaging came out too large. We had these large boxes. Well, you can't carry large boxes of vials of vaccinations out into villages. That requires too much refrigeration.

Cold Chain

	Primary vaccine store Up to 6 Months	Intermediate vaccine store		Health centre Up to one month	Health post Up to one month
		Region- up to 3 months	District- up to one month		
OPV	-15°C to -25°C		+2°C to +8°C		
BCG	2°C to +8°C (-15°C to -25°C also possible)				
Measles, MR, MMR					
YF					
Hib freeze-dried					
Meningococcal A&C					
HepB	+2°C to +8°C Never Freeze !				
IPV					
DT, DTP, DTP Hep B					
Hib liquid					
Td					
TT					

Cold Chain

Cold Chain Structure



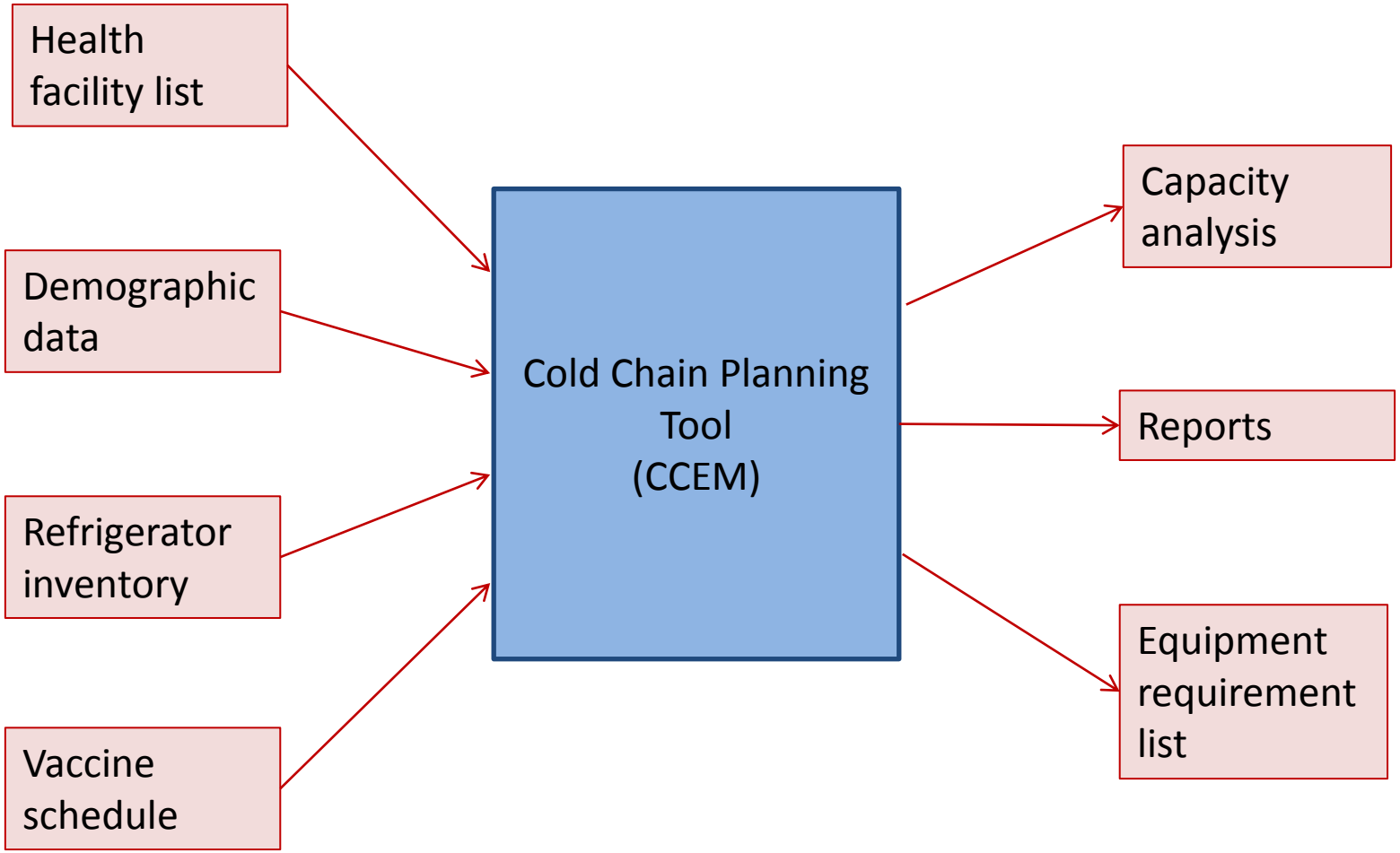
Is Mozambique ready to introduce Rotavirus Vaccine?

- Is the cold chain of adequate capacity and quality to safely store vaccines from entry in to the country to use at peripheral health facilities?
- What areas of the cold chain should be targeted for improvement?
- How much will it cost?

