

# Lessons from the use of information technology in immunisation programmes

The importance of agile learning

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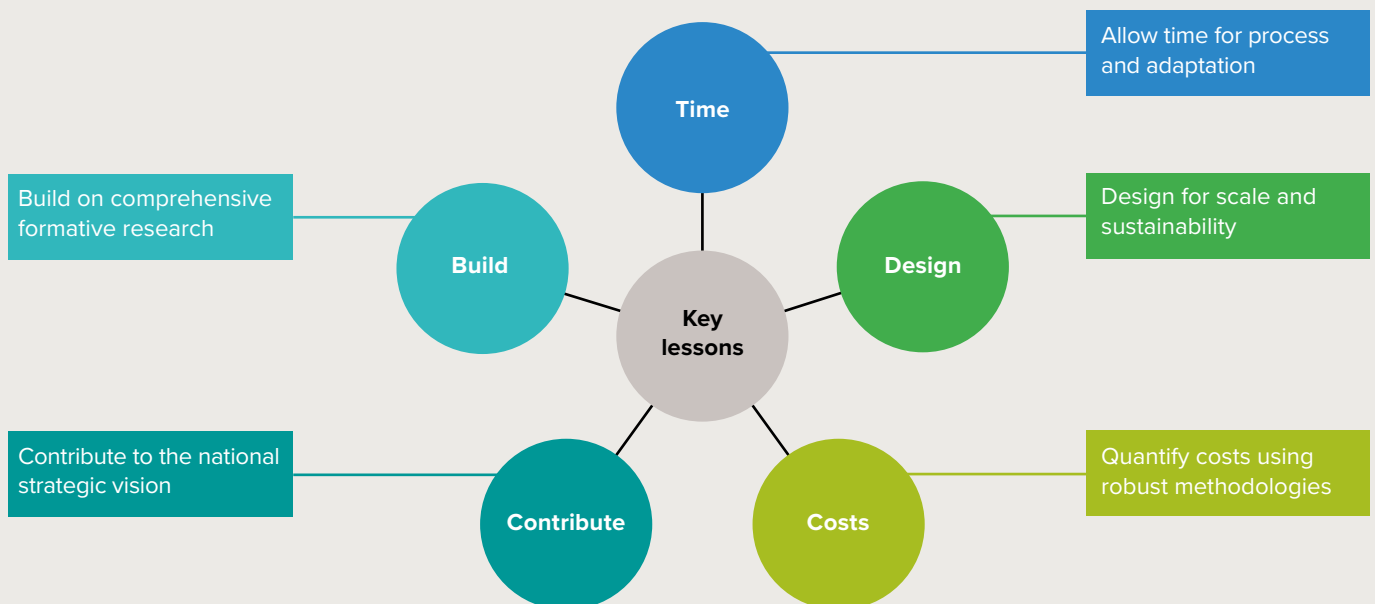
## Summary

A range of information and communication technology (ICT) is available to improve immunisation programmes in low- and middle-income countries. In several of them, Mott MacDonald has recently been involved in developing and evaluating technology solutions for immunisation programmes.

In this paper, we present two case studies, one from Pakistan and Tanzania. We review our experience to identify five key lessons in figure 1 (see page 14 for an expanded diagram).



Figure 1: Five key lessons



## 1. Technology solutions for immunisation programmes

ICT solutions are now common features of immunisation programmes in low- and middle-income countries. Many take the form of electronic health (eHealth) and mobile health (mHealth) initiatives.

Several initiatives focus on enhancing data quality for better decision-making on immunisation coverage and vaccine logistics and include management tools for improved monitoring and accountability.

Mott MacDonald has recently been involved in developing and evaluating technology solutions for immunisation programmes in a number of countries.

In this paper, we draw on this experience to present two case studies, one from Pakistan and one from Tanzania.

The study from Pakistan describes the step-wise development of an mHealth vaccinator monitoring application known as EVACCs.

The one from Tanzania illustrates the development of an electronic immunisation registry (EIR) and its implementation in three regions of the north of the country.

