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Evaluation of the Better Immunization Data Initiative

Final Evaluation Report for Zambia and Tanzania: Synthesis and Country Reports

10 September 2019

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Bill & Melinda Gates Foundation

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Note from PATH on the findings of this third party evaluation report

PATH's response to the Mott MacDonald evaluation report of the BID Initiative:

The PATH team would like to acknowledge the Mott MacDonald team for their thoughtful work in conducting the evaluation of the BID Initiative over the past several years. The process has been informative, and we valued their professionalism and ability to adapt with what has been a complex body of work. We believe their evaluation report brings forth critical points and aligns with many of our own lessons learned. While our comments below only highlight and respond to a few of their findings, we appreciate the overall evaluation work they conducted as contained in this report.

- One aspect that the PATH team would like to emphasize out of the BID experience, and which is highlighted in Mott MacDonald's findings, is the challenges in achieving consistent use of the electronic immunization registry (EIR) system while the legacy paper system remains in place. The requirement of the health workers to enter data into two systems creates many challenges, such as contributing to data quality challenges and the consistency of usage of the EIR. This phase of dual system usage has been prolonged in the initial test regions in both countries while the governments determines the process to make the formal shift of reporting systems. Our recommendation and hope is that in the future similar initiatives are able to work closely with the government to consider the process and timing of eliminating legacy tools from the onset of introducing similar systems in order to maximize the outcomes.

- With the Total Cost of Ownership (TCO) work, we would like to highlight that PATH did take into account the need for replacement of tablets in the ongoing maintenance costs, as noted in the footnote on page 15 of the report. This is based upon the rate of replacement experienced during the implementation of the project, which we felt to be the most appropriate rate to include in our calculations.

- In addition, on the TCO calculations, while we do understand the questions raised by Mott MacDonald, the timeframe of the project and funding did not allow for the TCO to be conducted in the way they would have preferred to have seen it done. This is due primarily to the project ending prior to be able to measure the true long-term maintenance and scale-up costs, as well as prior to the removal of the legacy paper system which impacted the ability to understand the exact costs, time savings, etc.

- In relation to the assessment on outcome 1 (data quality) we feel there are many challenges in assessing the data quality of the EIR to the legacy system tools, as both PATH and Mott MacDonald found significant data quality challenges within the legacy system itself in both countries. We feel it is important to highlight this fact and take into consideration when considering the data quality results outlined in the report. Measuring data quality within an EIR (and in particular electronic immunization registries) continues to be an area where we (the community of researchers & implementers considering such systems) can continue to work and align on the best routine approaches to measuring data quality during scale-up and ongoing implementation.

- It is important to note that the way Mott MacDonald measured outcome 2 (data use, focused on "user skills in entering, retrieving and interpreting EIR data") is a narrow definition of data use and there may have been other types of data use that occurred that weren't captured by this study design. For example, if HCWs increased their defaulter tracing using the paper forms rather than the EIR data, that would not be captured but would still be a positive outcome resulting from BID data use activities.

- The primary audience for the BID Learning Network (BLN) activities was intended to be the national level stakeholders of the various member countries (including Tanzania and Zambia), with some sub-national stakeholder participation at times. We raise this as clarification on the various points under outcome 3 where it is noted that sub-national participation in the BLN was low. For sub-national levels

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in Tanzania and Zambia other peer networking interventions were the primary interventions used such as WhatsApp groups.

- Since the time of the Mott MacDonald evaluation, work has continued under other funding to support both Tanzania and Zambia as well as the ongoing work of BLN. These fall primarily under outcomes 3 and 4 and the specifics include:

  - Tanzania: In addition to the four regions in Tanzania mentioned in this report, the government has now deployed the EIR and other interventions to five additional regions, with plans to achieve national scale in 2020. The EIR is now in 2,408 facilities across the nine regions, with over 800,000 children registered into the system. This work has been done with the Gavi Health System Strengthening (HSS) funding the government receives, and PATH has continued to support this work through Gavi Targeted Country Assistance funding. Additional investments have been made into the EIR system to address several of the challenges highlighted in this report, and various of the sustainability aspects have been put into place such as local hosting of the database and integration of the system with DHIS2.

  - Zambia: PATH has continued to support the work in Zambia in Southern Province. The government has recently received approval for the use of part of their Gavi HSS funding to support ongoing work in Southern Province and is awaiting approval of additional HSS funding to expand to Western Province. Additional work has been conducted on the EIR system to continue to strengthen its functionality and to support the transition to local hosting and integration with DHIS2.

  - BLN: The BLN continues to work with countries across the region and is focusing efforts on a Gavi funded initiative with a sub-set of ten countries who are supporting each other in the implementation of their data improvement plans.

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Abbreviations

BID	Better Immunization Data (initiative)
BCG	Bacille Calmette Guerin
BLN	Better Immunization Data Learning Network
BMGF	Bill and Melinda Gates Foundation
CCIT	Cold Chain Inventory Tool
CDC	Centers for Disease Control and Prevention
CDE	Casual Daily Employee
CHAI	Clinton Health Access Initiative
CHAZ	Churches Health Association of Zambia
CHW	Community Health Worker
CIDRZ	Centre for Infectious Disease Research in Zambia
CMYP	Comprehensive Multi-Year Plan
CSO	Central Statistics Office
DDUM	District Data Use Mentors
DHIO	District Health Information Officer
DHIS2	District Health Information System 2
DIM	District Immunization Mentors
DIVO	District Immunization and Vaccine Officer
DMO	District Medical Officer
DQA	Data Quality Assurance
DUP	Data Use Partnership
DVD-MT	District Vaccination Data Management Tool
EIR	Electronic Immunization Registry
EIS	Electronic Immunization System
EMR	Electronic Medical Record
EPI	Expanded Program on Immunization
HCW	Health Care Worker
HIA2	Health Information Aggregate 2
HMIS	Health Management Information System
HPV	Human Papilloma Virus
HRIS	Human Resource Information System
HSS	Health Systems Strengthening
ICC	Inter-Agency Coordinating Committee
ICT	Information and Communications Technology
ICT4D	Information and Communications Technology for Development

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IDSR	Integrated Disease Surveillance Response
IMCI	Integrated Management of Childhood Illness
IVD	Immunization and Vaccine Development
JAR	Joint Annual Review
JICA	Japan International Cooperation Agency
JSI	John Snow, Inc.
M&E	Monitoring and Evaluation
MCH	Maternal and Child Health
MoH	Ministry of Health
MoHCDGEC	Ministry of Health, Community Development, Gender, Elderly and Children
MSL	Medical Stores Limited
OPV	Oral Polio Vaccine
PAHO	Pan American Health Organization
PCV	Pneumococcal Conjugate Vaccine
PMTCT	Prevention of Mother to Child Transmission
QR	Quick Response
RCH	Reproductive and Child Health
RIVO	Regional Immunization and Vaccine Officer
RV	Rotavirus Vaccine
SHIO	Senor Health Information Officer
SMT	Stock Management Tool
TCA	Targeted Country Assistance
TIIS	Tanzania Immunization Information System
TImR	Tanzania Immunization Registry
TOC	Theory of Change
TWG	Technical Working Group
UAG	User Advisory Group
UCC	University Computing Center
UDSM	University of Dar Es Salaam
UNICEF	United Nations Children's Fund
USD	United States Dollar
VIMS	Vaccine Information Management System
WHO	World Health Organization
ZDHS	Zambia Demographic and Health Survey
ZEIR	Zambia Electronic Immunization Registry

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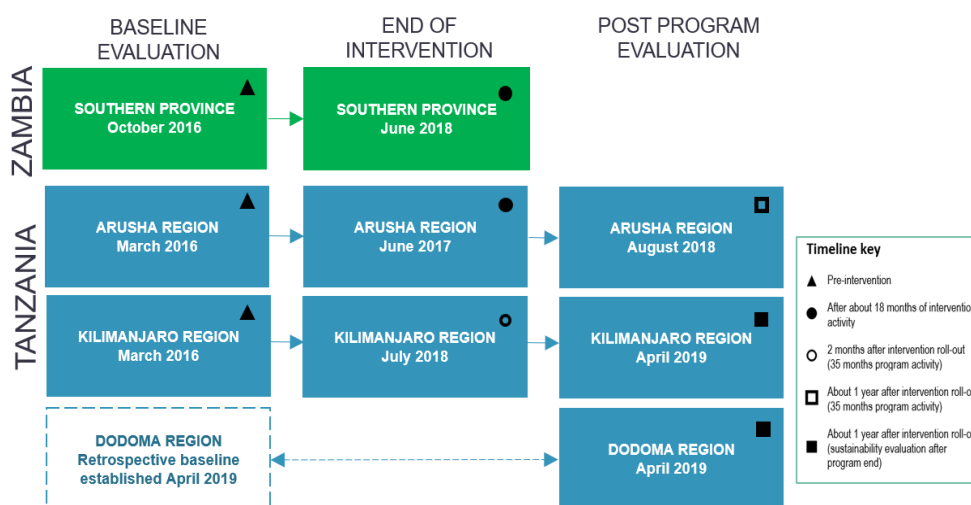
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Executive Summary

Background

The Better Immunization Data (BID) Initiative aimed to improve the quality and use of data for more effective immunization programs in Sub-Saharan Africa. The initiative was funded by the Bill and Melinda Gates Foundation (BMGF) over the period 2013-2018. It was implemented by PATH in two demonstration countries, Zambia and Tanzania. The BID package of interventions included an electronic immunization registry (EIR), data use interventions and stock management solutions. The intended outcomes of the BID Initiative in the two demonstration countries were defined in a results framework. This framework described four primary outcomes relating to: the improved quality of immunization data (Outcome 1); increased use of immunization data for decision-making (Outcome 2); country ownership and implementation of BID interventions at scale (Outcome 3); and additional resource commitments secured (Outcome 4). Learning and experience from the demonstration countries continues to be shared through a community of practice known as the BID Learning Network (BLN).

Mott MacDonald has provided independent evaluation services for the BID Initiative with the aim of verifying and explaining results and identifying lessons learnt. This report presents a synthesis of findings from successive milestone evaluations. Full reports for each of these evaluation exercises are included as annexes to the synthesis report. This report also includes findings from a special study in Dodoma Region to assess the effectiveness of an alternative rollout strategy.

Methodology

The non-experimental, theory-based design of the BID evaluation was tailored to the complexity of the BID Initiative and the innovative nature of the interventions. The evaluation design focused on ten case study districts - three in the Southern Province of Zambia and seven in Arusha, Kilimanjaro and Dodoma Regions of Tanzania. These case study districts were purposefully selected to represent a range of implementation settings. Evaluations in the case study districts focused on geographic regions and took place at key program milestones, namely: at baseline; after the package of interventions had been implemented; and in the post-program period (to assess sustainability).

Sequencing of the BID evaluations across countries and regions, 2016-2019

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A standardized methodology was used for each milestone evaluation. This was based on a triangulated, mixed methods approach for assessments against the BID Initiative's theory of change and results framework. To review changes in data quality at scale in each case study district, the evaluators used data quality assurance (DQA) tools to assess the availability, completeness and accuracy of immunization and vaccine stock data, with a focus on six proxy antigens over a three-month period in a panel sample of six health facilities. These assessments were completed by cross-checking the data in the BID master database against primary records at health facilities (with tally sheets and stock ledgers found to provide reasonable reference points at baseline). The assessments were also conducted on the legacy reporting system at each milestone evaluation to provide a counterfactual reference point.

To review changes in data use for decision-making, the evaluators focused on user skills in entering, retrieving and interpreting EIR data. We used a standardized competency assessment tool to score a range of user skills at each milestone evaluation. In addition, progress on these and other outcomes was assessed qualitatively using key informant and in-depth semi-structured interviews, direct observation and review of secondary data.