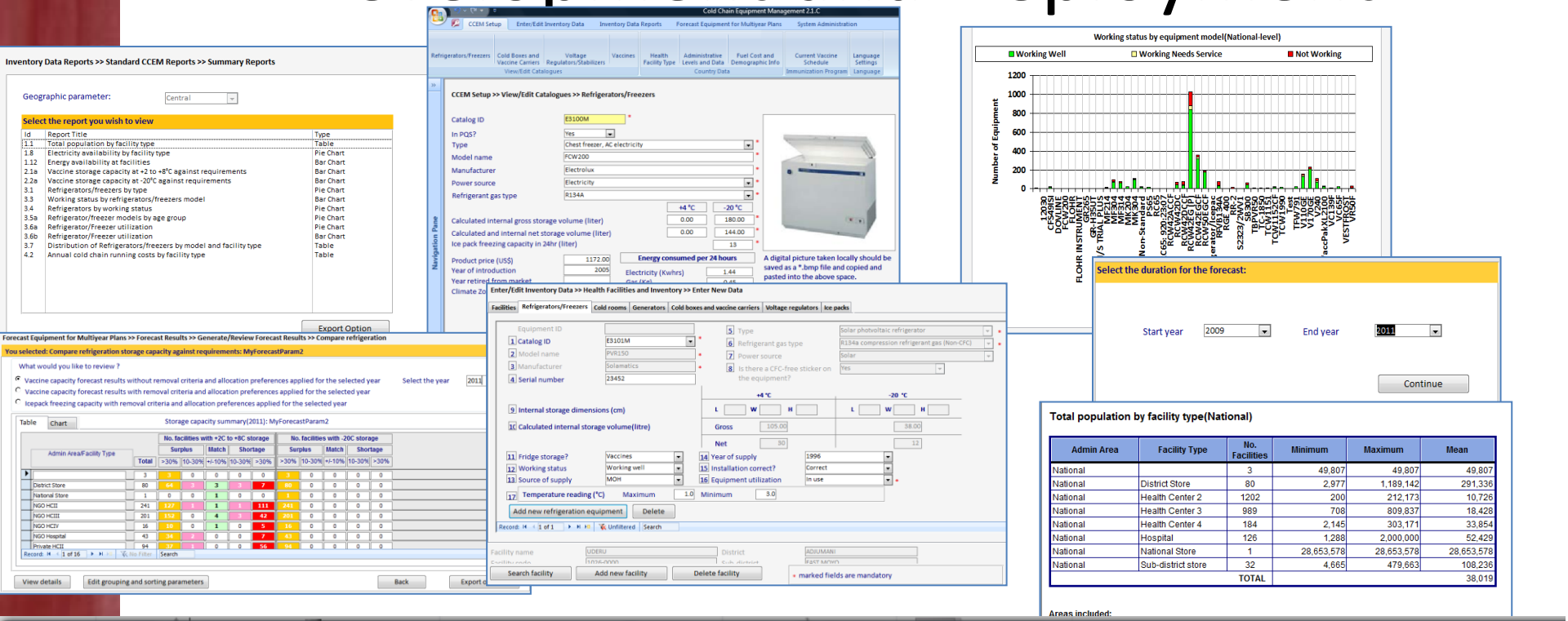
Cold chain inventory

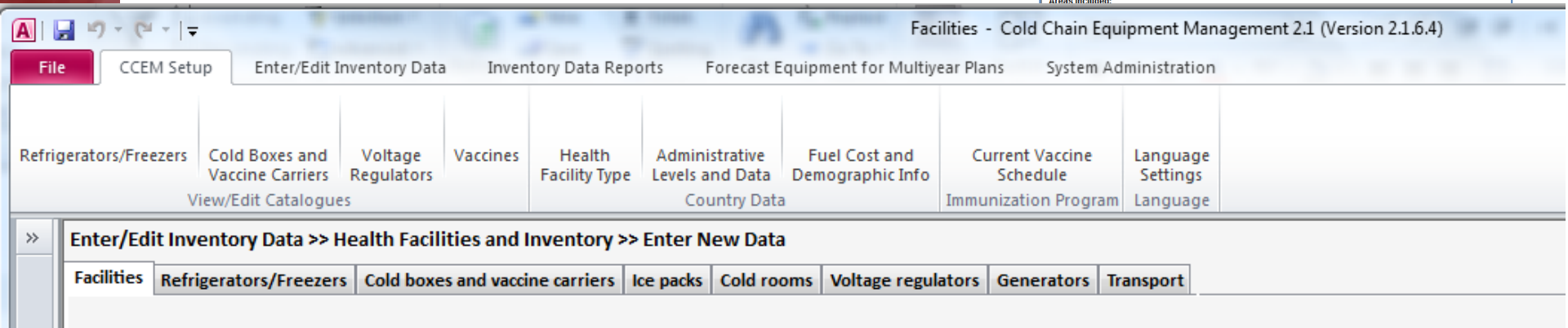
- What is the status of a country's cold chain?
- How many refrigerators?
- What types are they?
- How old?
- Are they working?
- Are they big enough for the required vaccines?
- Where are they?