We used a cross-cutting conceptual framework to review the lessons from each study and highlight the importance of complementing agile delivery approaches with agile learning.



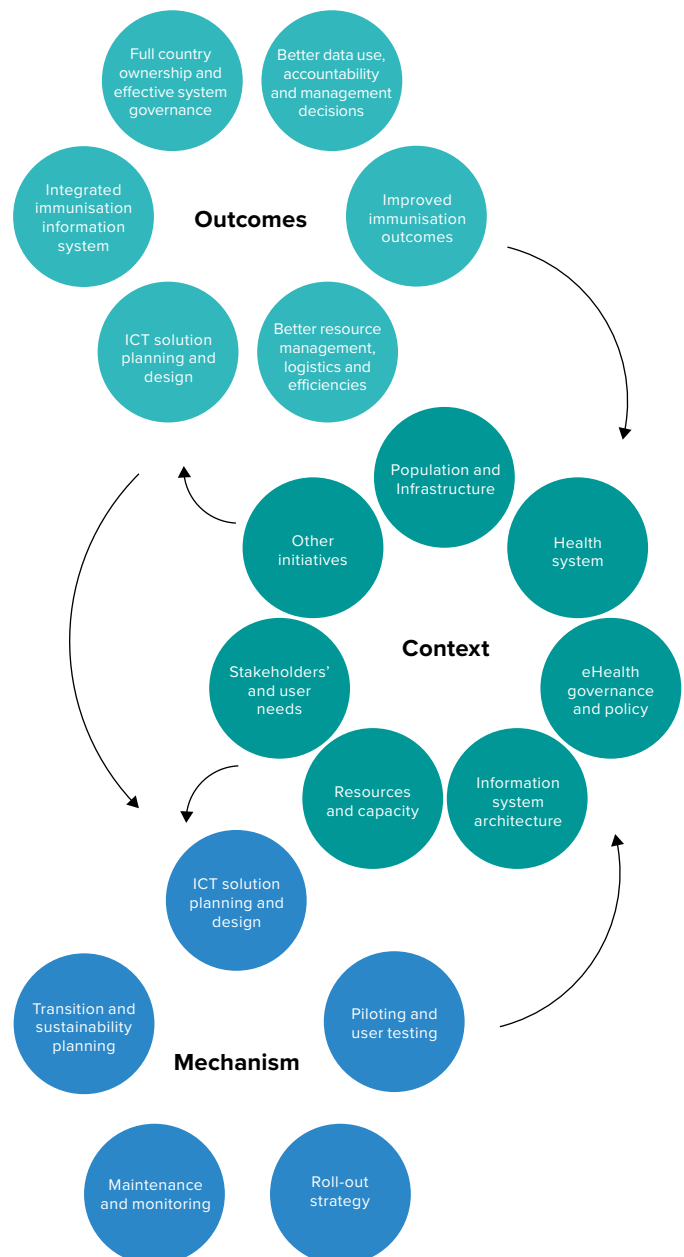
## 2. Reviewing technology solutions for immunisation programmes: A conceptual framework

To compare experiences and lessons across immunisation programmes, we have applied a ‘realist’ conceptual framework. The core proposition is that programme outcomes will be determined by mechanisms (the implementation of interventions) and context.

In other words, evaluations should look beyond an intervention and its outcomes to understand the influence of the surroundings (context). This core proposition informs some broader questions: what works, for whom, in what contexts, how and why?<sup>1</sup> By drawing on experience and practitioner toolkits,<sup>2</sup> we have expanded and adapted the realist conceptual framework for reviewing the use of ICT solutions in immunisation programmes.

The case studies draw on the detailed material contained in programme reviews and evaluations, publications of implementing partners and a wider body of secondary literature. As far as possible, we have triangulated data sources to corroborate programme descriptions and verify key findings. We also aimed to touch on the main dimensions of the conceptual framework to extract observations and lessons that will contribute to shared knowledge.