To support comparisons between case study sites and identify factors in success and emerging lessons, we applied a realist analytical framework. For this analysis, we structured our findings around the themes of **context**, the **mechanism** (implementation of interventions) and **outcomes**.

Findings Part 1: Key findings from Zambia

Due to time and resource constraints, the evaluators were only able to conduct baseline and end-of-intervention evaluations in Zambia (it was not possible to conduct a post-program evaluation). From the evaluations, we found that key features of the **context** affecting the adoption and scale- up of the BID interventions in Zambia were: a) unreliable internet connectivity (especially in rural facilities) and a dependence on supplies of internet bundles; b) a 'legacy' immunization reporting system that was fully integrated into wider reproductive, maternal and child health reporting and stock management systems; c) multiple cadres of health care workers involved in immunization reporting; d) routine provision of immunization outreach services; and e) the presence of other related digital health initiatives.

Key findings on **the mechanism** used by PATH were:

- EIR design and deployment: The final version of the Zambia EIR (ZEIR) was built on an Open SRP platform and was fully functional by program end. Key design challenges included: provision for offline working; multiple users of single devices; methods for data back-entry; version updates; data exports to DHIS2 (note the original software developer was replaced due to difficulties in producing a scalable design).
- Rollout strategy: This involved four PATH-led 'touch visits' to all health facilities in the target province. Using this strategy, the PATH implementation team was able to rollout the BID package of interventions to all 298 eligible facilities in Southern Province by March 2018.
- Maintenance and sustainability: Provision for *long-term* system monitoring, maintenance and upgrades was still uncertain by program end. Government requested PATH to modify the ZEIR design to accommodate linkages to other initiatives; however, this was not possible within the timeframes of the program.

Key findings on **outcomes** were:

- Outcome 1 – improved data quality at scale:
  - For counterfactual referencing, the evaluators tracked data quality in the legacy system over time. Using our standard DQA methodology, we found that, at facility level, there was a slight deterioration in accuracy of immunization reporting between baseline and the end-of-intervention evaluation – at baseline 24% of paired data points matched accurately (n=374) compared to 19%

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(n=324) at the end-of-intervention evaluation. Qualitative investigations suggested that the multiplicity of reporting systems at facility level (including those for other initiatives) may have been a factor affecting reporting accuracy.

– The evaluators applied the same DQA methodology to assess the accuracy of immunization and stock data in the ZEIR master database at the end-of-intervention(18 month) evaluation. The ZEIR data did not compare well to primary source data for immunizations or stock, with very few paired data points matching across the six proxy antigens over the three-month period in the panel sample of health facilities. These findings were, highly consistent with qualitative assessments where the evaluators found nurses were not using ZEIR to enter data on every client - this meant aggregated data in the ZEIR database was incomplete and did not match primary immunization data sources.

● Outcome 2 – improved data use for decision-making: At the end-of-intervention evaluation, the evaluators found that, among the 19 trained users assessed at facility level, 74% were found to be fully or mostly competent in using ZEIR to register a new child. Unfortunately, the evaluators were not able to complete competency assessments relating to data retrieval and interpretation and defaulter tracing because all the facilities in the sample were using an old version of ZEIR where these actions were not possible.

● Outcome 3 – implementation at scale and country ownership:

– All eligible health facilities in Southern Province had received the BID package of interventions by March 2018. Interviews with district, provincial and national key informants suggested that the potential of ZEIR was fully recognized, especially its potential for time savings, real-time data transfers and data visibility at each system level. However, these key informants also expressed several concerns including: the long timeframes required for software development and modifications; the potential for reporting fragmentation and lack of harmonisation across initiatives; the implications for long-term management and resource investments by government; and other sustainability concerns - such as data security issues and the need for additional technical skills transfer.

– With regards participation in the BLN, there was some good participation in face-to-face meetings by a cross-section of representatives from the national immunization program, but relatively little consistent participation in online events and social media, especially at sub-national levels (where connectivity was generally a constraint).

● Outcome 4 – resource commitments:

– PATH originally hoped to produce a comprehensive total cost of ownership (TCO) assessment to provide governments with data on the cost implications of adopting the BID package of interventions. However, in practice, a complete TCO analysis was not possible due to challenges in defining: a) costs incurred by other role-players (e.g. by government for staff time) and b) long-term maintenance and scale-up costs. Nevertheless, PATH was able to provide a sound and transparent analysis of its own costs.

– Extrapolating from the data provided by PATH, we estimated the cost of scale-up to all 10 provinces would be ~US$10.8 million – of which total rollout costs would be ~US$8 million (spread over several years). For Zambia, US$8 million equates to 15% of all annual immunization expenditure by government and its partners. We noted that, by program end, we were not able to align cost estimates for Zambia to measurable outcomes – this analysis would be needed to build a structured business case for investment.

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Findings Part 2: Key findings from Tanzania

In Tanzania, key features of the implementation **context** were: a) patchy internet connectivity, with health facilities dependent on a supply of internet bundles for internet access; b) a vertical immunization and vaccine stock legacy system that operated in parallel to other health information and logistics systems; c) an available cadre of immunization officers at district and regional levels; and d) the presence of another digital health project that was *complementary* to the BID Initiative (i.e. the Vaccine Information Management System (VIMS) for electronic reporting from district to national levels).

Key findings on **the mechanism** used by PATH were:

● EIR design and deployment: The final version of Tanzania EIR software, the Tanzania Immunization Registry (TImR) was built on a standards-based Open IZ platform and was fully functional by program end. As in Zambia, the original developer was replaced due to difficulties in producing a scalable design. Despite compressed timeframes, the new developer successfully addressed key design challenges relating to: offline working and data synchronisation; data warehousing and data processing speeds; and the need to add new features "on the fly" and provide system maintenance services.

● Rollout strategy: This started with the PATH-led 'touch strategy' and evolved to become District Data Use Mentors (DDUM) strategy. For the DDUM strategy, district officers were trained as mentors to lead scale-up. This was found to improve country ownership and sustainability, so the strategy was adopted for rollout in Tanga and Kilimanjaro Regions and the remainder of Arusha Region – although there were some challenges with quality assurance and duration of inputs. Further adaptations led to the IMPACT Team approach used for Dodoma Region – this was a more rationalised trainer-of-trainer approach, with stronger elements of data use for quality assurance.

● Maintenance and sustainability: To support sustainable system maintenance and monitoring, PATH and the EIR developer (MEDIC) invested considerable time and resources in capacity development of national-level Information and Communications Technology (ICT) units. However, by the post-program evaluation, the trained ICT personnel had all been appointed to new positions. There was, therefore, considerable uncertainty about sources of technical and ICT support over the longer term.

Key findings on **outcomes** were:

● Outcome 1 – improved data quality at scale:
  – From review of the IVD legacy system for counterfactual referencing, the evaluators found little significant change in data quality in the Northern Zone over the evaluation period 2016-2019. For example: at baseline, using the standard DQA methodology, the accuracy of facility immunization reporting in the Northern Zone case study regions was estimated to be 47% (n=324 paired data points). At the 35-month evaluation, the accuracy of facility immunization reporting was estimated to be 44% (n=288 paired data points) – with the small improvement observed in Kilimanjaro Region at the Post Program evaluation probably due to changes in reporting formats. For the special study in Dodoma Region, the evaluators confirmed that the IVD legacy system was similar to the Northern Zone, although the accuracy of IVD immunization data in rural Bahi District was noted to be better at 72% (n= 105 paired data points) than Dodoma Urban at 33% (n= 126 paired data points) - possibly due to differences in management support.
  – To assess data quality in the EIR reporting system, the evaluators applied the same DQA methodology to compare immunization data in the EIR master database with primary facility records in each of the implementation regions.
  – In Arusha Region, at the end-of-intervention (18 month) evaluation, of 288 paired data points, 8% of BID EIR records matched primary records. Notably, the primary records (tally sheets)

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consistently recorded more immunizations administered than the EIR database, suggesting the EIR data was incomplete. From qualitative enquiries, we found nurses were not using the EIR consistently because they found the application (then the TIIS version) to be slow and unstable. At the post-program (35 month) evaluation in August 2018, we found even lower levels of accurate (complete) data in the EIR database. Qualitative investigations indicated this was because nurses trained in TIIS were not confident in using the updated TImR version. After program completion, there were also growing problems with supplies of internet bundles.

– In Kilimanjaro Region, we used the same DQA methodology to assess the accuracy of the immunization data in the EIR master database. At the end-of-intervention evaluation (July 2018), we found just 5% of 231 data points in the master database matched primary facility records. Qualitative investigations suggested that, while users in this region had benefited from training in TImR from the outset, many felt they needed more instruction and practice in using the system. At the post-program evaluation (April 2019), estimated accuracy of EIR master data was 6% (n=231 paired data points) - although BCG records were relatively good, with 27% of paired data points matching. From qualitative enquiries, we found EIR usage was still inconsistent and very few users had downloaded the most recent TImR updates. Overall, usage in Moshi Municipal appeared better than in rural Mwanga District, probably due to more diligent follow-ups by the DIVO in the urban center. We also noted that, by this stage, some hardware problems were beginning to emerge – either due to loss, damage or missing power cables, or due to wear, tear, malfunctions and/or reduced battery life.

– In Dodoma Region, the special study provided the evaluators with an additional opportunity to examine EIR data stored on the tablet computers and data uploaded to the master database. Using the standard methodology, we first compared immunization records in the EIR master database with primary facility primary records. Just 4% of 231 paired data points in the master database matched primary records for the two case study districts. But when we examined data stored on the EIR tablet computers, we found that for Bahi District 16% of 105 data points matched accurately (with Measles 2 accuracy reaching 28%); however, for Dodoma Urban, accuracy results were extremely poor at 0% (n=126). These results for Bahi District indicated EIR data was not being successfully uploaded in a timely manner. Qualitative investigations suggested that uncertain supplies of internet bundles could be affecting data uploads; however, we noted that, even in Bahi District, the EIR was not being used for every client. In Dodoma Urban, EIR usage was significantly affected by high DIVO turnover and hardware distribution problems, especially in non-government facilities.

● Outcome 2 – improved data use for decision-making:
  – In Arusha Region, at the end-of-intervention (18 month) evaluation, we found very good overall levels of EIR competency, with 86% of nurses (n=20) assessed as being fully or highly competent in registering a new patient; while 82% (n=24) were fully or highly competent in a set of other data use tasks. Notably, scores were weaker on stock management with only 59% of nurses (n=22) assessed as being fully or highly competent. At the post-program (35 month) evaluation, scores for using the EIR to register a new patient were still very good, with 74% of assessed nurses (n=20) as fully or highly competent. However, by this stage, there had been a marked decline in other areas of competence - e.g. for the task set on retrieving and interpreting data and defaulter tracing, only 30% of nurses assessed (n=21) were scored as fully or highly competent. Qualitative investigations confirmed this decline was largely due to nurses' lack of familiarity with the new TImR update.

  – In Kilimanjaro Region, at the end-of-intervention evaluation, we found good overall levels of EIR competence, with 74% of assessed nurses (n=14) scored as fully or highly competent in registering a new client, and 47% (n=16) of nurses scored as fully or highly competent in the set of other data use tasks. These findings were consistent with qualitative findings that the recent training by mentors had prioritised skills in client registration. At the post-program evaluation, there were still

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very good scores for competencies in registering a new client, with 84% (n=12) of assessed nurses scored as fully or highly competent. However, skills in other EIR task areas had declined considerably, with only 2 nurses (n=12) in Moshi Municipal scoring well in the task set on data interpretation and defaulter tracing. These findings were confirmed by qualitative findings which showed that, when nurses used the EIR, it was mostly for client registration tasks. Users continued to report that EIR data retrieval was slow, especially in mountainous Mwanga District where internet access was unreliable. Most nurses were not using the barcode scanners due to a perception that they slowed data retrieval. Once again, nurses were concerned about adequate supplies of data bundles.