Inventory Based Cold Chain Capacity Analysis



Cold Chain Equipment Manager (CCEM) Development and Deployment





CCEM History

- 2006 CCEM development starts at the TechNet Consultation in Mexico
- 2007 CCEM piloted in collaboration with Uganda EPI team, WHO/IST, and UNICEF/TACRO.
- 2009 CCEM migrated to MS Access 2007, with a new user interface and stability enhancements
- 2010 Release of CCEM at TechNet Consultation in Kuala Lumpur

CCEM Deployments

- Country A (5306 facilities, 4946 refrigerators)
  - Inventory completed in February 2011
  - Introduction workshop in March 2011
- Country B (827 facilities, 1426 refrigerators)
  - Inventory completed in September 2011
  - Introduction workshop in September 2011
- Country C (2846 facilities, 3153 refrigerators)
  - Inventory completed in March 2011
  - Introduction workshop (with Country D) in July 2011
- Country D (1605 facilities, 3080 refrigerators)
  - Inventory competed in April 2011
  - Introduction workshop in July 2011

Results

- Successful in completing inventories and generating information for national cold chain plan
- Simple analysis methodology identifies bottlenecks in the cold chain
  - Quantifies costs for upgrades
- Substantial differences between countries

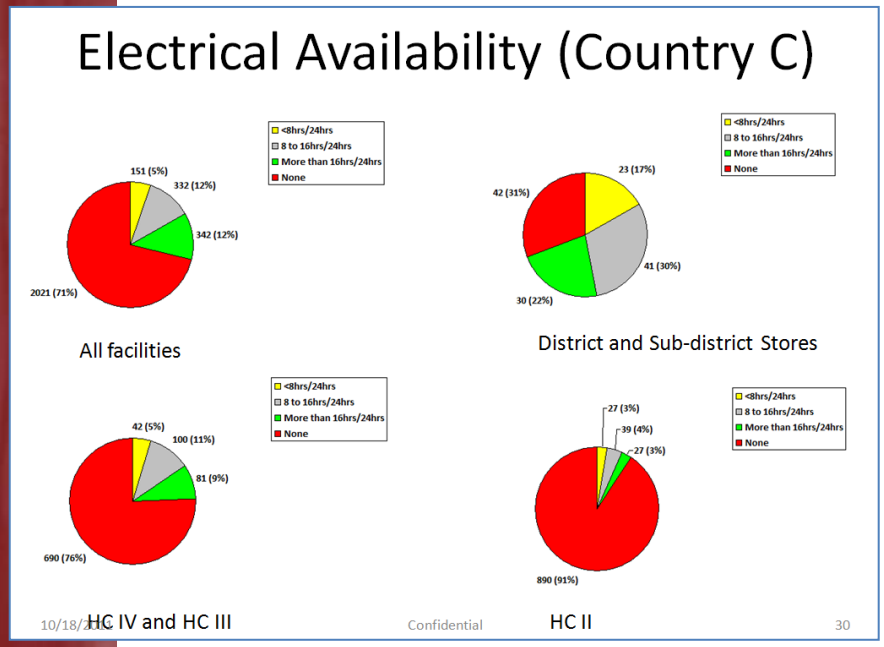
Country readiness analysis

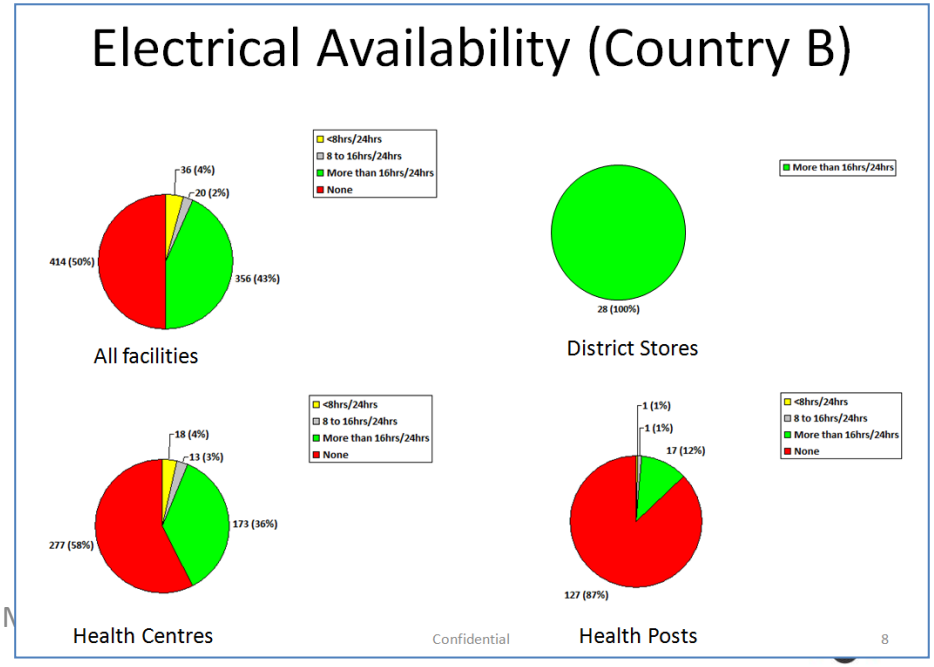
- Assess cold chain capacity with respect to vaccine introduction
- High level analysis focusing on structure of cold chain
- Ability to support conclusions with the underlying data