Figure 2: Outcomes, context and mechanisms



<sup>1</sup> See Marchal, B., Van Belle, S. and Westhop, G. (2015). Realist Evaluation. Better Evaluation. Retrieved December 2018 from [www.betterevaluation.org/en/approach/realist\\_evaluation](http://www.betterevaluation.org/en/approach/realist_evaluation)

<sup>2</sup> See for example, WHO/PATH (2013). Planning an Information Systems Project: a toolkit for public health managers. Retrieved from: [www.who.int/immunization/programmes\\_systems/supply\\_chain/optimize/planning\\_information\\_systems\\_project.pdf](http://www.who.int/immunization/programmes_systems/supply_chain/optimize/planning_information_systems_project.pdf). Also, Pan American Health Organization. (2017). Electronic Immunization Registry: practical considerations for planning, development, implementation and evaluation. Washington, DC: PAHO; Retrieved December 2018 from: <http://iris.paho.org/xmlui/handle/123456789/34865>

### 3. EVACCS in Pakistan

#### What's the context?

Pakistan's health care system is overseen by the federal government and includes public, private and civil society providers. Since 2011, there has been significant devolution to provincial health departments. Within this decentralised structure, health facilities fall under the auspices of district health authorities, and a large cadre of community health workers supports delivery of primary care.

In the 10 years prior to the intervention, Pakistan's progress on immunisation coverage was slow, and the country has continued to experience significant outbreaks of preventable diseases, such as polio and measles.<sup>3</sup> Multiple underlying challenges in the health system have hampered efforts to improve maternal and child health services and engage community vaccinators.<sup>4</sup> Poor performance of Pakistan's Expanded Programme on Immunisation (EPI) has been attributed to a combination of factors, including sub-standard management, weak data reporting and surveillance, and inadequate staffing and funding. Some reports also point to demand-side factors relating to community health-seeking behaviour – a sequence of remedial actions individuals take to rectify ill health.<sup>5</sup> Since 2014, several donors have responded to these challenges by contributing to the National Immunisation Support Project (NISP) through a World Bank-managed multi-donor trust fund. NISP initiatives on vaccine logistics and to improve health systems have led to some progress, but this has been patchy. In particular, challenges relating to human resource management, population growth and movement have proved difficult to address.<sup>6</sup>

This case study focuses on the eastern province of Punjab, which is home to 53% of Pakistan's population. More than one-third live below the poverty line and nearly 60% are under 25.<sup>7</sup> The province is relatively industrialised, but electricity supplies are erratic. There are good mobile phone and internet networks, but coverage dips in rural areas. Since 2010, there have been various health sector reform initiatives in the province;<sup>8</sup> however, by 2014 there were still unacceptably low levels of immunisation coverage, with estimates ranging from 49% to 66% of children being fully inoculated.<sup>9</sup> As in other provinces, immunisation services were failing at the last mile, in part because vaccinators did not visit all communities and there were weak mechanisms for monitoring and supervision.<sup>10</sup>

<sup>3</sup> World Health Organization. (2018). Pakistan: Expanded Programme on Immunization. Retrieved December 2018 from: [www.emro.who.int/pak/programmes/expanded-programme-on-immunization.html](http://www.emro.who.int/pak/programmes/expanded-programme-on-immunization.html)

<sup>4</sup> ul Haque, M., et al. (2016). The Pakistan Expanded Program on Immunization and the National Immunization Support Project: An Economic Analysis. Washington DC: World Bank. Retrieved December 2018 from: <http://documents.worldbank.org/curated/en/264971484109785001/pdf/111815-WP-PAKImmuneizationEA-PUBLIC.pdf>

<sup>5</sup> Ibid

<sup>6</sup> Gavi, the Vaccine Alliance. (2017). Improving Sustainable Immunisation Coverage in Pakistan in Partnership with the Alliance, Gavi Board meeting, 14 June 2017. Document 07b. Retrieved December 2018 from: [www.gavi.org/about/governance/gavi-board/minutes/2017/14-june](http://www.gavi.org/about/governance/gavi-board/minutes/2017/14-june)

<sup>7</sup> Pakistan Bureau of Statistics. (2017). Sixth Population and Housing Census. Islamabad: Government of Pakistan.