– In Dodoma Region, sample sizes for competency assessments were reduced because some tablets were not working (especially in Dodoma Urban), or were not available at time of visit (in Bahi District. Among nurses who could be assessed, 100% (n=8) in Bahi District were scored as fully competent in using the EIR to register a new client; this compared to just 33% (n=7) in Dodoma Urban. Similarly, for other data use tasks, 100% (n=8) of assessed nurses in Bahi District were fully/mostly competent, compared to 43% (n=7) in Dodoma Urban. Although, it was difficult to make direct links to the IMPACT Team approach, we noted that nurses had better all-round skill sets in Dodoma Region. Qualitative investigations suggested that, once again, the differential findings between the case study districts were associated with continuity of DIVO and management support.

– At district level, across the board, we found that DIVOs were still not using EIR data, other than to cross-check data from other data sources and for intermittent monitoring of EIR usage. Moreover, all DIVOs interviewed preferred to use IVD paper reports to populate VIMS at district level, mostly because they perceived the EIR data to be incomplete and unreliable.

● Outcome 3 – implementation at scale and country ownership:
  – By program end, the BID Initiative had been rolled out to a total of 1,273 health facilities in Tanzania (including Tanga and Dodoma Regions). Our regular key informant interviews at national level confirmed there was a good level of buy-in for the BID Initiative from the outset – although this was driven by a vision for integrated EIR and VIMS information systems in the form of an Electronic Immunization System (EIS). This strategic vision was also behind government's efforts to advance paperless reporting in Tanga Region and the successful 2017 grant application to Gavi, the Vaccine Alliance, to scale-up the EIS interventions to all regions in Tanzania by the end of 2019.

  – With regards participation in the BLN, the National IVD Manager had been an active participant in BLN meetings and events. She had participated as a facilitator and as a contributor to BLN discussions and suggested these engagements had been useful for updating her technical knowledge and for networking with peers from other countries. Participation by other stakeholders at district and facility levels was less frequent, although many of these stakeholders had established active and productive peer support networks through WhatsApp groups.

● Outcome 4 – resource commitments:
  – As in Zambia, PATH initially planned to provide a TCO estimate to inform future scale-up decisions. However, in practice, it was not possible for PATH to complete a full TCO analysis due to challenges in estimating the costs of other role-players (such as government and Gavi), as well as scale-up cost to new regions and costs over the longer term.

  – Extrapolating from the data provided by PATH, we estimated the cost of scale-up to all 31 regions of Tanzania would be ~US$14 million – of which total rollout costs would be ~US$11 million spread over several years. For Tanzania, this US$11 million equates to 9% of all annual immunization expenditure by government and its partners.

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- For Tanzania, PATH estimated future annual recurrent costs per region at ~US$36,850, which would come to US$1,142,350 each year for 31 regions. This would cover internet bundles, data hosting, supportive supervision and printing (e.g. barcodes, resource materials etc). But these estimates did not include central recurrent costs, most of the cost of procuring additional / replacement tablet computers,[1] and other system development costs (e.g. investments in ICT and server capacity). We note that, once again, none of these cost estimates could be compared with measurable outcomes, which would be needed to create a business case for further investment.

- As part of a wider evaluation of resource commitments, the evaluators reviewed the available financial data to assess costs associated with the IMPACT Team approach. This was then compared to available costing data on PATH's DDUM approach, with Kilimanjaro selected as the most comparable region. Although alignment of budget lines and the scale of rollout was not straightforward, the available data indicated the rollout costs in Dodoma Region were approximately US$260 per facility, compared to US$438 per facility in Kilimanjaro Region. It, therefore, seemed there were considerable cost savings associated with the IMPACT Team approach. These savings were likely to be due to delivery by a smaller [InSupply] team that provided highly structured inputs at defined intervals over shortened timeframes. It was, however, difficult to draw definitive conclusions about the cost-effectiveness of the IMPACT Team approach because, like for the DDUM approach, it was not possible to align inputs to convincing outcome-level results.

Discussion

The BID theory of change was based on an overarching primary hypothesis that the BID package of interventions would lead to improved immunization data quality and use at scale in two demonstration countries, and these outcomes would, in turn, lead to country commitments and additional resources for further scale-up. Based on the evaluation work to date, the evaluators have concluded that program evidence supporting the primary hypothesis is inconclusive. However, the successive milestone evaluations have directed us to a set of six supplementary hypotheses that could be usefully be tested to strengthen the theory of change. These hypotheses focus on: i) the benefits of recruiting early adopters in low volume facilities where users have fewer time pressures; ii) the risk of premature rollout before the EIR app. has been fully developed and piloted; iii) the need to situate the package of interventions within a wider health systems strengthening approach; iv) the potential benefits of mixed digital-paper solution for low resource settings; v) opportunities to develop a more integrated reporting solution from the outset; and vi) opportunities to leverage the cost savings and data use for quality improvement features of the IMPACT Team approach.

Conclusion and recommendations

Across Sub-Saharan Africa, there is growing momentum in the use of EIRs and digital health solutions to drive improved data quality and use. As our evaluation work has shown, there are multiple factors that may determine the effectiveness of these solutions – some of these are about the technology design, deployment and maintenance, and some are about the wider health systems environment. Processes for finding the most appropriate digital health solutions for different settings can take time; they also require an openness to adaptation and course-correction. Ultimately, like all digital health initiatives, EIR-based solutions must be measured against their cost-effectiveness in delivering improved health outcomes when compared with other health interventions.

Based on findings from successive evaluations of the BID Initiative as it has been rolled out in Zambia and Tanzania, we have identified several recommendations for: a) donors and development partners and

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[1] The costings included equipment replacement at a rate of 5%. However, this is likely to be a significant under-estimate given that (a) more, and more robust, tablets were required and (b) tablets are unlikely to last much longer than an average of 5 years.

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b) governments and implementing partners considering scale-up of the BID package of interventions. These recommendations are elaborated in Section 8 and are summarized below.

Summary of recommendations

Recommendations for donors and development partners

- Continue to build the evidence base on the effectiveness of EIRs and data use interventions for strengthening immunization programs in low- and middle-income countries
- Systematically test emerging hypotheses on how to improve program design and strengthen the theory of change
- Generate robust data on the cost implications by making provision for full TCO analyses that can be used by government for cost-effectiveness assessments

Recommendations for governments and implementing partners

- Ensure national-level ICT capacity gaps are addressed so there is adequate provision for EIR scale-up, monitoring and maintenance
- Consider investing in high-specification tablet computers with built-in scanners for durability and improved user efficiency
- Consider investing in local Focal Points to provide rapid technical, troubleshooting, and operations support to assist system monitoring
- Strengthen in-country server capacity to ensure adequate data processing speeds at scale, and accommodate future digital health initiatives
- Commission regular data security assessments to ensure personal health data is fully protected and health workers observe the highest standards of data privacy.
- Commission a robust evaluation study of paperless reporting in Tanga Region to review progress, assess feasibility and identify lessons for scale-up
- Commission studies to identify the most cost-effective implementation strategy for scale-up in each country setting
- Think critically about short-term and long-term costs and weigh these against potential benefits and impacts of the solution. Situate this analysis within a wider cost-effectiveness assessment to inform decision-making on scale-up

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1   Introduction

The BID Initiative aimed to strengthen immunization programs in Sub-Saharan Africa through improved data quality and use. The initiative was funded by the Bill and Melinda Gates Foundation (BMGF) and was implemented by PATH over the period 2013-2018. The BID Initiative was based on three interventions: an electronic immunization registry (EIR); a stock management initiative; and a suite of data use/change management tools. PATH implemented these interventions using phased rollout strategies in two demonstration countries - Zambia and Tanzania. Learning and experience from the demonstration countries continues to be shared through a community of practice known as the BID Learning Network (BLN).

Mott MacDonald was contracted to provide independent evaluation services for the BID Initiative. The evaluation assignment had four main dimensions, namely: (i) review of implementation progress (ii) evaluation of results and the cost implications; (iii) explanation of results; and iv) comparison of results across demonstration countries to identify lessons learnt.

Figure 1: Four dimensions of Mott MacDonald's evaluation role

Mott MacDonald has now completed all its evaluation tasks. In Zambia, these included evaluations at baseline (October 2016) and after delivery of the package of interventions (June 2018). In Tanzania, evaluations followed the phased rollout of the program in Arusha Region and Kilimanjaro Region and included baseline, end-of-intervention and post-program (sustainability) evaluations. In addition, Mott MacDonald completed a special study in Dodoma Region (April 2019) to assess the effectiveness of an alternative strategy for scale-up.

This report forms Deliverable 21 under Mott MacDonald's contract with BMGF and presents a synthesis of findings from successive evaluations. The report begins with a short description of the BID Initiative and a description of the rationale, conceptual frameworks and methodology for the evaluation work. Part 1 of the synthesis findings focuses on evaluation findings from Zambia and Part 2 focuses on evaluation findings from Tanzania, including Dodoma Region. The final section of this report includes a discussion that reviews findings across case study settings and identifies a set of hypotheses for further investigation. We conclude the synthesis report with a summary of recommendations for: a) donors and development partners; and b) governments and implementing partners.

The annexes to this report present detailed evaluation findings from the evaluations in Zambia and Tanzania respectively. Additional annexes provide a review of the BID theory of change and information on the panel sample of health facilities.

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2 The BID Initiative

The goal of the BID Initiative was to strengthen the use of data to improve the performance of immunization systems in Africa. PATH aimed to achieve this goal by harnessing technology and change management interventions to improve immunization data quality and decision-making, initially in two demonstration countries, namely Zambia and Tanzania.

The intended results from BID were summarized in a results framework (Figure 2). These results described four high-level outcomes relating to improved immunization data quality and use, country ownership and scale-up, and additional resources commitments.

Figure 2: PATH's Results Framework for the BID Initiative
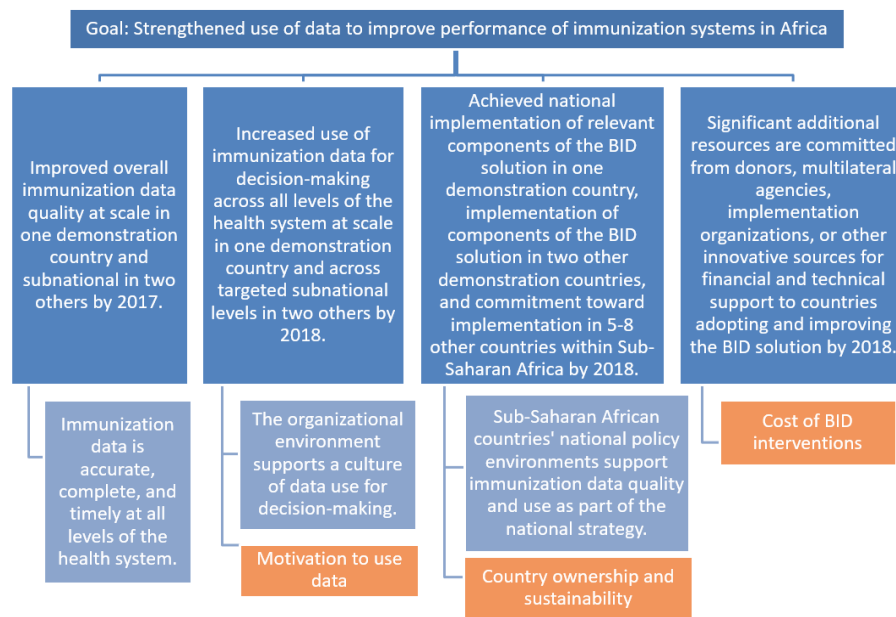
The rationale for the BID Initiative was based on a theory of change. The overarching hypothesis of the BID theory of change was that successful delivery of the BID package of interventions (which included an electronic immunization registry, combined with data use and stock management initiatives) would lead to improved immunization data quality and use at scale in two demonstration countries; these outcomes, would, in turn, lead to country commitments and additional resources for further scale-up to new countries. The BID results framework and theory of change have been the main reference points for evaluating the effectiveness of the BID Initiative.