Cold Chain Equipment Status Summary

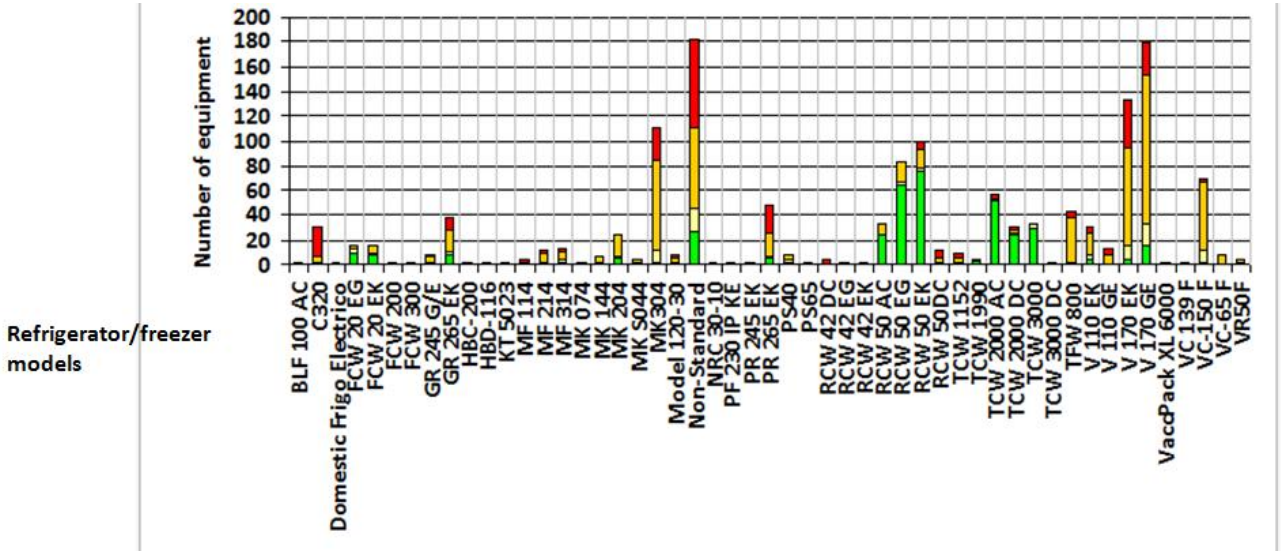
	Country A	Country B	Country C	Country D
Overall cold chain readiness	🟡	🟡	🟡	🟢
Capacity by level •Stores (National, Regional) •District stores •Health Centres (public/private) •Peripheral facilities (Health Posts and Dispensaries)	🟡 🔴 🟢 🟡	🔴 🟡 🟢 🟢	🔴 🟡 🟢 🔴	🟡 🟢 🟢 🟢
Equipment Quality/Age	🟡	🟢	🟡	🔴
Shortages with PCV 13		🟡	🟡	🟢
Shortages with Rotavirus	🟡	🔴	🔴	🟡
Key Cold Chain Investment required for launch	Increase capacity at district and national store for Rota launch	Purchase cold rooms for regional stores	Purchase new cold rooms for Rota launch	Begin replacing old equipment prior to next vaccine launches