<sup>8</sup> See Mott MacDonald's technical resource publications. Retrieved December 2018 from: [www.trfpakistan.org/Portals/18/Resources/Publications/Punjab-HealthSectorStrategy.pdf?ver=2017-03-22-181031-467](http://www.trfpakistan.org/Portals/18/Resources/Publications/Punjab-HealthSectorStrategy.pdf?ver=2017-03-22-181031-467)

<sup>9</sup> ul Haque, M., et al. (2016). Op. cit.

<sup>10</sup> Raquaz, S., et al. (2016). Iterative Design of an Immunization Information System in Pakistan. Retrieved December 2018 from: [https://homes.cs.washington.edu/~anderson/papers/2016/razaq\\_dev2016.pdf](https://homes.cs.washington.edu/~anderson/papers/2016/razaq_dev2016.pdf)



### What is the intervention mechanism?

In Pakistan, we managed the Provincial Health and Nutrition Programme (PHNP), which is funded by the UK's Department for International Development. The PHNP (2014-2019) aims to assist provincial health departments to improve maternal, child and reproductive health and nutrition outcomes. It includes a component known as health reform roadmaps.<sup>11</sup> This is supported by our implementation partner, Acasus, and there is a particular emphasis on achieving immunisation coverage targets.

With a focus on immunisation objectives, Acasus has worked collaboratively with the Punjab Health Department, the Punjab Information Technology Board and the World Bank to introduce EVACCS – a smartphone-based vaccinator monitoring application. The Punjab Information Technology Board gives all of the province's community-based vaccinators a low-cost mobile phone with the EVACCS app installed. This enables vaccinators to report their immunisation activities by recording community visits using global positioning system (GPS) co-ordinate check-ins and photo uploads.

The latest version of the software (EVACCS 3) uses near field communication (NFC) technology to read electronic chips on vaccination cards, track children through the inoculation schedule, identify defaulters and provide a daily work roster for vaccinators.

Data uploads are managed by the Punjab Information Technology Board. Reports are displayed on dashboards using polygon-based maps that turn green when a vaccinator conducts immunisation activities in a community. EVACCS has become both a management tool for vaccinators and an accountability tool for district health authorities.<sup>12</sup>

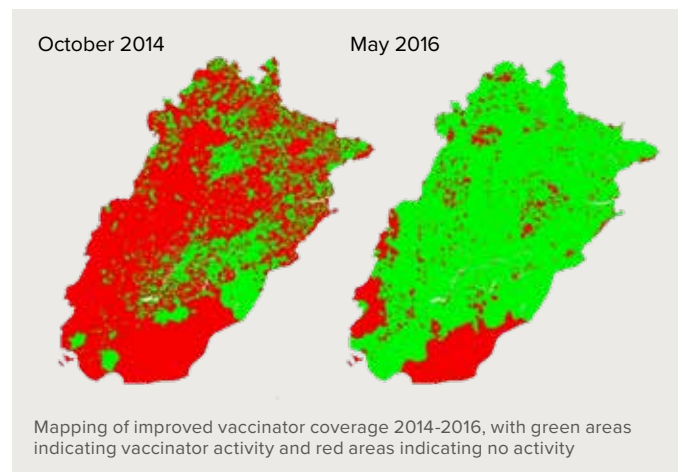
### What have been the outcomes?

Within the context of the PHNP and the health roadmap initiative, EVACCS is reported to have contributed to dramatic improvements in immunisation coverage – primarily due to improved vaccinator performance. By 2016, 82% of children in Punjab province had been fully immunised.<sup>13</sup>

PHNP reports for 2017 indicate that EVACCS monitoring has been extended to 96% of communities in Punjab, with some 165,000 validated child-level data entries collected each month, and 60 vaccinators and managers nominated for performance incentives.