PATH tailored the BID interventions to the specific requirements of each country using a 'Collaborative Requirements Development Methodology' (CRDM) and a broader 'learning by doing' approach. PATH also monitored progress towards results through a series of baseline and midline/endline surveys that refer to key indicators in the program logical framework (logframe). Lessons have been shared through the BLN platforms and documented in a 'Lessons Learnt Encyclopaedia'. To inform dialogue on resource commitments, PATH has also conducted 'before and after' studies to assess changes in staff time spent on information, and collected data on the cost of the BID interventions.

PATH's monitoring methodologies were robust. The independent evaluation methodology was, therefore, designed to be complementary, with emphasis on verifying PATH's findings and explaining differential results across diverse operational settings.

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3   Evaluation rationale and methodology

3.1   Evaluation design

The design of each country evaluation was based on a single, overarching evaluation design for the BID Initiative. This design took account of the multifaceted, evolving and systems-focused nature of the BID interventions. This complexity meant the BID program did not lend itself to a conventional impact evaluation or randomized control design. Given these features and the objectives of the independent evaluation, the evaluators adopted a non-experimental, theory-based design. This approach involved testing the program theory of change and use of 'plausibility analysis' to assess the program's contribution to results across a range of implementation settings.[2]

To apply the approach, the evaluators identified a purposeful sample of three case study districts in the Southern Province of Zambia, and five case study sites in Arusha and Kilimanjaro Regions of Tanzania.[3] Within each of the case study districts, the evaluators tracked a 'panel sample' of six health facilities over time to support a longitudinal 'interrupted time series' analysis.[4]

3.2   Successive evaluations

This evaluation design framed a series of data collection visits to Zambia and Tanzania. In Zambia, the evaluation visits were conducted in the case study districts at baseline (October 2016) and shortly after the BID intervention package had been implemented (June 2018). In Tanzania, the evaluation visits to the case study districts followed PATH's phased rollout of the intervention package in the Northern Zone, and included a final 'post-program' evaluation to review sustainability themes. So, in Arusha Region, evaluations included a baseline evaluation in March 2016, an end-of-intervention evaluation in June 2017 and a post-program evaluation in August 2018. In Kilimanjaro Region, evaluations included a baseline evaluation in June 2017, an end-of-intervention evaluation in July 2018 and a post-program evaluation in April 2019 (see Figure 3).

The evaluators also conducted a special study in Dodoma Region to evaluate the effectiveness of an alternative implementation strategy for scale-up developed by JSI/InSupply in collaboration with PATH. This evaluation was conducted in April 2019 using an adapted version of post-program evaluation tool-kit. Since there was no baseline for measuring and comparing results in Dodoma Region, the evaluators used retrospective enquiry to construct a qualitative 'proxy' baseline.

Each evaluation was intended to add to the evolving story of the BID Initiative, and to support a distillation of lessons and success factors through periodic comparisons across case study sites and countries. This report forms a final instalment in a series of evaluation reports that iteratively consolidated learning and evidence from the program.

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[2] For a discussion on the evaluation questions of attribution and contribution, see: White H. & Phillips D. 2012. Addressing attribution of cause and effect in small *n* impact evaluations: Towards an integrated framework. International Initiative for Impact Evaluation (3ie). Working Paper 15.

[3] This reflects the larger program coverage area in Tanzania.

[4] Where possible, the evaluators also examined the strength of the program's contribution to results by reviewing the relationship between outcomes and duration of exposure to BID interventions and considered the potential effects of other initiatives in the area.

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Figure 3: Sequencing of the BID evaluations across countries and regions, 2016-2019
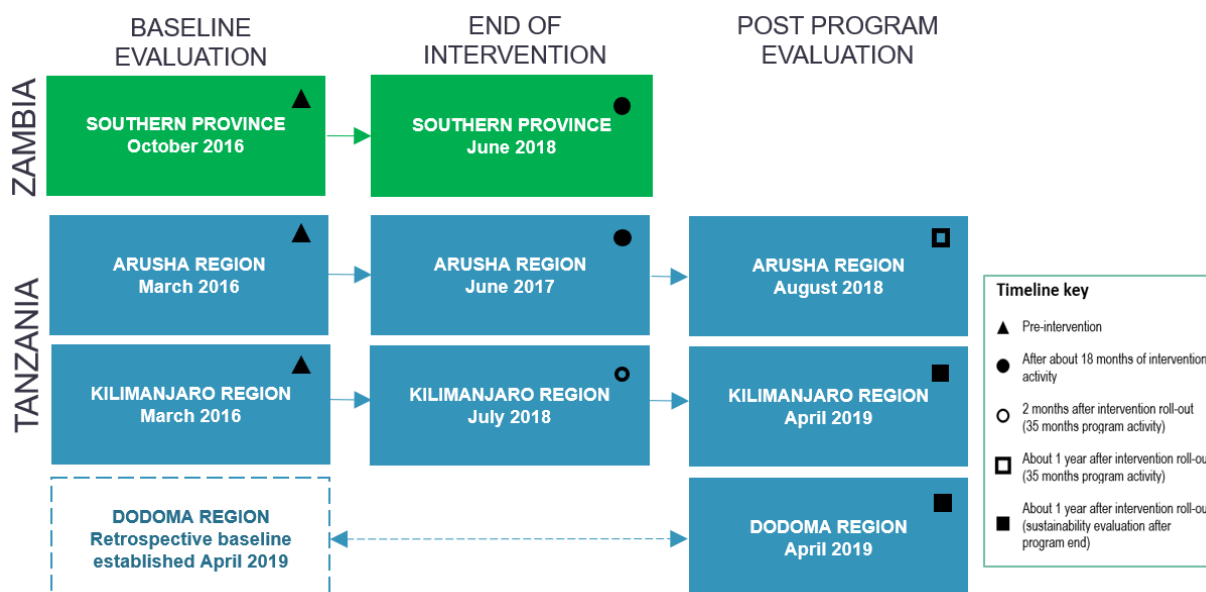
3.3   Data collection methodology

The data collection methodology for each evaluation was standardized to support comparisons against the baseline and across case study sites. Evaluation tool-kits were built around mixed methods of enquiry and assessments of progress towards intended outcome level results. The mixed methods data collection approach included key informant and stakeholder interviews, data quality assurance (DQA) reviews, direct observation and a competency assessments of EIR use by health care workers. The health economics work (for Outcome 4) involved review of the implementer's financial data, and benchmarking against data from secondary sources. The evaluation methodology and tool-kits received the research and ethical clearance required for each demonstration country.

The full methodology for the evaluation data collection and analysis for each demonstration country is described in detail in Annexes 1 and 2 respectively. The limitations of our methodology (such as purposeful sampling not being fully representative and the absence of control sites for assessing attribution and the counterfactual) are fully acknowledged. Efforts have been made to address these limitations through systematic triangulation techniques and contribution analysis.

3.4   Comparative assessment framework

Inductive reviews of findings from initial evaluations indicated that a 'realist' approach was useful for organizing analytical themes for comparison across case study sites. A realist approach suggests that program outcomes will be shaped by the combined effects of the 'mechanism' (program interventions) and the program context. This translates into some core realist questions for enquiry, namely: what works, for whom, in what contexts, why and how? [5]

To apply the realist approach, the evaluators defined the dimensions of context, mechanisms and outcomes that could usefully be used to structure the comparison of findings from Zambia and Tanzania.

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[5] See https://www.betterevaluation.org/en/approach/realist_evaluation

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The dimensions identified for each theme are shown in Figure 4 below. As far as possible, these dimensions have been used to structure the findings and comparative analysis presented in this report.

Figure 4: Dimensions of the evaluation analysis within a realist framework

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Findings Part 1:

Key findings from Zambia

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4 Synthesis of findings from Zambia

In keeping with the analytical framework, the evaluation findings from Zambia are organized around the themes of context, mechanism and outcomes. Findings on the context and mechanism focus on elements that are most likely to have influenced outcomes.

4.1 Context

Population and infrastructure: Southern Province in Zambia has a population of around 1.9 million (2015) – although there are relatively high population clusters in urban and border areas, rural areas are characterised by low-density, dispersed populations of just 22/km^2 (2017).[6] Some remote communities are cut off during the rainy season, while seasonal migrations, the demands of subsistence farming and weak infrastructure can affect the uptake of health services. Power outages are common. Internet connectivity at health facilities depends on use of data bundles and mobile phone networks; in some areas connectivity can be weak or patchy.

Health system and the Expanded Program of Immunization (EPI): In Zambia there is a decentralized health structure, with provinces and districts managed by Provincial/District Health Management Teams. Health centres are responsible for delivery of multiple primary health care programs. The expanded program of immunization sits within the Maternal and Child Health (MCH) Directorate of the Ministry of Health (MoH). EPI activities are integrated within MCH and IMCI (Integrated Management of Childhood Illness) service delivery and are usually offered from health facilities two or three times per week. Human resources are stretched, especially in rural areas. Community Health Workers (CHWs) and Community Health Assistants often assist MCH nurses and, in remote areas, these volunteers support periodic outreach services (including immunization services) through satellite health posts.

Health information system and immunization reporting: In Zambia, EPI reporting is an integral part of routine District Health Information System 2 (DHIS2) reporting. Facility data on information coverage is submitted monthly to districts using a Health Information Aggregation 2 (HIA2) form – this is part of a report book for submission of all DHIS2 data. Facilities record vaccine stock data separately using monthly stock returns; District Pharmacists use stock control cards and the supply vouchers to prepare monthly reports and replenish stocks from the district and national vaccine store.

Other initiatives: At baseline, the evaluators noted that the BID Initiative was one of several related initiatives in Southern Province, all of which were consistent with the Zambia eHealth Strategy (updated 2017-2021). Other significant initiatives included: a) mVacc (UNICEF's initiative for community-based reporting of child health milestones using mobile phone technology); b) Logistimo (WHO's web-based stock logistics system) and SmartCare (a multi-partner initiative to develop an electronic patient record system).

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[6] Government of Zambia, Central Statistics Office. Population and Demographic Projections 2011-2035.

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Box 1: Key features of the implementation context in Zambia

- Health facilities in rural areas often had unreliable internet connectivity – internet access generally required internet bundles; mobile phone network coverage was patchy.

- Immunization reporting was fully integrated into DHIS2 reporting, and is not easily demarcated from the wider health information architecture;

- Vaccine stock logistics reporting was separate from DHIS2 immunization reporting.

- Several cadres of health workers (e.g. Community Health Workers and volunteers) often assisted in immunization data entry within clinic workflows.

- Health facilities in rural areas often provided outreach services to remote communities, where additional immunization records were generated.

- There were other initiatives working on immunization data and use in Southern Province.

4.2   Mechanisms

EIR design and deployment: The EIR application for Zambia was called the Zambia Electronic Immunization Registry (ZEIR). Following some initial sub-contracting difficulties,[7] the first software developer was replaced by the Kenya-based developer, Ona. The Ona design for the ZEIR built on WHO's Open Smart Register Platform (Open SRP) - a generic digital tool for health workers to electronically register and monitor their clients. Despite compressed timeframes, Ona made impressive progress in producing a functional, user-friendly ZEIR design. While it managed to overcome earlier design problems (e.g. the need to build in provision for offline functionality and allow for multiple users of single devices), Ona reported that other issues were more challenging, such as late requests for more reporting fields (e.g. Vit. A, bednet distribution, deworming, growth monitoring), and the need to establish appropriate field validations. Although these challenges were largely addressed over time, some governance issues (such as securing codes for data export to DHIS2) were more political in nature and, therefore, somewhat outside of Ona's scope of work.

