

A case for better immunization information systems

This document discusses the rationale for improving immunization information systems and describes the experience of piloting different types of systems. It also provides advice on the feasibility of different kinds of systems in different contexts. It draws on evidence gathered during project Optimize demonstrations in Albania, Guatemala, Senegal, South Sudan, Tunisia, and Vietnam.

WHY DO INFORMATION SYSTEMS NEED IMPROVING?

Current status: Immunization information systems in developing countries have not evolved much since the start of the World Health Organization (WHO) Expanded Programme on Immunization (EPI) in the late 1970s. Typically, health workers at the service delivery level use paper-based systems to register the children who have been vaccinated and the vaccines and other resources used during the process. They report these data to supervisors through monthly, aggregated reports. Managers then monitor and evaluate key performance indicators and in theory can take corrective action when needed.

In reality, information that is produced this way does little to support meaningful decision-making:

- **Coverage estimates alone are insufficient**
Coverage estimates by district or health center are relevant when coverage is geographically uneven; however, district coverage estimates say nothing about the root causes of why children are unvaccinated or about problems across the system, like ineffective supply chains.
- **Data quality is generally poor**
The quality of the data itself is in doubt. A bias for over reporting the administered number of doses, together with uncertainties over the target demographic population, have made coverage estimates an increasingly blunt tool to manage immunization programs.
- **Data arrive too late**
Data produced by aggregate reporting systems always come late and are often incomplete. In theory, corrective action can be taken based on historical data; for example, the national stores manager can decide to change resupply policies for district X because that district reports frequent stockouts. In practice, capacity for analysis is often lacking, and managers have more use for systems that tell them that there is a stockout problem in district X right now.

Current reporting systems are also labor intensive, and increased pressures from migration and urbanization have led to increasingly over-burdened systems. Because reporting systems do little to help health workers in their day-to-day jobs, health workers have little motivation to improve quality, speed, or accuracy of reporting.

"...it is critical to strengthen the key data sources and capacity for analysis, synthesis, validation, and use of health data in countries."

A Call for Action on Health Data from Eight Global Health Agencies, 2010

THE CHALLENGE

There is now an increased demand for accurate, relevant, and timely data to support decision-making at the national and global levels.

- The Decade of Vaccines initiative calls for the monitoring of equity in vaccination, yet current systems monitor coverage by district, which only shows geographic inequities.
- Estimated immunization coverage has stalled at a level of about 80 percent worldwide. To push beyond this barrier, and vaccinate the “fifth child,” new approaches will be needed, along with better information about who the unvaccinated are and why they are not vaccinated.
- The large-scale introduction of newer, more sophisticated, and more costly vaccines has further highlighted the need for efficient vaccine management, which can be achieved in part through the use of appropriate, electronic management information systems.

WHAT'S IN A NAME

Immunization registry systems	Contain the immunization records for individual people in a certain area. They feature reminder functionality and can be used to provide aggregate vaccination coverage data if complete.
Medical record systems	Contain full medical records of individuals, including immunization data.
Logistics management information systems	Is often used in a public health context to indicate any system that helps manage logistics processes.
Stock management systems	Track at a minimum ordering, receipt, storage, and issuing of stock.
Warehouse management systems	Control the movement and storage of stock within one store.
Supply chain management systems (enterprise resource planners)	Support stock management as well as forecasting, planning, procurement, and accounting.
Cold chain management systems	Keep an inventory of cold chain equipment, and may include features such as capacity planning or temperature monitoring.

THE OPPORTUNITY

The rate of innovation in the field of information and communications technology has been staggering.

Some potential game changers are:

- Availability of mobile networks and devices to connect even the most remote locations.
- Availability of Internet access and cloud-based server hosting, making it possible to operate systems without the need to install and maintain software on thousands of computers.
- Availability of barcodes that could be printed on vaccine packaging, enabling traceability of vaccine lots down to the district level or beyond.