The reports also indicate improved management engagement in vaccinator activities. This has led to increased efforts to recruit vaccinators to vacant posts, and additional investment in their transport and logistics support.<sup>14</sup>

**Figure 3: Punjab coverage**



<sup>11</sup> Cheema, A. (2016). Punjab Health Reforms Roadmap. Retrieved December 2018 from: [www.usefpakistan.org/Alumni/Public/alumniconference/2016/pres/Aneeq\\_Cheema.pdf](http://www.usefpakistan.org/Alumni/Public/alumniconference/2016/pres/Aneeq_Cheema.pdf)

<sup>12</sup> Raquaz, S., et al. (2016). Op. cit.

<sup>13</sup> Sawar, M. (2017). How Pakistan Turned Around Its Vaccination Program Using Technology. MIT Technology Review. Retrieved December 2018 from: [www.technologyreview.pk/pakistan-turned-around-vaccination-program-using-technology](http://www.technologyreview.pk/pakistan-turned-around-vaccination-program-using-technology)

<sup>14</sup> See also: Whelan F. (2018). The fastest increase in immunization coverage ever recorded. Retrieved December 2018 from: [www.acasus.com/insights/view/public-health/the-fastest-increase-in-immunization-coverage-ever-recorded](http://www.acasus.com/insights/view/public-health/the-fastest-increase-in-immunization-coverage-ever-recorded)

## Reflections on EVACCS in Pakistan

- **Punjab province offered a conducive context for EVACCS.** The ICT capacity was in place, along with strong government and management buy-in. There was also enough user compliance and motivation to use the data generated. Senior politicians recognised the political capital to be gained from tangible improvements. In addition, the necessary infrastructure was in place – although, notably, in rural areas poor internet connectivity has slowed data uploads.<sup>15</sup>
- **There was a supportive programme environment.** EVACCS was one element of a wider change management initiative. The PHNP team played an important role in assisting the government to improve vaccinator performance and EVACCS implementation – from its design and deployment to procurement of low-cost Android devices and vaccinator hiring. In addition, the PHNP and NISP teams have been working with the Punjab Health Department on various related health system and governance challenges.
- **There was a step-wise approach to design and deployment.** EVACCS addressed a clear, locally defined operational problem. The design moved from a basic solution to a more complex one over a series of steps.<sup>16</sup> Each took into account user confidence and evolving needs. A key first step was consensus building on the management information indicators that would be used to hold to account district and provincial managers as well as vaccinators. Later, the shift to tracking geographical coverage with polygon maps and dashboards was an important response to users' needs for accessible data to aid transparent decision-making.
- **EVACCS was designed to enhance, not replace, immunisation information systems.** The design and deployment of EVACCS has been consistent with the global principles of digital development,<sup>17</sup> for example by ensuring interoperability and linkages to the wider health information system architecture. It was not designed to replace other reporting systems, information systems or surveys; rather, it has been used as an extra resource for data triangulation and validation. This has simplified rollout and articulation with the wider health information system architecture.

<sup>15</sup> Raquaz S. et al. 2016. Op. cit.

<sup>16</sup> Ibid

<sup>17</sup> Principles for Digital Development. (2018). Retrieved December 2018 from: <https://digitalprinciples.org>



## 4. The Electronic Immunisation Registry for Tanzania

### What's the context?

Tanzania has a decentralised health system that is overseen by the Ministry of Health, Community Development, Gender, Elderly and Children. Public sector and non-governmental health settings fall under the jurisdiction of district or council health management teams that, in turn, are overseen by regional management teams.

The national Immunisation and Vaccine Development (IVD) programme sits within the ministry's reproductive and child health (RCH) division. The programme leads policy, strategy, budgeting, vaccine procurement, training and supervision through a network of regional and district immunisation and vaccine officers (RIVOs and DIVOs). Primarily, facility-based RCH nurses deliver immunisation services and collect routine data using multiple records that include a child register, tally sheets and a stock ledger. Monthly reports for the district can then be compiled. At district level, aggregated facility data is manually entered into the district vaccination data management and stock management tools, and the district health information system (DHIS2) for electronic and manual data transfer to higher system levels.