Rollout strategy: PATH's implementation strategy for ZEIR and data use interventions were designed around four 'touch' visits by PATH staff. This touch strategy was rolled out in three stages: Stage1: preliminary data use interventions in two districts (Livingstone and Mazabuka); Stage 2: classroom-based group training of 'champions' from facilities and districts who were tasked with providing training and mentorship support to facilities in combination with PATH's touch visits; Stage 3: (from late 2017) scaling-up and completion of touch visits so that all 290 eligible facilities in Southern Province received training in ZEIR and data use by March 2018.

Maintenance and sustainability: PATH contracted a local software company, Blue Code, to support ZEIR monitoring, maintenance and upgrades. However, by program end, the longer-term arrangements for this service were uncertain. Interviews with government stakeholders at national, provincial and district levels[8] suggested that there was little clarity on the strategic vision for ZEIR, the transition steps necessary to move from legacy system, or the resource implications for government (see also findings for Outcomes 3 and 4 below).

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[7] The original contractor, the University of Oslo, was unable to overcome challenges relating to offline functionality, multiple users of single devices and scalability within the timeframes available.

[8] These stakeholders include district and provincial health information officers, district pharmacists in the case study districts, and national EPI, logistics and M&E officers.

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At the time of the end-of-intervention evaluation visit, PATH was completing final activities under a no-cost extension period agreed with BMGF. These activities were reported to include: further rollout of software updates; intensive work with district officers to increase skills in using ZEIR and the data generated; and training of EPI focal points in each district to provide supportive supervision for more consistent use of ZEIR and data at facility level.

In 2019, Government, PATH and other partners were awarded a US$ 1.4 million Gavi EPI-Optimization grant to strengthen system linkages and usage and build national capacity and ownership, with a view to scaling-up to Western Province. This grant covered a partnership with UNICEF to link ZEIR to mVacc (for SMS data transfers on births and community immunization monitoring).

Box 2: Observations on key features of the mechanism in Zambia (end-of-intervention evaluation)

- It had proved challenging to identify a distinct cadre of district level officers who could be co-opted to lead on the rollout of BID interventions in the implementation districts.

- By the end-of-intervention evaluation, many facility staff were not aware of the need to download version updates via Google Play Store, so had not yet used a fully functioning version of ZEIR.

- PATH sometimes had to extend training and supervision to the additional cadres (e.g. CHWs) who were playing an active role in recording immunization data.

- Implementation was hampered by logistical delays in procurement and distribution of Quick Response (QR) codes and data bundles.

- There were significant government concerns about data security issues associated with multiple users of single devices at health facility level – the system of unique usernames and passwords was not a satisfactory solution in Zambia due to the frequency of staff rotations and turnover.

- Some community stakeholders and partners had concerns about using photo identification for each child, and data protection issues relating to this.

- PATH had to support facility staff in developing workflow strategies to manage parallel reporting systems and outreach work.

- PATH was not able to find a cost-effective way to address the need for back-entry of data to enable a fully functioning ZEIR database.

- Following consultation with government, PATH intended to adapt the design of the stock and community components of ZEIR to accommodate linkages to other initiatives, such as UNICEF's mVacc and WHO's Logistimo systems. However, it was not possible to establish these linkages during the timeframes of the program.

4.3 Outcomes

The following results are based on end-of-intervention findings from a panel sample of 18 health facilities in the three case study districts (Livingstone, Kazangula, and Sinazongwe) of Southern Province (Annex 5).

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4.3.1 Outcome 1: improved data quality

To assess changes in immunization data quality within the health system over time, we reviewed DQA data from both the 'legacy' HIA2 reporting system and the EIR (ZEIR) reporting system. It is important to note that, although we used the IVD legacy system as a reference point for assessing EIR data quality, we did not assume data in the legacy system was correct; rather, the legacy data was simply used to *reflect* on data quality in the EIR system (see Annex 1 for a more complete description of the evaluator's DQA method).

At facility level, the evaluators found little change in the timeliness, availability and completeness of immunization and stock data within the legacy system between baseline and the end-of-intervention evaluation point. Notably, the accuracy of immunization data in the legacy system at facility level remained poor throughout. Indeed, when reported data was compared to primary source documents, there appeared to have been a slight deterioration in overall accuracy from 24% (n= 374 paired data points) at baseline to 19% at the end-of-intervention evaluation.[9] Qualitative investigations suggested that the multiplicity of reporting systems (including SmartCare) at facility level may have been a factor affecting reporting accuracy (Annex 1).

A similar picture emerged at district level when DHIS2 data for the six proxy antigens were compared to the (legacy) HIA2 data reported by the 18 health facilities over a three-month period. At district level, overall data accuracy had declined slightly from 46% (n= 288 paired data points) at baseline to 41% (n=184 paired data points) at the end-of-intervention evaluation. The accuracy of stock data was consistently very poor at baseline and at the end-of-intervention evaluation point (Annex 1).

The evaluators applied the same methodology to assess the accuracy of immunization in the ZEIR master database for each of the 18 sampled facilities. The ZEIR data did not compare well to primary source data (in tally sheets) for immunizations, with very few paired data points matching across the six proxy antigens over the three-month period for the sampled facilities (Figure 5).

Figure 5: Comparison of records in the ZEIR master database and primary records for sampled facilities at the end of intervention evaluation, Zambia (June 2018)

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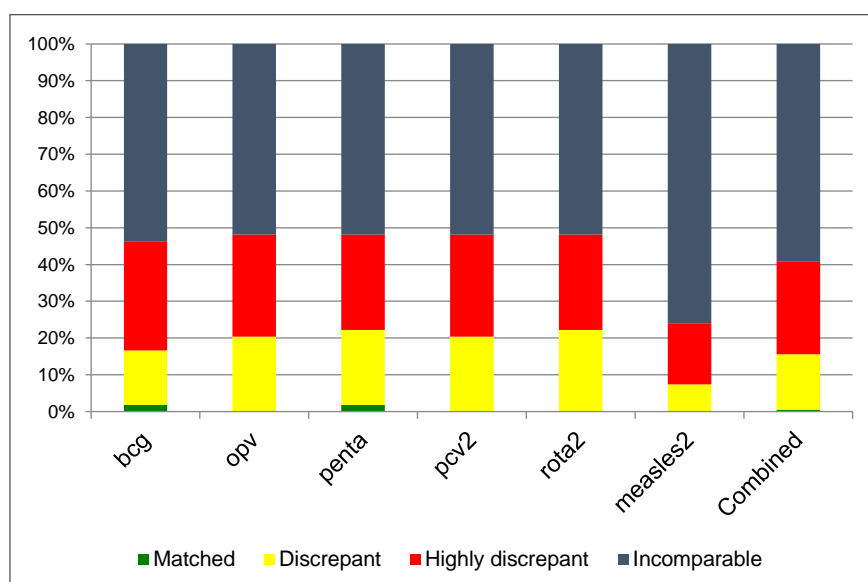
[9] Here, data accuracy refers to complete matching of reported and primary source data. Records were compared for six proxy antigens over a three-month period in the 18 sampled health facilities (total 324 data points) - see the methodology section of Annex 1.

These finding were, however, highly consistent with qualitative assessments where the evaluators observed that facility staff were not using ZEIR consistently for every client. This meant the ZEIR database was incomplete. In general, ZEIR was only being used when the MCH nurse or CHW had time in the midst of other data recording. The main obstacles to timely and complete data entry were found to be unreliable internet connections, slow EIR functioning, lack of time amidst other reporting demands and insufficient numbers of staff trained in using the ZEIR system.

4.3.2   Outcome 2: Data use for decision-making

For Outcome 2, the evaluators first assessed health care workers' competency in using ZEIR for data entry and retrieval. For health care workers trained in using ZEIR, competency levels for registering a new child were observed to be high, with 74% of users assessed (n=19) found to be fully or mostly competent. Unfortunately, the evaluators were not able to complete competency assessments relating to data retrieval and interpretation and defaulter tracing because all the facilities in the sample were using an old version of ZEIR where these actions were not possible.[10]

The evaluators also considered whether there was any change in data use using the legacy system. At baseline, data use for three scenarios were considered – these involved data use for assessing immunization coverage, defaulter tracing and stock management. Triangulated qualitative assessments[11] at baseline showed that, at facility level, data use for the three scenarios tended to be *ad hoc*, informal and focused on monthly HIA2 reporting and stock accounting/replenishment. At the end-of-intervention evaluation, similar qualitative assessments indicated that there had been little change in data use capacity or practice. Although there was some evidence of more frequent data review meetings at district level, it was difficult to attribute this change to the BID Initiative, as other initiatives (such as SmartCare) also included data use interventions.

4.3.3   Outcome 3: implementation at scale and country ownership

For Outcome 3, the evaluators conducted a desk review of program documents and completed key informant interviews with government officers at district, provincial and national levels.[12]

Implementation of BID interventions had reached 298 health facilities across all districts of Southern Province by mid-March 2018, using a four-touch strategy delivered by the local PATH team and a cadre of trained champions. Rapid implementation had thus been achieved at scale although, due to the issues described in Box 2, there appeared to be some shortfalls in the quality of the interventions and the participation of district officers.

Interviews with district, provincial and national key informants suggested that the potential of ZEIR was fully recognized, especially its potential of time savings, real-time data transfers and data visibility at each system level. However, these key informants also expressed several concerns including: the long timeframes required for software development and modifications; the potential for reporting fragmentation and lack of harmonisation across initiatives; the implications for long-term management and resource

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[10] The evaluators found versions 3.1 and 3.2 in use. Later versions allowed data to be retrieved and reports to be generated, but users first needed to download these updated versions through Google Play Store.

[11] These qualitative assessments involved direct observation, in-depth interviews with health care workers and key informant interviews with heads of facilities, district MCH coordinators a district health information officers (DHIO).

[12] These key informants included district and provincial health information officers, district pharmacists in the case study districts, and national EPI, logistics and M&E officers.

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investments by government; other sustainability issues, such as data security issues and the need for additional skills transfer.

The National EPI Manager remained committed to the BID Initiative and confirmed there had been full government involvement at every stage. He also suggested BID interventions needed to be scaled-up beyond Southern Province to demonstrate their effectiveness in a range of operational settings in Zambia. However, more generally, senior officers at provincial and national levels were unable to articulate a strong strategic vision for BID interventions.

4.3.4 Outcome 4: resource commitments

Review of the costing information

In the context of information systems, "total cost of ownership" (TCO) means all the costs incurred to design, set up, operate and maintain a system. As recommended by the Pan American Health Organization (PAHO)[13] for an *economic* assessment (as opposed to simply a costing exercise), the TCO should be discussed alongside the outcomes (benefits) of the system to inform decisions about whether or not the information system is a priority for resource allocation.

When the BID Initiative started, the aim was to measure the TCO to provide government and potential funders with relevant information. In practice, only some of the costs were documented, namely those incurred by PATH. This was not a complete description of the TCO because:

● Other role-players, such as the Government of Zambia, incurred costs relating to staff time etc
● The cost analysis only covered the time period of the BID Initiative (with a little work done on estimating future costs). Clearly there are ongoing costs for the Southern Province, as well as costs for scaling up to new provinces.

Also, the costs were not compared with outcomes, which would have helped create a business case for further investment.