Better access to technology allows program managers to develop, buy into, or adapt existing systems to strengthen immunization programs. These systems can offer different combinations of functions:

- **Immunization registries** track individual immunization records, helping health workers identify defaulters and find out why some children are not fully immunized.
- **Logistics management information systems** track vaccine stock and cold chain conditions, helping managers make sure that vaccines are being kept in the right conditions and made available when they are needed.

OPTIMIZE WORK IN INFORMATION SYSTEMS

Over the last five years, project Optimize has worked with ministries of health in partner countries to demonstrate the benefits of different kinds of information systems:

- Albania developed IIS, an immunization information system that supports birth and vaccination registration, vaccine stock management, cold chain management, and the management of adverse events following immunization. This system was piloted in one district and scaled up to all other districts starting in 2013. Albania also studied the managerial benefits of remote temperature monitoring in cold chain equipment.
- Vietnam developed VaxTrak, a vaccine track-and-trace system that manages stock and tracks lots down to the district level. This system was implemented in 13 provinces, as well as in all 13 districts of one province. Separately, an immunization registry was piloted in one district. The national immunization program is interested in scaling up both systems nationally if funding can be secured.
- Guatemala developed SIGSA Web, an integrated medical record and stock management system, including immunization registration and vaccine stock management. It was scaled up to most health areas in 2012, but it was never fully accepted by all stakeholders, and political turnover makes the future of this system uncertain.
- Senegal developed a last-mile distribution system to support its moving warehouse implementation. The development was not successful, and its use was discontinued. Additionally, a remote temperature monitoring system was put in place for 15 remote health centers.
- South Sudan implemented Logistimo, a mobile phone-enabled cloud-based stock management system marketed by Logistimo, an Indian company, in all state stores and all six county stores of one state.

While this document focuses on Optimize experiences, there are numerous efforts outside of Optimize as well. Noteworthy examples include the following:

- WHO developed the District Vaccine Data Management Tool, a Microsoft Excel-based reporting tool that is now used in many African countries.
- The WHO Regional Office for Africa developed the Routine Immunization Management system for the reporting of district coverage data.
- PATH developed Cold Chain Equipment Manager, a Microsoft Access-based tool to enter and analyze cold chain equipment inventories and assist with purchasing decisions.
- VillageReach developed a management information system and is now leading a coalition to develop OpenLMIS.org, a repository for open-source logistics management information systems, with a reference implementation in Tanzania.



Starting in 2011, Albania developed a comprehensive immunization information system. Photo: PATH/Illir Kaso

BENEFITS

Better data is not a goal in itself, and health information systems are only valuable to the extent that they produce better health outcomes or increase the efficiency of reaching those outcomes. The way information systems can help is described in the following sections and illustrated with examples from Optimize demonstrations. Most of this evidence is anecdotal; in the available time, the system interventions have not been scaled and sustained to the extent where a measurable impact on cost and effectiveness has been achieved.

“IIS has made my work so much easier and I am now more assured that I vaccinate all children in my neighborhood. I cannot imagine having to move back to the old (paper-based) system.”

Liza, vaccinator at Vasil Shanto urban health center in Shkoder District, Albania

Better Strategic Decisions

Ideally, the high-quality relevant data produced by immunization information systems are used by global and national-level decision-makers to drive resource allocation and other strategic decisions. However, there is little evidence that this actually happens in real life:

- The GAVI Alliance has been frustrated in its attempts to make financial support depend on achieving performance targets, as doubts about the underlying data persist. Moreover, previous efforts may have distorted coverage data by providing incentives for over reporting.
- New vaccine introduction decisions rely on extensive and costly assessments, such as the Effective Vaccine Management assessment, because data regarding critical factors such as cold chain readiness are not systematically available.
- The Reach Every District strategy, launched by WHO in 2002, encourages use of data for microplanning, but implementation is often challenged because of the poor quality of the data.

