The catalytic potential of rapid, iterative software development

Software lessons from Pakistan, Zambia, and Kenya lay groundwork for successful electronic immunization registries

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This case study explores the localization and adaptation of OpenSRP's immunization module, the benefits of iterating on open-source software, and lessons learned during use in Pakistan, Zambia, and Kenya.

Background and context

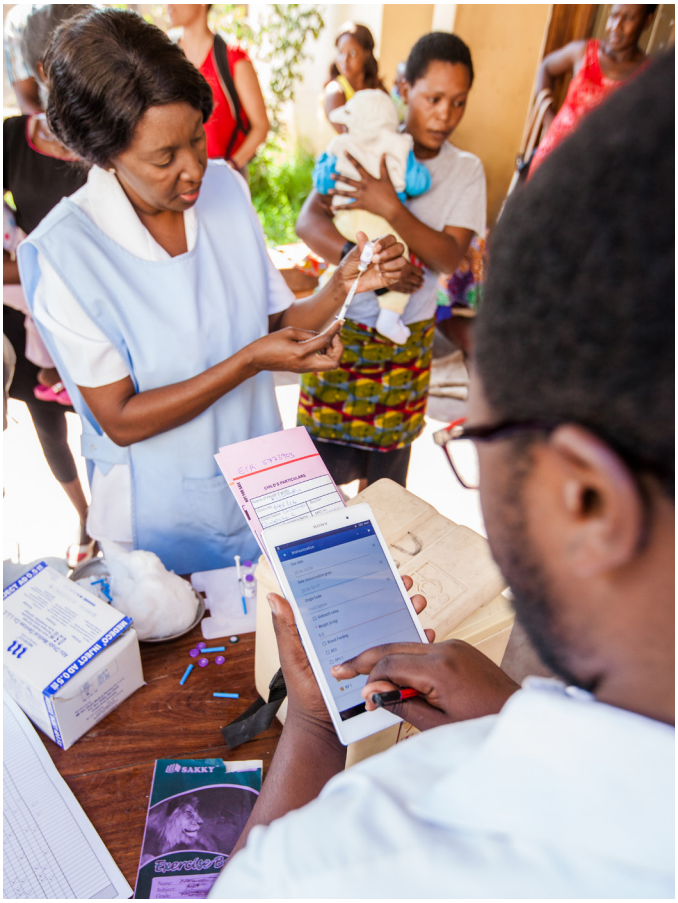
Routine immunization is one of the most successful and cost-effective public health interventions. But despite significant gains in the last decade, global vaccination coverage has stalled at 86 percent (WHO 2018). A major obstacle to closing the immunization gap is a lack of timely, high-quality data to inform decisions in planning, performance management, and service delivery. Challenges include difficulty identifying infants who don't receive vaccinations, complex data collection forms, and poor visibility into vaccine stock.

Electronic immunization registers (EIRs) help to monitor individual immunization schedules and vaccination histories. They contain comprehensive data on the number and type of vaccines delivered, and in some cases, stock management and growth monitoring of children. EIRs support immunization programs by providing timely and precise information and may reduce workloads associated with paper-based records.

Pakistan, Zambia, and Kenya are among a growing number of countries implementing EIRs to improve data quality and program performance. Seeking a solution that had already demonstrated proof of concept, they turned to the Open Smart Register Platform (OpenSRP), a mobile health platform based on global standards of care that allows frontline health workers to electronically register and track individuals for immunization.

Launched in 2014, OpenSRP's modular design can be adapted to different country needs, settings and a variety of health areas, including immunization, family planning, antenatal care, and maternal and child health, to name a few. OpenSRP leverages several core modules of the Open Medical Record System (OpenMRS), which was created in 2004 to enable design of a customized medical record system using a central concept dictionary. OpenSRP allows for interoperability with other prominent open-source systems (DHIS2, OpenMRS, RapidPro); patient identification, registration, and management; workflow support and reporting; supply chain management; and performance management.

With the use of open-source software developed through user-centered design, and with research-informed adaptation, each new iteration of the application in these countries has proven more functional and affordable than the last.



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Module development in Pakistan

One of the final strongholds of the polio virus, Pakistan has a fragmented health care system and faces religious, political, and socio-economic barriers to immunization. Its paper-based system of health records has made it difficult for health workers to monitor vaccination targets and has hobbled government campaigns to eliminate polio, measles, and other diseases. Furthermore, the backbone of Pakistan's health system, its lady health workers (LHWs), are responsible for a wide array of primary care services—ranging from family planning to antenatal and postnatal care—and have little time to spend on immunization data systems.