The costing information shared by PATH has helped us identify some of the cost drivers – i.e. the items which account for most of the costs. However, the information provided does not tell us much about total future recurring costs, as most of these were not estimated.

Table 1 below shows expenditure on BID in Zambia from the PATH report on costs.[14]

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[13] PAHO (2017). Electronic Immunization Registry: Practical Considerations for Planning, Development, Implementation and Evaluation. Available at: http://iris.paho.org/xmlui/handle/123456789/34865
[14] Mvundura M, Di Giorgio L and Werner L (2019). *Evaluating the expenditures for developing, deploying and maintaining electronic immunization registries in Tanzania and Zambia: evidence from the BID Initiative.* Draft.

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Table 1: Expenditure by PATH for development and rollout of the BID Initiative package of interventions in Southern Province, Zambia

System design and development	
System design and development costs of electronic immunization registry (in use)	US$486,965
Learning costs (electronic immunization registry which was shelved)	US$427,407
Other costs	
Back entry costs	US$21,086
Labor costs	
BID Initiative staff	US$1,851,105
Southern Province-specific costs	
Rollout costs	
Hardware	US$254,424
Meetings	US$32,470
Training	US$29,368
Deployment (per diems, transport and accommodation to access health facilities etc.)	US$445,655
Annual recurrent costs	
Internet connectivity	US$20,007
Data hosting (server)	US$8,000
Printing (e.g. QR codes + ZEIR resource materials)	US$2,926
Total costs over project period	**US$3,579,413**

From Table 1, it seems the main cost drivers were:

- System design and development – 14% of total, or 26% when development of the system which had to be abandoned is included
- BID Initiative staff – 52% of total
- Rollout costs – 21% (of this, 58% was deployment costs and 33% was for hardware).

In PATH's estimates, annual recurrent costs accounted for less than 1% although, of course, these would occur every year. The label "annual recurrent cost" is rather misleading because in fact this is just the known costs of keeping the technical system working: it does not include recurrent staff or transport costs, nor does it include system updates and refresher training. Most of the future recurrent costs are unknown for the reasons given above: the analysis was time-limited and only considered costs incurred by PATH.

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However, these costs are for only 1 province, whereas Zambia has 10 provinces in total. An extremely crude way of estimating scale up costs would be to take the province-specific costs for Southern (US$792,850, rounded to US$800,000) and multiply it by 10, giving US$8 million. So, US$2,786,563 start-up costs (from Table 1), plus the US$8 million provincial rollout costs, gives a national total of US$10.8 million. System design and development accounts for 4% of this total, or 8% when the "learning" costs for the system which was shelved are included. Rollout and annual recurrent costs account for 74%.

There are many caveats to this estimate of US$10.8 million – including that the fact that the so-called "annual recurrent costs" are considerably under-estimated and have just been included for one year and that the significant "labor cost" item was not only for start-up – nevertheless, the figure is a start as a working estimate. It is however, likely to be a fairly significant under-estimate, as it does not include government staff time and the BID labor costs were not counted as region-specific costs. WHO and the International Telecommunication Union estimate that eHealth projects typically allocate 60-70% of their budget to human resources (especially for training) in the implementation/operating phase.[15]

Having explained that this estimate, is likely to be an under-estimate overall, there are also factors which could reduce some of the line items. As Mvundura et al explain,[16]rollout in Southern province had to be done within compressed timeframes, so more PATH staff and fewer government staff were involved compared to implementation in Tanzania. Moreover, there were likely to be lessons learnt from the rollout in Southern Province which could be used to reduce costs in subsequent provinces.

The cost figures demonstrate that:

- System design and development costs seem very significant at the start, but in the context of overall implementation they can be a relatively small proportion. The design of the system has implications for future costs (e.g. in terms of how user-friendly it is and inter-operability with other systems) and it can be worth using resources upfront to get these things right. Whilst shelving an unsuccessful design may seem expensive and wasteful at the time, it can be a wise long-term decision that saves money.

- Whilst digital information systems are generally thought of in terms of hardware and software, they also require considerable human resources. Individual staff are often involved in a variety of types of activity (e.g. management, training and visits to facilities), so it can be difficult to assign staff costs to different stages of implementation. A problem with this is that, in the longer-term, it is government staff who will perform many of these roles, and the costs of government workers are often lost in budgets because they are not an additional project cost if activities are expected to take place using existing staff. It is therefore important to think in terms of human resource capacity - the quantity and quality (i.e. skills) required – as well as direct project costs. The project will stall if the required staff are not available.

- Rollout costs are crucial in a national program. This is partly a matter of what hardware for facilities is selected and partly a matter of the training/deployment model used. Investments in making systems as user-friendly as possible can pay dividends because they can reduce the amount of time required to train each user.

Putting the costs of scaling up into perspective

The analysis above puts the total rollout costs at about US$8 million, which could be spread out over several years. To put this into some kind of perspective, about US$54 million was spent on routine immunization in Zambia in 2017, of which 17% came from government. 29% of the total spending was on vaccines. So, if we thought of the US$8 million as a one-year expenditure, that would account for 15% of

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[15] WHO and PATH (2013). Op. Cit.
[16] Mvundura et al. (2019) Op cit.

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total immunization spending, 21% of non-vaccine immunization spending, 86% of total government spending on immunization or 109% of government non-vaccine immunization spending.[17]
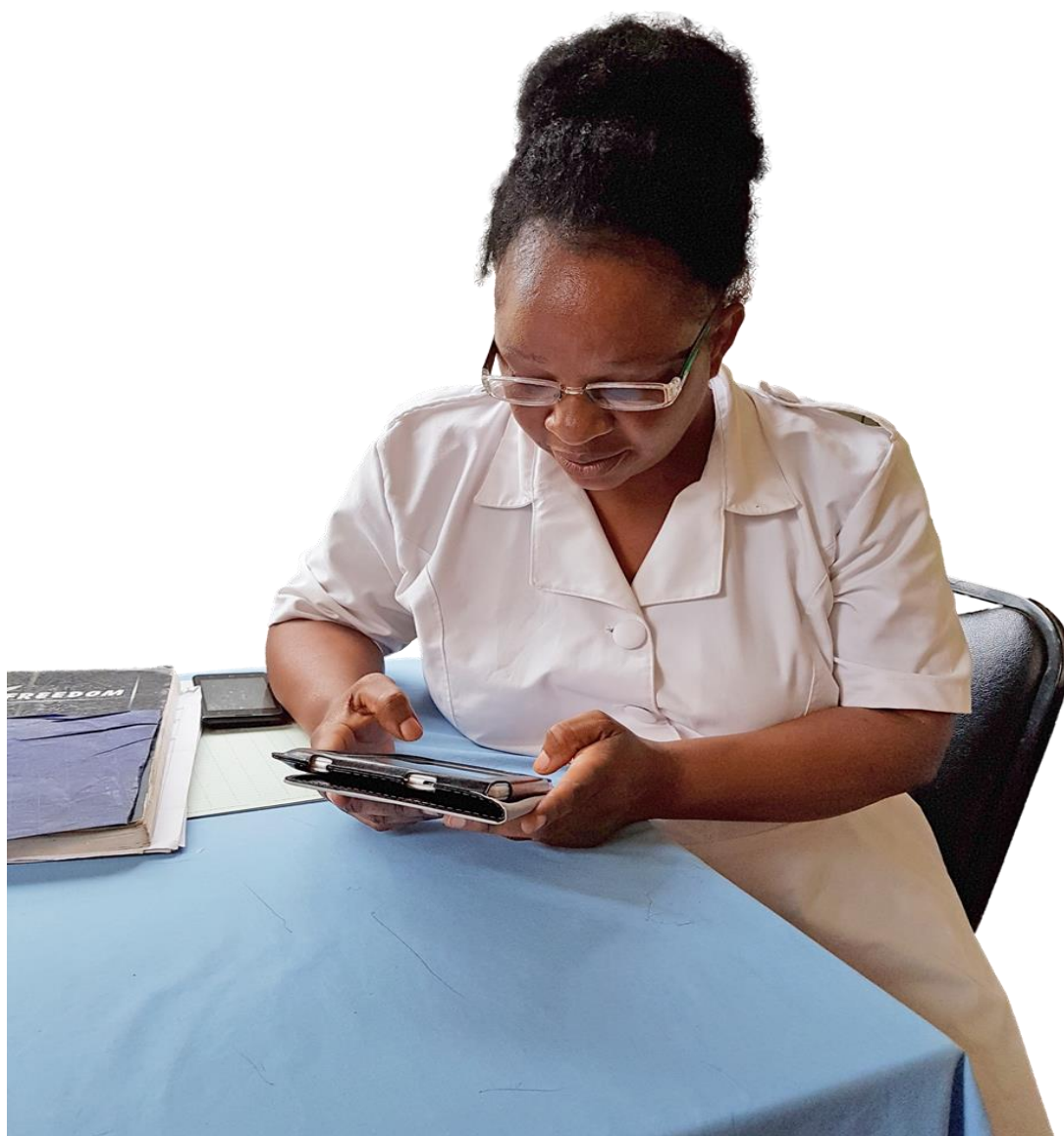
Whilst these overall cost estimates are very crude, they do provide food for thought. At 21% of a year's total (government and others) non-vaccine immunization expenditure, the information system is not cheap, though of cost in practice spending would be spread out over several years. Moreover, the cost needs to be seen in the context of how many additional immunizations will be generated by better information. Decision-makers from government and international agencies should be furnished with as complete costing information as possible to inform their choices. It certainly cannot automatically be assumed that investing in an immunization information system is a "good buy".

Box 3: Observations on outcomes from the end-of-intervention evaluation in Zambia

- Inconsistent usage of ZEIR by health care workers was the main factor affecting the completeness (and hence accuracy) of data in the ZEIR master database.

- Inconsistent child registration and the lack of a community component for registering home births meant that ZEIR had not satisfactorily addressed the objective of providing accurate denominator estimates for facility catchment areas.

- Lack of comprehensive district involvement in the rollout of ZEIR meant there was little evidence of change in the enabling environment of data use. There was considerable scope for improving the implementation (touch) strategy to strengthen program outcomes.

- The strategic vision for the BID Initiative was not well understood by key government stakeholders at sub-national levels. This may have had implications for leadership in promoting take-up of BID interventions. Provincial government officials were keen to see more complementary working with other digital health initiatives (e.g. mVacc, Logistimo, SmartCare).

- By the end of the intervention, there was still a need for the developers to work on residual bugs in the ZEIR application. There was also a need for a clear strategy for system monitoring, maintenance and updates, and a need to follow up on the requirements for data transfers between ZEIR to the DHIS2 system.

- By the end of the program, TCO figures were still unclear and it remained difficult to define the final scalable package of interventions for costing purposes. Moreover, available costing data could not be compared to measurable outcomes, which would have helped create a business case for further investment and scale-up.

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[17] Figures on immunization spending in Zambia *from Co-financing information sheet for Zambia, 2018.* Gavi, the Vaccine Alliance. Available at https://www.gavi.org/country/zambia/documents/

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Findings Part 2:

Key findings from Tanzania

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5   Synthesis of findings from the Northern Zone

The evaluation findings from Tanzania are, once again, organized around the themes of context, mechanism and outcomes. Findings on the context and mechanism focus on elements that are most likely to have influenced outcomes.

5.1   Context

Population and infrastructure: In the BID implementation regions of the Northern Zone, the population density is generally high in urban and border areas at around 1,560/km^2 (2012); however, in the less accessible rural areas (such as the highland areas of Kilimanjaro Region) the population density is just 45/km^2 (2012).[18] Electricity supplies can be unreliable in rural areas and many facilities rely on solar panels. Health facilities generally depend on data bundles to access the internet via mobile phone networks.