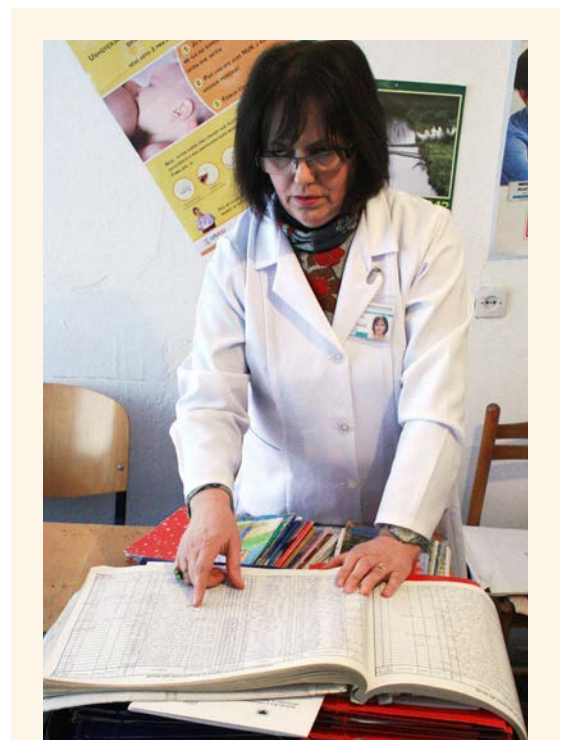
These examples illustrate the weaknesses of current systems, rather than prove the potential of new and improved systems. Neither Optimize nor others have been able to implement, scale, and sustain systems long enough to generate evidence that better data indeed lead to better policy decisions. However, the potential is still illustrated by these examples:

- In Albania, IIS is providing clues about the fraction of parents who refuse vaccination for each vaccine. This may eventually lead to more targeted communication about those vaccines and toward the communities that are most likely to refuse immunization.
- Also in Albania, the registry-based system provides more credible coverage estimates, which are slightly lower than the existing reporting system.
- In Guatemala, an initial analysis of child immunization records revealed that a birth dose of hepatitis B vaccine was often administered after several weeks, thus unnecessarily delaying the remainder of the vaccination schedule. As a result, a debate was started about the birth-dose strategy.

Better Management

A typical national EPI manager is indirectly responsible for the work of thousands of staff and the proper functioning of pieces of cold chain equipment, as well as for the proper management of millions of vaccine doses that are distributed through the cold chain on a yearly basis. In countries with poor infrastructure, that is sometimes a daunting task, especially if no information is available about the status, effectiveness, and efficiency of this supply chain.

As a matter of fact, many national programs have no visibility over vaccine stock balances beyond the central stores, do not know how much vaccine ends up being wasted, have only a rough idea about current cold chain capacity, and cannot be sure if stockouts at the lower levels are a big problem.



Nurses appreciate the reduction in paperwork after adopting a new, computerized immunization information system. Photo: PATH/Ilir Kaso

Information systems can help; knowing real vaccine consumption rates helps with forecasting and distribution planning, and having visibility over stock balances can help correct overstocking and understocking situations as they occur. Monitoring temperatures in refrigerators helps to identify under-performing equipment or persistent cold chain breaks.

In Optimize collaborations with countries, the following examples illustrate these managerial benefits:

- In Senegal, immunization program staff considered information systems vital when integrating vaccines into the pharmaceutical supply chain. By having access to vaccine stock information, they retained visibility and control over vaccine supplies, even though another institution (the national pharmacy) was managing their vaccines.
- Also in Senegal, real-time temperature information from remotely monitored solar refrigerators gave the regional program manager enough confidence to change the resupply frequency of 15 remote health centers from monthly to quarterly, thus enabling a “moving warehouse” strategy to resupply these centers.
- In Tunisia, the implementation of web-based Vaccination Supplies Stock Management (w-VSSM) led to better stock management practices as more districts were able to report wastage and base vaccine forecasts on hard data. The accuracy of stock records also improved markedly. Better management practices may in turn have contributed to better vaccine availability.
- In Albania, an analysis of stock balances at the district level showed that before IIS was implemented, some vaccines were overstocked while there were shortages for others. Since IIS was implemented, stock is managed more consistently between minimum and maximum levels.
- Also in Albania, an analysis of temperature information led to a decision to replace 6 of the 25 refrigerators that were included in a remote—mobile phone-based—temperature monitoring study.
 - In South Sudan, Logistimo was used to monitor vaccine availability and buffer stocks in real time, enabling supervisors to take corrective action when necessary. Managers could also monitor system usage and identify which staff needed additional training or support.



County managers are trained to use Logistimo on mobile phones. Photo: Jan Grevendonk

Health Worker Empowerment

Maybe the most important benefits of information systems are the ones that are seen by staff in health facilities and districts as they use information to improve the quality of their day-to-day decisions and work. Currently, many health workers are discouraged because they are given performance targets without the tools to attain them. Ideally, having better data can empower people to do a better job.

- In Albania and Vietnam, the implementation of immunization registers has led to slightly timelier vaccination. Presumably, this happened because the systems can remind parents of upcoming vaccination appointments, while nurses can monitor the vaccination status of all children in their catchment area and make sure they are all accounted for.
 - The registry systems in Albania and Vietnam also have made it easier for staff to access the records of children that come from other communities.
 - In South Sudan, Logistimo helps logisticians establish the appropriate order quantities, because they can refer to average consumption rates in previous months.
 - In Tunisia, users of w-VSSM have reported that the information they obtain helps them to determine vaccine needs at lower levels, avoid buffer stocks and stockouts, and simplify the organization of their work.
 - As a bonus, the overall time spent on compiling and reporting data in Albania, Tunisia, and Vietnam has decreased.

“At the start, I was not happy with the new system. We were used to the paper system.... After that, we realized that the system can replace paperwork. What’s more, the system is a good means of ensuring traceability, checking the orders submitted, and determining the needs of the regions.”

**National stores manager,
Tunis, Tunisia**

The Right System

There is probably not one ideal system that all immunization programs should rush to implement. Rather, different kinds of systems will fit in better depending on the following factors:

Program priorities

Countries that have achieved very high coverage and have a well-functioning immunization program may want to focus on understanding the root causes for non-vaccination of the small percentage of unimmunized children or on improving system efficiencies. Lower-performing countries need to prioritize the basics, using information systems to make sure that vaccine is available when and where it is needed, for example.

Infrastructure

It is obviously important that the chosen solution can be implemented using the available electricity, Internet, and mobile phone infrastructure in a country. The most adaptable information systems will allow data collection and access to information through a variety of strategies (online, offline, and paper based), but infrastructure constraints will in many cases still limit the options. For example, it would be hard to imagine successful implementation of an immunization registry without good online access at least down to the district level.

Organizational capacities

Systems must be supported locally after the donor or technical assistance provider leaves, and not all ministries of health have the means to host an application and maintain a database on local servers in air-conditioned rooms. Even fewer will be able to continuously improve the software, make new reports, etc. Cloud-based systems that are hosted and maintained by a provider of software as a service may offer an alternative for those countries that are most challenged in this respect.

Level of integration

Some countries have an explicit electronic health strategy that limits their available options, as the chosen technology needs to comply with national standards. There may also be a desire to integrate information systems across the health system. Vertical integration means that an information system addresses many of the needs of a single program. Examples are IIS in Albania and the state-level systems in the United States. Horizontally integrated systems can support one function (like stock management or accounting) across many programs. Examples are Logistimo and OpenLMIS.org. Successful integration efforts therefore seem to focus on doing one thing for everybody or everything for one user group. There are no known examples of systems that successfully do everything for everybody across a national health system.