This case study focuses on three regions in the northern zone of Tanzania – Arusha, Kilimanjaro and Tanga. All three areas are highly populated agricultural regions, with some mining, tourism and fishing industries. Over the past 10 years, there has been considerable investment in infrastructure, but most health settings have only basic equipment. Staff are stretched and electricity supply is unreliable. In general, health settings depend on data bundles to access the internet through patchy mobile phone networks. Urban health centres can be busy, with up to 100 children attending for immunisation services daily. At baseline, the quality of immunisation and vaccine stock data reported by the settings was found to be poor, in part due to the complexity of the paper-based system. There were also questionable denominator estimates, little defaulter tracing and regular vaccine shortages.<sup>18</sup>



<sup>18</sup> PATH Tanzania. (2018). BID Initiative Final Evaluation Report: immunization data quality and use in Tanzania. Retrieved December 2018 from: [http://bidinitiative.org/wp-content/uploads/BID-Initiative\\_ME-Endline-Report\\_Tanzania\\_FINAL\\_20August2018.pdf](http://bidinitiative.org/wp-content/uploads/BID-Initiative_ME-Endline-Report_Tanzania_FINAL_20August2018.pdf)

### What is the intervention mechanism?

The Better Immunisation Data (BID) initiative was funded by the Bill and Melinda Gates Foundation and implemented in Tanzania between 2013 and 2018 by PATH (an international non-profit organisation that seeks to transform global health through innovation). BID aimed to improve the quality and use of data for more effective immunisation programmes, with a focus on the three key challenges of inaccurate immunisation coverage estimates, lack of defaulter tracing, and unreliable vaccine stock data.<sup>19</sup> The BID package of interventions included an electronic immunisation registry (EIR), data use interventions and stock management solutions. We provided independent evaluation services.

Working closely with government and service providers, PATH spearheaded the development of the EIR software, known as the Tanzania Immunization Registry (TImR). PATH's Canadian subcontractor, Mohawk College, used a disciplined agile delivery methodology<sup>20</sup> to design the EIR solution. The EIR uses standards-based Open IZ software that was adapted to be locally scalable and extensible, as well as interoperable with DHIS2 and other information system initiatives.<sup>21</sup> At facility level, the EIR software is accessed using a standard tablet computer. The design supports single-point data entry, retrieval of individualised immunisation records, vaccine stock management, real-time reporting to district level and retrieval of customised data reports to inform decision making.

PATH's implementation strategy for the EIR evolved to maximise efficiencies for scale-up and increase the involvement of district health management teams (DHMTs). As a result, DIVOs and other district officers were actively involved in providing EIR training and mentoring support to facility staff under the technical guidance of the PATH and Mohawk College teams. To assist scale-up and sustainability, PATH supported ICT capacity development at national and district levels. It continues to provide technical support for interim software maintenance, and contributed to resource mobilisation efforts for expansion of in-country server capacity and scale-up to new regions.

Since 2016, PATH and other development partners, such as US-based public health consultancy John Snow Inc, have been working with the IVD programme to reduce fragmentation of data reporting at higher levels by developing a vaccine information management system (VIMS). Both VIMS and the EIR are designed to be consistent with the National eHealth Strategy that ran between 2012 and 2018 and the strategic vision of the Data Use Partnership (DUP).<sup>22</sup> There is now an emerging vision for integration of the VIMS and EIR systems to enable back-to-back electronic immunisation reporting from health facility to national level.

<sup>19</sup> In Tanzania, there were multiple specific challenges relating to: unreliable denominator estimates; incomplete or untimely immunisation data reporting; lack of unique identifiers for defaulter tracing; complex and duplicated data collection forms; and weak capacity for data management and use at all health system levels.