Health system and IVD program: In Tanzania, the Immunization Vaccine Development (IVD) program and sits within the Reproductive and Child Health (RCH) section of the decentralized Ministry of Health, Community Development, Gender, Elderly and Children (MoHCDGEC). Implementation of the IVD program is overseen by a network of Regional Immunization and Vaccine Officers (RIVOs) and District Immunization and Vaccine Officers (DIVOs) who are accountable to Regional and District Medical Officers. Immunization services are provided by hospitals, health centres and dispensaries. Urban facilities can be very busy (with 50-100 children attending daily); outreach services are not common. The government's recent certification reviews have led to acute staff shortages and frequent staff rotations.

Health information system and immunization reporting: Tanzania's Health Management Information System (HMIS) has recently transitioned to a web-based DHIS2 system. Facilities submit monthly HMIS (Mtuha) reports to districts – this includes data on child health and immunization coverage. A separate and parallel system is used for immunization and vaccine stock reporting to the National IVD Program. Facilities submit monthly IVD reports to DIVOs which cover both immunization coverage and vaccine. Since December 2018, the web-based Vaccine Information Management System (VIMS) replaced the former District Vaccination Data Management Tool (DVD-MT) for submitting district level IVD data to the national level.

Other initiatives: In the second half of 2017, Tanzania was awarded a Health Systems Strengthening (HSS) grant from Gavi, the Vaccine Alliance. In addition, PATH and other partners, such as John Snow, Inc. (JSI) and the Clinton Health Access Initiative (CHAI) were awarded targeted country assistance (TCA) funds to support "rollout of VIMS and the BID Initiative".[19]

At national level, considerable momentum has been built around the Data Use Partnership (DUP). Within this partnership, a number of international development partners (such as PATH, CHAI and Jhpiego) have been working with government to develop a harmonized investment road map for improving health data in Tanzania.

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[18] Tanzania National Bureau of Statistics. Population and Housing Census 2012.
[19] See Tanzania's HSS proposal to Gavi, the Vaccine Alliance. Retrieved from:
https://www.gavi.org/country/tanzania/documents/proposals/proposal-for-cceop-support-2017--tanzania/

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Box 4: Key features of the implementation context in Tanzania

- Slow and unreliable internet connections meant the EIR solution needed to have offline functionality.

- Although immunization data was included in HMIS / DHIS2 reporting, the national IVD program maintained its own vertical reporting system from facility level; this included vaccine stock reporting. This helped define a clear scope for the EIR solution within the health information architecture.

- In Tanzania, there are distinct cadres of health worker who work with immunization and vaccine stock data at facility level (i.e. RCH nurses) and at district and regional levels (i.e. DIVOs and RIVOs).

- At baseline, there were no 'competing' digital health initiatives in the implementation regions. The VIMS initiative at district level and the DUP initiative at national level were entirely complementary.

- Recent devolution of budget management to health facilities meant health facilities now needed to cover costs, such as procurement of data bundles.

- There were still several legal and institutional requirements in place that limited health care worker's ability to use locally-generated data for decision-making (e.g. on denominators and coverage targets).

- The introduction of VIMS had been a strategic priority for the National IVD Program for several years. It was anticipated that the EIR would support back-to-back electronic reporting of immunization and stock data from facility to national level in the form of an integrated Electronic Immunization System (EIS).

5.2   Mechanism

EIR design and deployment: The software developer, MEDIC (based at Mohawk College, Canada) was recruited by PATH to replace a former developer that had designed the Tanzania Immunization Information System (TIIS) solution. The TIIS solution was not scalable, so MEDIC was contracted to develop the Tanzania Immunization Registry (TImR) application as an alternative.

Throughout 2017, the MEDIC team worked on a number of design challenges using a 'disciplined agile delivery' (DAD) methodology to tailor the design to user needs and context. Particular challenges for the developer included: data synchronization issues associated with offline-online EIR functions; the need to proceed rapidly to scale-up; requests for extended maintenance and technical support inputs; and an additional requirement to support system integration with VIMS. Despite these challenges, MEDIC was able to release TImR v1.1 for deployment in October 2017. This version of the EIR application featured better compression and error correction for speeding up data uploads; it also included automatic backup/recovery features and offline functionality.

In Tanga and Kilimanjaro Regions, health care workers were trained in using the TIMR v1.1 application from the outset. However, in Arusha Region (the pilot region), health care workers were initially trained in the TIIS version and needed refresher training to use the upgraded version of the EIR.

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Rollout strategy: In 2017, PATH modified its original 'four-touch' implementation strategy and replaced it with the District Immunization Mentors (DIM) strategy - later renamed the District Data Use Mentors (DDUM) strategy. This involved training a cadre of mentors from the District Health Management Team to provide leadership in rolling out the EIR and data use initiatives to all eligible facilities in their district. PATH continued to provide technical support and to meet mentor costs for the period of the rollout.

The evaluators were able to review the DDUM strategy as part of their end-of -intervention evaluation in Kilimanjaro Region. At this evaluation we confirmed that, in general, two staff members per facility had received training from either the DIVO or a mentor over the rollout period. However, in Mwanga Region (where many facilities are remote and difficult to access), several nurses mentioned the training was a brief one-off training that only focused on registration of a new patient. Although nurses were able to telephone their mentor for follow-up support, most received no other training visits. This suggested a need to strengthen the quality assurance elements of the rollout strategy.

In 2018, PATH worked with JSI/InSupply to adapt the DDUM strategy for scale-up in Dodoma Region. A key feature of the IMPACT Team approach was the formation of teams of regional and district health officers to support data-driven quality improvement of the immunization program. Compared to the earlier DDUMs approach, JSI/InSupply's inputs were highly rationalised. They included an intensive classroom-based trainer-of-trainers intervention covering all components of the BID Initiative, with an additional focus on linkages to VIMS. The classroom-based training was followed by a week of site-based practical training, a period of monitoring and supervision (4-6 weeks), some remote technical support and a review visit (November 2018).

The evaluators reviewed implementation of the IMPACT Team approach for the special study in the post program evaluation (see Annex 3). Although key informants expressed high levels of satisfaction with the training provided, they also requested more follow-up visits and refresher training. In practice, implementation of the approach was hampered by: a) EIR operational issues (such as hardware problems, lack of internet bundles and barcodes); b) lack of technical troubleshooting skills in the IMPACT Teams and limited access to timely technical assistance; and c) time and resource constraints that limited additional visits to facilities facing challenges.

Maintenance and sustainability: Following the award of Gavi TCA funds, PATH was able to invest in additional measures to support sustainability of BID interventions. PATH (and MEDIC) have provided technical capacity development assistance to MoHCDGEC Information and Communications Technology (ICT) staff on software maintenance and customization. Unfortunately, despite significant investment in skills transfer activities, the trained ICT staff have been appointed to new positions, leaving a major gap in technical support for EIR system monitoring, maintenance and updates.

PATH has also deployed a Focal Point officer to selected Regional Health Management Teams to provide technical guidance and support for scale-up. Other system maintenance costs will be covered under the Gavi HSS grant until 2022.

Box 5: Observations on key features of the mechanism in Tanzania (post-program evaluation)

- Many end users in Arusha and Kilimanjaro Regions struggled to download and use successive EIR updates – we observed a number of different versions in use at facility level.

- Even though MEDIC made significant improvements to the speed of data uploads and offline functionality, many users at facility and district levels still found the software was prone to "sticking". Reports of EIR operational problems were common at facility level, but it was not clear whether these were due to software or usage issues.

- The DDUM strategy used in Kilimanjaro Region had some weaknesses, especially around performance management and the duration of mentorship support. The IMPACT Team approach used in Dodoma Region had some positive data use and quality improvement features, but needed to include refresher training and more follow-up support.

- The presence of the VIMS project, as well as the timing of additional Gavi funding and the momentum of the DUP initiative appear to be important elements of an enabling environment for sustainability of the BID Initiative.

- PATHs inputs to in-country ICT capacity building, strategic management and the governance environment have also been significant investments in program sustainability. However, following staff rotations, additional investments in ICT capacity are likely to be a priority.

5.3 Outcomes

5.3.1 Outcome 1: Improving data quality

To establish the evidence for improved immunization data quality at scale (Outcome 1) in Tanzania case study districts, the evaluators first assessed whether there had been changes in data quality in the legacy IVD reporting system over the duration of the program since baseline. We assessed data quality using the criteria of availability, completeness and accuracy by reviewing reported data against primary source records for six proxy antigens over a three-month period (Annex 2 and 3).

Progression in data quality in the legacy system

At baseline, the evaluators found there was considerable scope to improving the quality of data in the IVD (legacy) system in the Northern Zone of Tanzania. Across the five case study districts, there was reasonable availability of the documents required for preparing monthly IVD reports but completeness was partial - with just 69% (n=120) of documents required for IVD reporting were found to be fully complete. The accuracy of immunization data reported in IVD reports over a three-month period was estimated to be 47% (n=324 paired data points), based on consistency between reported immunization data (for six proxy antigens) and primary source documents across 30 health facilities. The accuracy of stock data was similar (62%, n=324), but there were often significant calculation errors.

At the 35-month evaluation point, the accuracy of facility immunization reporting for the Northern Zone was estimated to be 44% (n=288 paired data points) – this was similar to the baseline and suggested there had been little change over the duration of the program. Although the evaluators observed a small

improvement in the accuracy of legacy system reporting in Kilimanjaro Region at the Post Program evaluation, this was probably due to improvements in the IVD reporting format.

For the special study in Dodoma Region, the evaluators confirmed that the IVD legacy system was similar to the Northern Zone, although the accuracy of IVD immunization data in rural Bahi District was noted to be better (at 72%, n= 105 paired data points) that Dodoma Urban (at 33%, n= 126 paired data points) - possibly due to differences in management support.

## Progression in EIR data quality in Arusha Region

For the **end-of-intervention evaluation** in Arusha Region, the evaluators examined the accuracy of the immunization data in the BID master database for the 18 facilities in the three case study districts by comparing immunization totals against primary records at facility level (tally sheets). Of 288 paired data points examined for the six proxy antigens over a three-month period (February-April 2017), only 8% of BID EIR records matched the primary records (Figure 6). Notably, the primary records consistently recorded more immunizations administered than the EIR database, suggesting EIR data was incomplete. There was very little consistent use of the EIR for stock management at this stage because the TIIS application was not well designed for this function.

Qualitative investigations (direct observations and user interviews) suggested that the EIR was incomplete (and so inaccurate) because it was not being used for every eligible client. The main reasons RCH nurses gave for irregular use were: the time required to enter EIR data in busy clinics; a shortage of data bundles; lack of trained/confident users and perceptions of malfunctions (either of the software or tablet). In addition, some nurses believed they should not register patients from outside their catchment area as this would result in "false defaulters" in the system.

We completed the **post-program evaluation** of the EIR in Arusha Region just over a year later in July/August 2018. At this stage, there was a particular focus on whether the launch of the new TImR software had led to improved and sustained EIR data quality. When we compared immunization data in the BID master database to primary records (tally sheets), we found even lower levels of matching data (Figure 6). Once again, tally sheet data was always considerably higher, indicating that EIR data was incomplete.

From qualitative enquiries, we found that nurses were still not using the EIR for every client. Indeed, there had been a decline in use because nurses trained in using the TIIS version reported that they did not feel confident in using the updated (and unfamiliar) TImR version.