CHALLENGES AND BARRIERS

Many program managers and donor organizations alike understand the potential of better information systems and the use of information and communications technology (ICT). Yet, while small-scale pilots proliferate and have shown some benefit, we have not yet seen widespread adoption of new technology in immunization systems or indeed in public health in developing countries. So what are the barriers for the uptake of better information systems?

Program priorities

Public health managers often lack the skills and experience to plan and manage complex ICT projects; in particular, the development of software is a specialized and risky business. In Optimize demonstration projects, all development efforts took much longer than expected and in one case never resulted in a viable system. Even when public health people work together with specialized organizations, the goals of those external

stakeholders may be misaligned. Unless ministry of health officials are firmly in the driver's seat, they may end up with systems that are not appropriate for their context, not scalable, and not sustainable. Project Optimize captured some of the detailed lessons learned in a document that aims to help public health staff take control of their system projects, *Planning an information systems project: A toolkit for public health managers*.

Lack of Information

Even if there are many pilots, these are not consistently documented and evaluated. It is hard to assess what has worked and what has not. First, there is a natural bias to publicize only positive experiences. Second, existing documentation is not always helpful to enable replication. Because information about innovation is not available in a structured and accessible way, people who could benefit from it depend on donors or technical assistance providers to "push down" new technology and systems. This hardly guarantees a good match between the needs and the solutions. Efforts to improve this situation are ongoing. OpenLMIS.org, for example, hosts a library of technical documentation. They are also in the process of developing an open-source software package for the management of stock and logistics. More of both are needed, packaged, replicable solutions as well as information about them.

Lack of sustained funding

There is considerable donor interest in funding pilots and software development. This will, over time, close the innovation gap outlined above. But software acquisition and piloting constitutes a relatively small portion of the total cost of ownership of any information system project, especially in public health, where systems may need to be deployed and maintained in thousands of sites, involving continued training of thousands of users, scale-up and running costs may be significant. Donors may be eager to show the benefits of a mobile health system in a pilot with 25 nurses, but have typically less appetite to buy airtime for 2,000 users for the next ten years. That puts the onus on ministries of health to decide where to put limited resources. Running costs can be reduced through excellent design. But information is never free, and even if the benefits outweigh the costs, only committed public health administrations can guarantee system longevity.

Incentive misalignments

Information systems are a combination of people and technology. They will not work if the people who are supposed to use the technology are not motivated to do so, either because they perceive no benefits from the system, or because they are not willing to expose problems. Benefits are furthermore only reaped when all users play their roles. In Vietnam, some users at the higher levels perceived no benefits because only a few of the facilities at the lower level they oversaw were piloting the system and, therefore, were not motivated to use VaxTrak initially. In South Sudan, users who were submitting orders through the system were discouraged after the higher-level managers would not act on them. It took a concerted effort and high-level involvement to get the system going.

Computer literacy

Computer literacy, especially in older health workers, represented a barrier in some demonstration projects. This can be mitigated to a certain extent by appropriate training strategies and user-focused design. Over time, new generations will also be more comfortable with digital technology.

Technical barriers

Lack of Internet connection and inconsistent access to electricity are other potential barriers to system implementation. Sometimes this can be mitigated by selecting the right system model for the context in which it will be implemented. For example, slow connection speed hampered the use of w-VSSM in Tunisia, but this was resolved by the development of an offline module. In Albania, paper reports were used for small and remote

places. In South Sudan, one of the least-connected countries in the world, a functional stock management system could be implemented by using inexpensive mobile phones that connect directly to a database that is hosted on Google servers. In Guatemala, the lack of connectivity in health centers led to a strategy in which encounter data were entered by clerks at the district level. However, the project was never able to implement this process in a way that was acceptable to users.