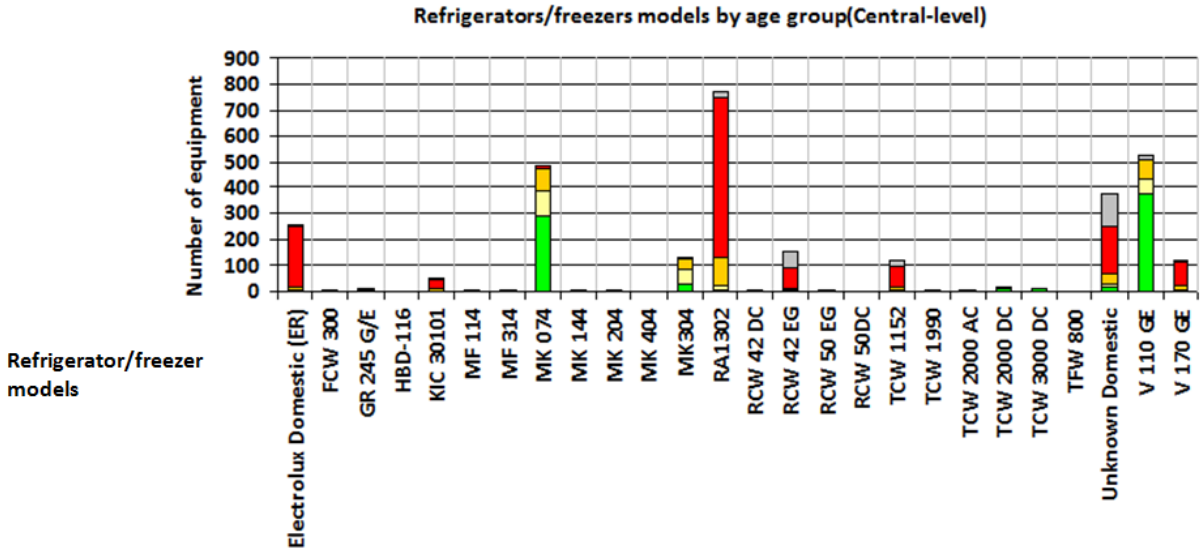
Infrastructure (Electricity)



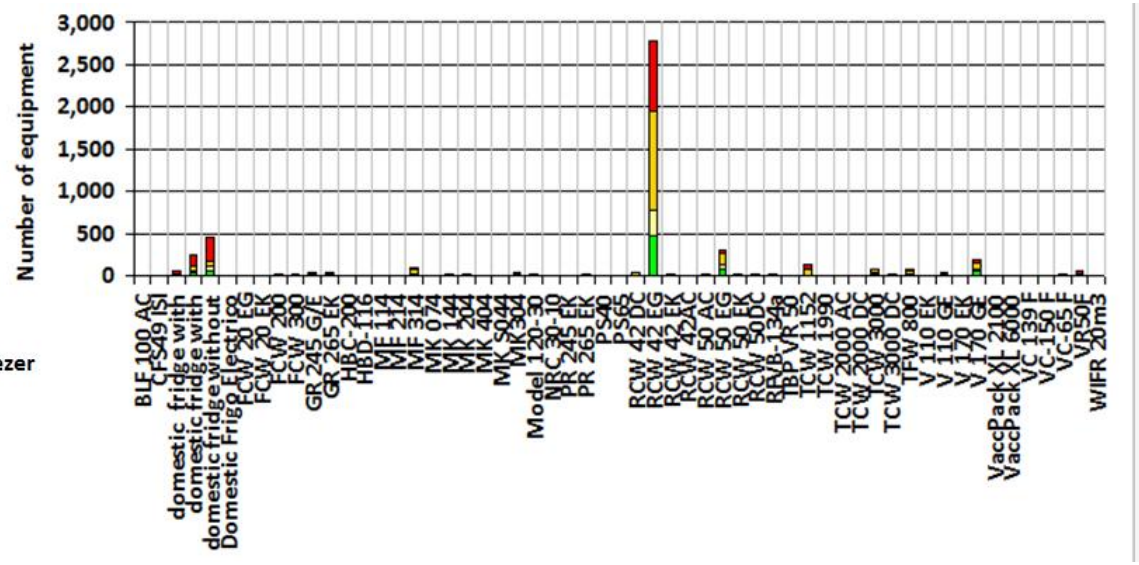


Equipment Profiles (B & D)