Between April 2016 and December 2017, Interactive Research and Development (IRD) used OpenSRP to develop a software application for overburdened health workers in Pakistan. They joined Bangladesh and Indonesia to form the Technologies

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for Health Registers, Information, and Vital Events (THRIVE) Study Group. The dedicated group of technology and implementation partners and research institutions grew out of a joint research effort. With the World Health Organization serving as the Secretariat and Ona, a Nairobi-based technology company, as the lead technology partner, together they built out the app, piloted it across the three countries, and established a standardized process for adapting and introducing OpenSRP.

Beginning with immunization, the THRIVE study countries set out to establish a multi-purpose platform. IRD had spent years developing its own app for immunization and studying LHW workflows, but OpenSRP represented a break from previous efforts. Rather than designing a general, one-size-fits-all system, the app allowed health workers to use a single, similar interface across multiple health areas.

Many digital health initiatives have focused on data collection, but few have helped health workers with other responsibilities, such as decision-making. To address this deficiency, the Pakistan register was designed based on careful mapping of LHW workflows. It incorporated a data dashboard and a tool that visually tracks, analyzes, and displays key metrics, such as immunization coverage rates. In addition, Pakistan's register included automated notifications about each child's vaccination status. A geographic information system was used for locating LHWs and for quality assurance.

In 2016, after nine months of software development, IRD began a one-month pilot. As the register was introduced to health workers in Korangi town, IRD collected user feedback. The groundwork laid in Pakistan led to further refinement of the system in Zambia and Kenya.

Adaptation in Zambia and Kenya

Zambia

In 2012, the Ministry of Community Development, Maternal and Child Health (MCDMCH)[1] in Zambia identified poor data quality as a major barrier to improving its immunization programs and ensuring better health outcomes for children. Beginning in 2014, the BID Initiative partnered with the MCDMCH to make reliable, easily accessed, and actionable data available at all levels of the health system.

Starting in Southern Province, the BID Initiative applied an iterative approach to developing and deploying solutions. Interventions included a suite of tools for improving data collection, quality, and use. The largest and most intricate tool in this suite was the development and introduction of an EIR for Zambia.

[1] While the BID Initiative's initial memorandum of understanding was with the Ministry of Community Development, Mother and Child Health (MDCMCH), Mother and Child Health later reverted back to the Ministry of Health in 2016.

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In planning the Zambia Electronic Immunization Register (ZEIR), the BID team and the government recognized a need to minimize software development and learning costs. The early success of OpenSRP in Pakistan, provided a foundation for the efficient development and localization of ZEIR by Ona.

OpenSRP had to be adapted to reflect Zambia's vaccine schedule, its clinical and data workflows, and the different use scenarios of its health workers. This adaptation became ZEIR. BID partnered with the MOH, Ona, and a User Advisory Group (UAG) with representation from community leaders and health workers at facility, district, provincial, and national levels to develop tools and system requirements that adequately addressed Zambia's health context. Ona, as the design lead for OpenSRP, collaborated with end users in a workshop setting to develop the first iteration of the system. The UAG continued to work closely with Ona to lead the user-centered design process by providing feedback at all stages of development, testing, and implementation to ensure a quality product that could be rolled out across Southern Province and scaled nationally.

Based on input from health workers, for example, software developers color-coded the child's digital vaccine card to resemble the paper registers many had used throughout their careers—using blue to indicate boys and pink to designate girls. Also, children are registered in ZEIR with a simple form that mimics the look of the paper child health cards that mothers carry. Other features include unique log-ins for different health workers in the same facility, offline functionality, and the ability to record all vaccinations given at once, instead of requiring health workers to make multiple entries.

After being piloted in six facilities in Livingstone between March and May 2017, ZEIR was rolled out across all 299 facilities providing immunizations in Southern Province, along with other data use interventions.

Kenya

In 2015, the Kenya Ministry of Health through the National Vaccines and Immunization Program (NVIP) identified sub-optimal vaccination coverage as one of the challenges affecting the country's immunization program. NVIP attributed this mainly to the lack of a reliable population denominator, data quality issues related to the paper-based system, as well as a lack of follow up with children to track defaulters.