Lack of standards

The lack of standards played a minor role in Optimize projects. The VaxTrak system in Vietnam was developed to use barcode scanning technology to control the flow of vaccines through the system. However, the lack of international standards for barcodes made local manufacturers unwilling to consider printing them on

packaging. This was rather easily resolved by the use of menu-based lot selection. Lack of standards will become more important as systems need to become more interoperable. Working through the Vaccine Packaging and Presentation Advisory Group, Optimize has helped drive the development of the appropriate barcoding standards for vaccine products.

EIGHT STEPS FOR BETTER DECISION-MAKING

1. Define how a better information system will benefit health outcomes.
2. Think about the skills and roles required and form a team.
3. Define what the system needs to do.
4. Find the right solution.
5. Select the right vendors.
6. Estimate implementation and operating costs.
7. Create an implementation plan.
8. Understand and manage project risks.



More information can be found in *Planning an information systems project: A toolkit for public health managers*.

WAY FORWARD

For information systems and technology to make a difference, three things need to happen:

- The costs and benefits of alternative approaches and technologies need to be evaluated more vigorously.
- A “marketplace” needs to be created where packaged and well-supported software solutions and experiences can be shared.
- A pathway to scale-up and long-term financial sustainability of information systems needs to be further developed.

Evidence about the benefits of using information systems and technology in immunization programs in lower- and middle-income countries is starting to materialize. However, in order to facilitate uptake and scale-up, much work remains to be done by all the relevant players in this field:

Organizations involved with the implementation of information systems should invest in documentation and evaluation of their interventions. Costs and benefits should ideally be detailed in business cases.

Technical assistance providers should decide what role they want to play in the development and scale-up of information systems. It is tempting to develop one or more software tools and then try to promote these in developing countries. It would be far better to converge around a limited number of proven solutions that are well designed, documented, and supported. Information technology needs an “ecosystem” of developers (vendors or open-source communities), as well as implementers and system integrators who can make the technology work in a certain context.

International organizations like WHO and the United Nations Children's Fund (UNICEF) should use their authority and convening power to align efforts by others, provide guidance to member states and technical partners engaged in the development of technology, and pool and share information about existing efforts. They can also create an enabling environment for innovation by playing a bridging role between the users and the developers of technology.

Donor organizations like the GAVI Alliance, bilateral donors, and the Bill & Melinda Gates Foundation have tended to prefer catalytic investments, for example in software development. Packaged and well-supported software solutions are still lacking, so more investments in this area are welcome. But just like it is not sufficient to develop a new vaccine and prove its cost-effectiveness, innovative information technologies that have proven their worth need to be scaled up and then sustained. Eventually, resources, such as those provided through the GAVI health system strengthening mechanism should be used to enable information systems to be scaled up, together with other system-strengthening interventions.

Developing-country decision-makers need to evaluate the benefits and costs of information systems and prioritize investments accordingly. They need to understand that information can be costly as well as valuable and drive their own agenda rather than depend on external initiatives. It is a burning need for better information by health staff that will make information system investments sustainable.

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FINDING MORE INFORMATION

Planning an information systems project: A toolkit for public health managers, 2013.

Project Optimize country reports [reports from demonstration projects in Albania, Tunisia, Senegal, and Vietnam], 2013.

Before and after: How an online immunization registry has benefitted health workers in Albania [photo book], 2013.

Demonstration videos of Optimize immunization information systems projects. Common Requirements for Logistics Management Information Systems [guidelines], 2010.

The Case for Developing and Deploying an Open Source Electronic Logistics Management Information System [Rockefeller Foundation white paper], 2012.

Keeping track of Vietnam's vaccines [fact sheet], 2012.

Albania pilots an immunization information system [fact sheet with pictures], 2012.

PATH | optimize.who@path.org | <http://sites.path.org/vpsse/optimize>

World Health Organization | vaccines@who.int

http://www.who.int/immunization_delivery/optimize/en/index.html

For more information, Contact

Jan Grevendonk grevendonkj@who.int | Kate Wilson kwilson@path.org