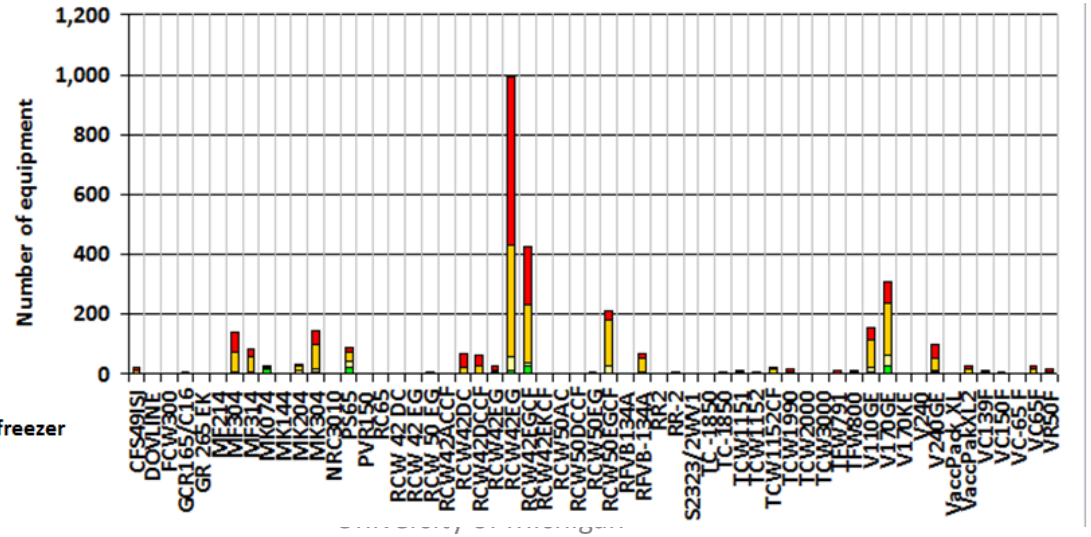




Equipment Profiles (A & C)



Refrigerator/freezer models



r/freezer

Country analysis

- Multi year simulation with equipment allocation, removal, and changes in vaccine schedules
- Outputs:
  - Facilities in shortage
  - Assignment of equipment to meet shortages
  - Capital and energy costs

Vaccine Storage Requirement WHO Method

- What vaccines are in the schedule
- How big is the vaccine and packaging (cm^3 per dose)
- How many doses
- What is the population receiving vaccine
- What is the coverage
- What is the population served by the facility
- What is the wastage
- How long is vaccine stored
  - Supply interval
  - Reserve stock

Vaccine	Doses per vial	Doses in schedule	volume per dose
BCG	10	1	1.2
DTP	10	3	3
OPV	10	4	1
HPV	1	1	15
PCV 7	1	3	56
PCV 13	1	3	12.9
Rota A	1	2	17.1
Rota B	1	2	45.9

Facility storage shortages

Current Schedule

Admin Area/Facility Type	Total	No. facilities with +2C to +8C storage				
		Surplus		Match	Shortage	
		>30%	10-30%	+/-10%	10-30%	>30%
NATIONAL STORE	1	1	0	0	0	0
REGIONAL STORE	11	0	0	0	0	11
SUB-DISTRICT STORE	24	14	1	1	1	7
DISTRICT STORE	112	73	4	7	6	22
PUBLIC HCIV	150	136	4	1	2	7
PUBLIC HCIII	763	682	15	11	11	44
PUBLIC HCII	983	647	3	22	3	308

Current with PCV13

NATIONAL STORE	1	0	0	0	1	0
REGIONAL STORE	11	0	0	0	0	11
SUB-DISTRICT STORE	24	10	2	3	0	9
DISTRICT STORE	112	44	9	15	7	37
PUBLIC HCIV	150	120	7	6	6	11
PUBLIC HCIII	763	597	36	36	30	64
PUBLIC HCII	983	604	19	38	8	314

Current with PCV13 + Rota

NATIONAL STORE	1	0	0	0	0	1
REGIONAL STORE	11	0	0	0	0	11
SUB-DISTRICT STORE	24	7	0	2	2	13
DISTRICT STORE	112	7	2	16	13	74
PUBLIC HCIV	150	100	7	6	6	31
PUBLIC HCIII	763	411	50	65	57	180
PUBLIC HCII	983	477	44	49	44	369

Computing equipment needs

- Assign equipment to facilities to make up short fall
- Options defined for facility types, e.g., assign MK 404 and V170 GE to district stores
- Assignment considers electricity availability

Equipment	2011	
Type	Qty	Cost $US
Cold Room +2'C to +8'C	8	437,928
Icelined refrigerator	100	103,121
Upright refrigerator; electricity & gas	39	66,885
Upright refrigerator; electricity & kerosene	28	68,376

Area	MK 074	MK 204	MK 404	MK304	V 170 EK	V 170 GE	WICR 15m3	WICR30m3	WICR40m3
Dispensary	3				1	3			
District Vaccine Store		7	55	8					
Health Centre - CHAM		7			3	3			
Health Centre - MoH		18			16	17			
Health Post	2				8	16			
National Vaccine Store								3	
Regional Vaccine Store							1	2	2
TOTAL	5	32	55	8	28	39	1	5	2

Using CCEM to understand cold chain logistics

- Explore different policy options using country data

Cold chain analysis

- What is the impact on cold chain capacity requirements of reducing country vaccine delivery periods from three months to one month?
- What is the cost savings in purchasing equipment required for PCV and Rota together, instead of separately?

Cold chain analysis

- What are the energy cost savings in replace gas equipment by electric equipment in facilities *with access to electricity?*
- What is the demand for a low capacity vaccine storage devices that does not require access to electricity?