<sup>20</sup> Ambler, S.W. (2013). Going Beyond Scrum: disciplined agile delivery. Retrieved December 2018 from: <https://disciplinedagileconsortium.org/Resources/Documents/BeyondScrum.pdf>

<sup>21</sup> See Mohawk College's 2016 news publication. Retrieved December 2018 from: [www.mohawknewsdesk.ca/data-is-the-new-immunity](http://www.mohawknewsdesk.ca/data-is-the-new-immunity)

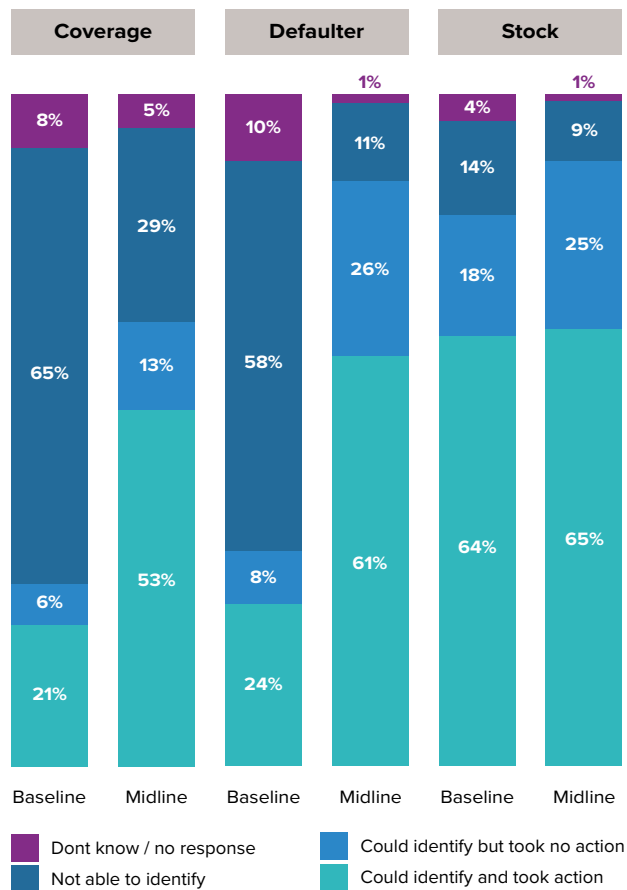
<sup>22</sup> PATH. (2016). Data Use Partnership: The Journey to Better Data for Better Health in Tanzania. Retrieved December 2018 from: <https://www.path.org/resources/data-use-partnership-the-journey-to-better-data-for-better-health-in-tanzania/>

### What have been the outcomes?

Through collaborative working with DHMTs, PATH successfully rolled out the EIR and BID package of interventions to 1273 health settings in the northern zone of Tanzania and Dodoma region<sup>23</sup> by June 2018. By August, 467,105 children had been registered into the EIR, creating an opportunity for further data analytics. There had also been good progress in building the capacity of users at facility and district levels. PATH’s competency reviews indicated user proficiency in EIR data entry to be high and data use for decision-making astute. In Tanga region, PATH’s baseline and midline surveys showed a significant increase in nurses’ (self-reported) use of data for decisions on immunisation coverage and defaulter tracing after EIR was introduced (see figure 4).<sup>24</sup>

Our independent evaluation found that the programme had not achieved a complete transition from paper-based to electronic immunisation reporting, so it was not possible to confirm time savings for users or improvements in system data quality. Nevertheless, the evaluators confirmed there was a large cadre of nurses skilled in EIR data entry and use for patient care. Despite some operational problems in using the EIR for every patient, there were generally high levels of motivation for moving towards electronic reporting. The Tanzanian government is now conducting an assessment in Tanga region to review the feasibility of adopting full paperless immunisation reporting. In addition, Gavi, the Vaccine Alliance, has allocated grants to expand the EIR and VIMS to all regions of Tanzania.

Figure 4. PATH’s baseline and midline survey findings



Findings from Tanga region showing improvements in nurses’ self-reported ability to identify data and use it for actions on immunisation coverage, defaulter tracing and stock management after the EIR was introduced (June 2018)

<sup>23</sup> In Dodoma region, implementation of the BID intervention package was led by John Snow Inc. (JSI).