In 2016, the International Training and Education Center for Health (I-TECH) began building a mobile platform to capture immunization data for children in Kenya as a way of addressing these challenges. It identified OpenSRP as the most suitable and flexible platform for the electronic register.

I-TECH reached out to the BID Initiative to share lessons learned and identify areas of potential collaboration, and then worked with Ona to adapt ZEIR for use in Siaya County, Kenya. The resulting system is called the Kenya Immunization Platform (KIP) which leverages the large scope of ZEIR with I-TECH's expertise in OpenMRS software development and deployment.

User-centered software adaptations for Kenya were based on field-tested workflows of clinical information, such as how health workers would perform client searches, be notified about upcoming services, and generate aggregate reports. A Technical Working Group including software developers, MOH staff, and funders met routinely to discuss design issues and the most relevant use cases for KIP.

A key to the success of KIP is the engagement of the open-source software development community. A Wiki page offers technical documentation and the source code is hosted on GitHub, allowing new and prospective users to collaborate on OpenSRP modules. The result is a vast peer review process that ensures security and accountability. I-TECH's development team, for instance, reviewed ZEIR's source code, forked it, and customized the existing features. As KIP is rolled out across Siaya County, the open-source community updates the public

Wiki page with the latest information and shares builds of the mobile application. This allows the OpenSRP community, as well as future adopters, to benefit from the collective efforts of previous developers. In addition, a Slack channel and Google group facilitate information sharing, and weekly conference calls allow developers to talk through challenges and demo new features. Open collaboration thereby leads to a software platform that stays on the cutting edge of technology

Sustainability and cost-savings in Pakistan, Zambia and Kenya

Investments in OpenSRP in Pakistan, Zambia, and Kenya have produced a software design that enables both flexibility and specificity. These characteristics increase adaptability from country to country, and allow the platform to expand to other health program areas.

Flexible design can greatly reduce the cost of future software development. Additional countries that adapt OpenSRP to create their own EIRs should see significant savings as they build on previous investments. Rather than building an EIR system from the ground up, countries iterate and adapt, using the lessons of those who have come before them. Each subsequent rollout reduces future financial investments.

This model of software development also translates into time savings. As the OpenSRP immunization module becomes more robust, future adaptations are less time intensive, resulting in faster rollout. In Pakistan, for instance, OpenSRP required nine months of development and adaptation prior to piloting, followed by 12 months of maintenance and refinement. ZEIR, on the other, was prepared for initial facility-level release in just three months, and a near-complete version was ready for broader rollout within six months. Similarly, KIP was successfully customized with limited staff time in six months.

Discussion

Open-source platforms empower countries to own, customize, scale, and manage EIRs through shared investment and reduced development costs. Throughout implementation in Pakistan, Zambia, and Kenya, several key lessons have emerged. These include:

- **The user interface requires careful design.** Because EIRs represent a substantial learning curve for most health workers, the user interface should be designed with their experience in mind, and then improved through several rounds of feedback. For example, data entry forms may be designed to resemble a paper vaccine card, and users may be allowed to customize the dashboard view and profile page.

- **Data from dashboards need to be translated into information that implementers can understand and use, both within facilities and across levels of the health system.** OpenSRP provides accessible dashboards with appropriate data for users at various levels of the health system, including client-level data for frontline health workers and aggregate data for higher-level staff. By presenting actionable information and intuitive data visualizations, health workers are more likely to use data for decision-making.

- **Training strategies must take into account the multiple updates required of software platforms, and create the time and capacity to keep pace with these changes.** Even after piloting, an OpenSRP application is likely to require multiple iterations as issues are revealed and features are added or improved. Implementers need a strategy for broadcasting these updates and users need an easy way to make these updates on their device. ZEIR and KIP are available through the Google Play Store, which allows for automated push updates with an internet connection, but some updates require additional technical support and training. In addition to creating training programs that allow for multiple software iterations, teams must develop timelines and budgets that allow for daily operational costs, technical support, and infrastructure maintenance.

The localization and adaptation of OpenSRP's immunization module in Pakistan, Zambia, and Kenya demonstrates the benefits of iterating on open-source software. Agile software development and continued sharing will be critical to the growth of the field and the maturity of health information systems, as countries embrace more affordable, functional, and scalable solutions for their health systems.

Cover photo: PATH/Chimwasu Njapawu