Sustainability and Adoption

- What are the prospects for sustained and expanded use of CCEM at the country level?
- What did we learn from the four countries?

Facility and Equipment Inventory

- Dominant cost for use of CCEM is inventory cost
- Estimated inventory costs $50K - $200K
- Controversy around CCEM relates to cost and feasibility of an inventory

Conducting a cold chain inventory

- Start with a list of all health facilities in the country
- Determine information to be collected
- Train enumeration teams
- Rent lots of land rovers
- Visit all facilities and conduct inventory
- Enter data into database
- Review and clean the data

Who are the stakeholders?

World Health Organization

unicef

Global Organizations

DFID Department for International Development

USAID FROM THE AMERICAN PEOPLE

JICA

Donors

BILL & MELINDA GATES foundation

JSI

care

Non-governmental Organizations

PATH

CLINTON HEALTH ACCESS INITIATIVE

GAVI THE GLOBAL ALLIANCE FOR VACCINES & IMMUNIZATION

Ministry of Health

Expanded Program of Immunization

Health System

Cold Chain Logisticians

T.C. SAĞLIK BAKANLIĞI THE MINISTRY OF HEALTH OF TURKEY

gsk

Dometic

Private Sector

VESTFROST

MERCK

सत्यमेव जयते
Ministry of Health and Family Welfare

Ministry of Health Malaysia

Value proposition

- Global level
  - “I want to know if a country’s cold chain is ready for introduction of a new vaccine”
- Donors
  - “What resources are needed to strengthen the country’s cold chain”
- EPI
  - “I need to manage the country’s vaccination programs and respond to external requirements”
- Logistician
  - “I need to manage the cold chain equipment in the system”

Adoption of CCEM by countries

- Country A
  - Inventory and country plan in process, decided to use CCEM to support inventory and planning.
- Country B
  - NGO supporting EPI strengthening brought in PATH to support inventory and planning work.
- Country C
  - Already using older version of CCEM for cold chain inventory. Refreshed inventory to work with new version of software.
- Country D
  - WHO supported inventory and country plan, with CCEM brought in to structure inventory.

Model for sustainable use

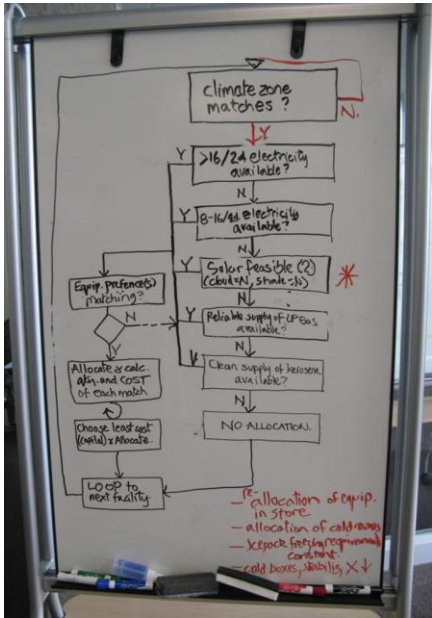
- Facility and equipment inventory kept up to date by country
  - Inventory must provide value to logistics system
  - Mechanism for updating the inventory from district level
- Use of inventory data in cold chain planning and reporting
- Global support for inventory based planning
  - Standardization of inventory and indicators
  - Alignment with other tools
  - Resources for maintenance and development of software
  - Possibly a consultant model for planning

Summary of country introduction

- CCEM adopted as an inventory solution
  - Structure for inventory
  - Database with data entry
  - Reporting
- Developers viewed CCEM as a planning tool (that required having a database)
- Tension during introduction workshops between the planning and inventory components
- Results from working with inventories have validated the planning component