<sup>24</sup> Graphic sourced from: PATH Tanzania. (2018). BID Initiative Final Evaluation Report: immunization data quality and use in Tanzania (p.27). Retrieved December 2018 from: [http://bidinitiative.org/wp-content/uploads/BID-Initiative\\_ME-Endline-Report\\_Tanzania\\_FINAL\\_20August2018.pdf](http://bidinitiative.org/wp-content/uploads/BID-Initiative_ME-Endline-Report_Tanzania_FINAL_20August2018.pdf)

### Reflections on the EIR for Tanzania

- **It took time to adapt the EIR solution to the operational context.** Although the EIR software solution was based on generic electronic medical record data storage technology, it took time to adjust its functioning to the connectivity environment (for example, building in offline functionality and operating within data bundle allowances). There was also a need for design flexibility and agility to respond to evolving user needs at each system level. It was also necessary to accommodate the complexities and data dependencies of the health information and logistics systems, and to engage with their respective governance and regulatory environments.
- **Securing government buy-in was an ongoing process.** Although PATH was in close dialogue with the government from the outset, the initiative gained traction with government partners only after three critical developments: the involvement of district officers in the rollout of a scalable version of the EIR under district medical officer leadership; linkages being forged with wider strategic initiatives, such as VIMS and the DUP roadmap; and the securing of resources from Gavi.
- **Transition, sustainability and resource planning have been complex.** In practice, the transition to full electronic reporting has been difficult and the EIR solution continues to run alongside the paper-based legacy system. This is due to several factors, including the need for further whole-system testing of the intervention package at scale. In addition, it has been time-consuming to address challenges presented by local server capacity; data back-entry and data back-up; ICT maintenance capacity; and provision for data privacy and security.<sup>25</sup> Transition and sustainability planning have needed active consensus-building, with consideration given to the full software lifecycle and the projected human resource capacity for scaling up. These complexities have also made it challenging to assess the total cost of ownership of the EIR to government.

<sup>25</sup> See also, PATH. (2018). BID Initiative: lessons learned encyclopaedia. Retrieved December 2018 from: [http://bidinitiative.org/wp-content/uploads/FINAL\\_LessonsLearned\\_Encyclopedia\\_6July2018-Logo.pdf](http://bidinitiative.org/wp-content/uploads/FINAL_LessonsLearned_Encyclopedia_6July2018-Logo.pdf)

## 5. Conclusions

The two case studies aim to systematically describe examples of technology solutions in immunisation programmes. They highlight the need for agile development of eHealth and mHealth solutions for immunisation programmes in low- and middle-income countries that can respond flexibly to complex, operational systems and user environments.

The global principles for digital development provide useful guidance for the design and deployment of digital solutions. However, they still need to be interpreted and adapted locally.<sup>26</sup>

Our case studies from Pakistan and Tanzania have also highlighted the need to actively capture lessons, particularly implementation experience and the longer-term issues of system maintenance, scale-up and sustainability. This, in turn, requires agile learning to ensure programme experience informs future practice.

Five generic lessons have emerged from our case studies to contribute to an agile learning agenda.



<sup>26</sup> Waugaman, A. (2016). From Principle to Practice: Implementing the Principles for Digital Development. Washington, DC: The Principles for Digital Development Working Group, January 2016.

## Five key lessons

### Build on a comprehensive formative assessment

This could be informed by existing standard methods such as the collaborative requirements development methodology. The methodology must be inclusive and iterative in eliciting user needs and workflows. It must also include mappings of the wider health information system architecture and data dependencies, as well as detailed reviews of the institutional, governance and resource environment. Ensure this information is shared with the developers and informs the design and deployment of the ICT solution.

### Contribute to the national strategic vision

Be aware of the wider policy and strategy environment, including the presence of an eHealth strategy. Future-proof the design by ensuring it is consistent with government's longer-term vision for immunisation and health information reporting. Be cautious about perpetuating vertical reporting systems. Seek to ensure digital initiatives remain complementary and mutually reinforcing at each level of the health information system. Be prepared to build on earlier initiatives.