Technology

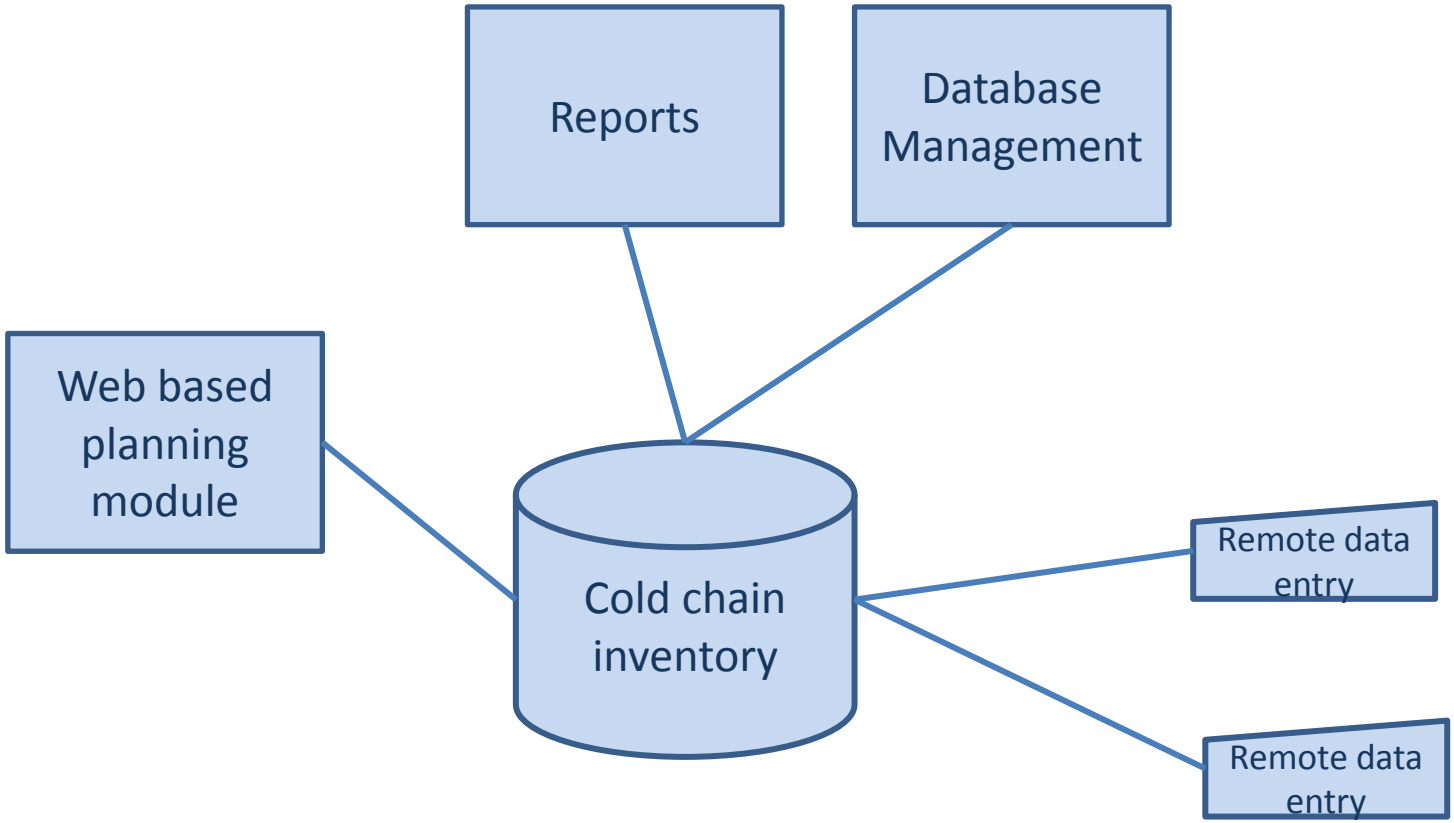
- What is the software technology environment for MOH software?
- How is the gap between public health and software engineering bridged?



Base technologies

- CCEM implemented as MS Access 2007 application
- Competition with MS Excel Tools
- MOH Environment strictly Windows / Office environment
  - Mix of Windows XP / Windows 7
- Internet access at MOH
- Reasonable to plan for Internet access to District level (likely with cellular modem)

Future Application Architecture

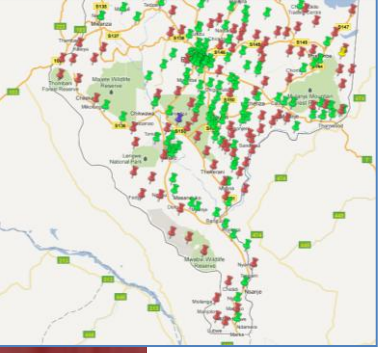


Software community

- No market for CCEM
- Open source is a necessary buzzword
  - Open source is a synonym for free
  - Particular license is not an issue
  - Ownership and control of data is sensitive
    - Storing data “in the cloud” would raise issues
  - Some local modifications have happened
    - Code branching is a worry / headache
- Country modification is necessary

Engineering CCEM

- Development History
  - CCEM 1.0: PATH with developer
  - CCEM 2.0: External contract
  - CCEM 2.1: PATH with project management and external developer
- Challenges and experiences from CCEM are not unique
- Lessons from CCEM 2.1
  - Need for specifications
  - Communication with developers
  - In house software testing
  - Management of data sets
  - Development of test data sets
  - Issue tracking



CCEM Opportunities

- Web based application on top of a real database
  - Database, Modeling Engine, and possibly a GIS
- Managed inventory
  - Remote updates
  - Data submission from peripheral facilities
- Integration with a general Health Management Information System (HMIS)

Questions or Comments?

Richard Anderson, anderson@cs.washington.edu

cs.washington.edu/homes/anderson

change.washington.edu

Software Downloads: www.path.org

http://www.path.org/publications/detail.php?i=1569