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Figure 6: Accuracy of immunization data in the EIR master database at the end of intervention and post program evaluations in Arusha Region
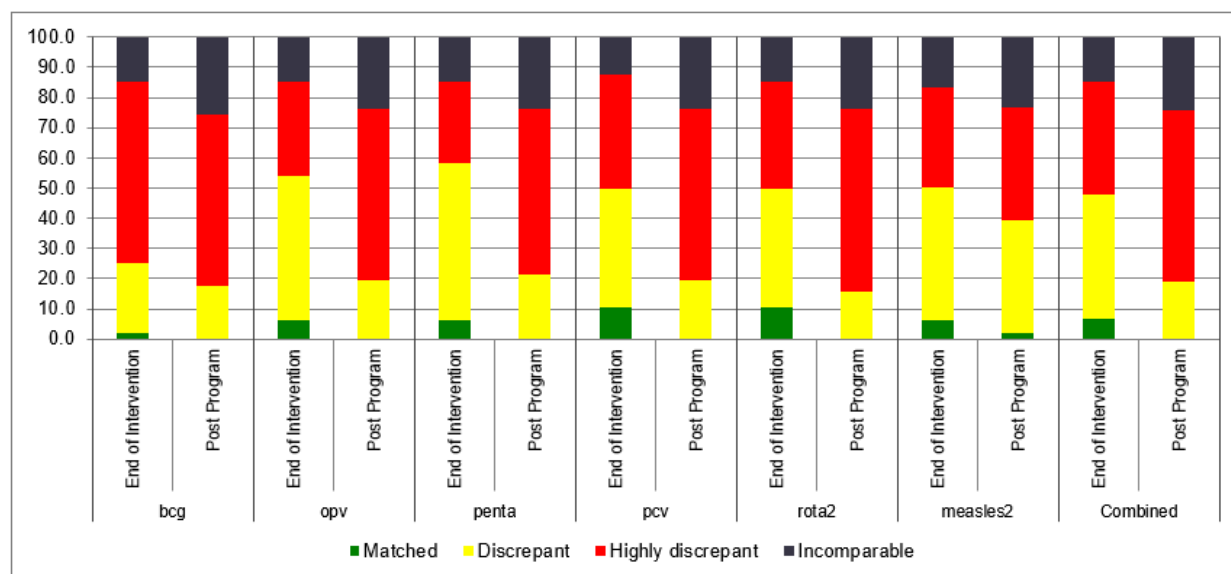
In May 2019, the evaluators conducted further key informant interviews in Arusha City to assess whether there had been any change since the post-program evaluation. We were informed that the availability of internet bundles and tablet maintenance remained the main constraints to EIR usage – it was reported that, of the 49 facilities in Arusha City, only 35 now had functioning tablet computers and only 14 could recharge their bundles on a regular basis.

Progression in data quality in the EIR in Kilimanjaro Region

Following implementation in Tanga Region, PATH led rollout of the BID package of interventions in Kilimanjaro Region over the period January-April 2018 using the DDUM approach. The evaluators conducted an **end-of-intervention evaluation** for the EIR in Kilimanjaro Region in June 2018. We used the standard methodology to assess the quality of data in the EIR over the period February- April 2018. Findings on accuracy were slightly better than for Arusha Region, with an average of 5% of 231 paired data points matching - although the accuracy of BCG and measles 2 data was considerably higher at 18% and 12% respectively (Figure 7).

Qualitative investigations suggested that, while many of the earlier operational problems with the EIR remained an issue in Kilimanjaro Region, users in this region had been trained in using the TImR update from the outset. The training by mentors was still relatively recent, but many users felt that they still needed more practice in using the system.

We returned to Kilimanjaro Region in April 2019 to conduct the **post-program evaluation**, with a focus on sustainability. We repeated the EIR data accuracy assessment using the standard methodology. Overall findings were very similar to those from the previous evaluation, but still weak. Average accuracy scores were 6% (n=231 paired data points) – although scores for BCG records were exceptionally good, with 27% of paired data points matching (Figure 7).[20]

From qualitative enquiries, we found that EIR usage was still inconsistent and this continuing to be the main factor in incomplete/inaccurate EIR data. There were still problems with supplies of internet bundles

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[20] The reason for better performance on BCG reporting was not clear but there are sometimes different delivery routines for BCG to minimise wastage.

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and, although some of the TImR bugs had been fixed, very few users had updated the software, so were still experiencing challenges. Overall, usage in Moshi Municipal appeared better than in Mwanga District, probably due to the commitment and active follow-ups of the DIVO in the urban center. We also noted that, at this stage, there were growing reports of hardware problems – either due to loss, damage or missing power cables, or due to wear, tear, malfunctions and reduced battery life.

Figure 7: Accuracy of immunization data in the EIR database at the end of intervention and post-program evaluations in Kilimanjaro Region
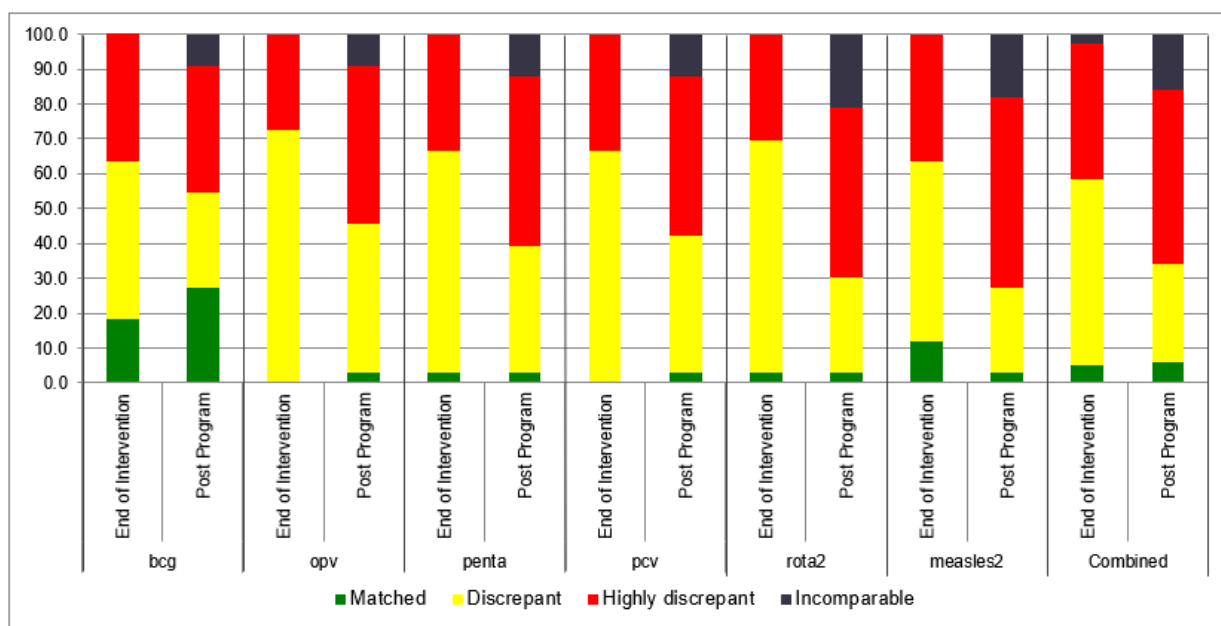
EIR data quality in Dodoma Region

For the post-program special study, we were able to examine EIR data stored on the tablet computers and data uploaded to the master database. We used the standard methodology to compare data in the EIR master database and primary records. Of 231 paired data points, only 4% of immunization data points matched across all antigens combined for the two case study districts in Dodoma Region (Figure 8).

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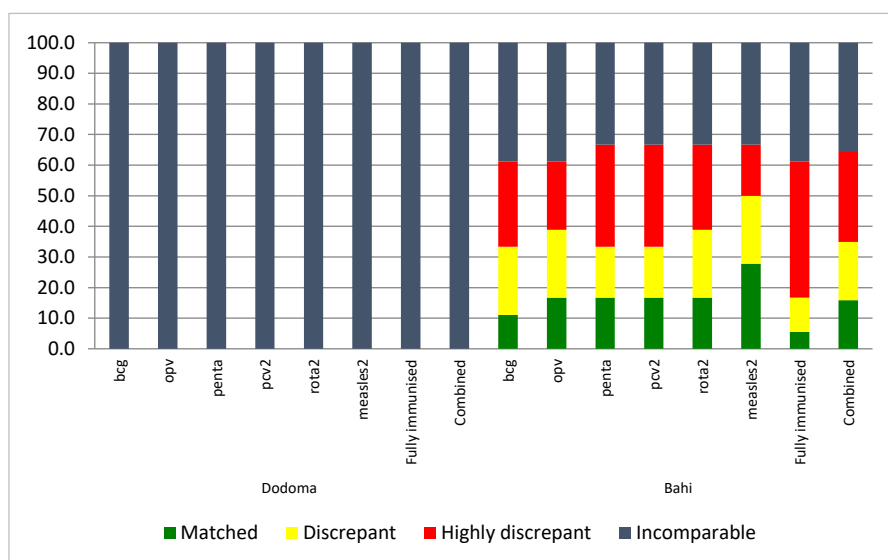Final Evaluation Report for Zambia and Tanzania: Synthesis and Country Reports

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Figure 8: Accuracy of immunization data in the EIR master database at the post-program evaluation in Dodoma Region
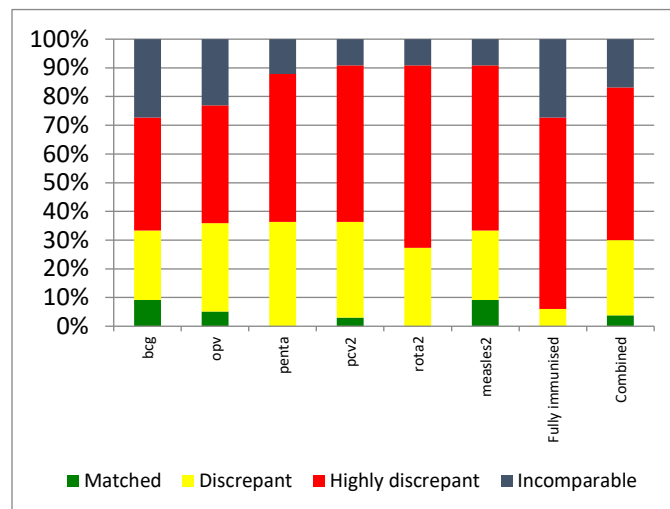
At the Post Program evaluation, we also compared facility primary records with data stored on the EIR tablet computers. From the review of paired data points, we found that for Bahi District 16% of 105 data points matched accurately (with Measles 2 accuracy reaching 28%); however, for Dodoma Urban, accuracy results were extremely poor (Figure 9 below).

Notably, overall accuracy results were better from the EIR tablets than for the EIR master database – suggesting that not all EIR data had been successfully uploaded from the tablets to the EIR master database.

Figure 9: Accuracy of immunization data saved in tablet computers at facility level at the post program evaluation in Dodoma Region

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Qualitative investigations indicated that, even in Bahi District, the EIR was not being used for every client so, as in Northern Zone, EIR data was not complete. There were also considerable hardware distribution problems in Dodoma Urban. Access to data bundles for internet access was a problem in both districts – possibly preventing timely uploads of immunization of data to the master database.

5.3.2   Outcome 2: Improved data use for decision-making

For the end-of-intervention evaluation and the post-program evaluation in the case study regions, we used standardized assessments to determine health care workers' competency in using the EIR to enter, retrieve and interpret immunization and stock data. For full accounts and graphic charts on the findings below, see Annex 2 and 3.

Data use at baseline

At baseline, the evaluators found some evidence of positive data use practices at facility level. Nurses were aware that official coverage targets could be misleading and described methods such as immunization campaigns for boosting coverage rates when necessary. Defaulter follow-ups were *ad hoc* and informal, and the emphasis in reporting was on calculating drop-out rates. There were regular physical counts to monitor vaccine stocks, and stock outs were avoided by borrowing from other clinics or direct local procurements.

Progression in data use in Arusha Region

For the **end-of-intervention evaluation** in Arusha Region (June 2017), we assessed user skills in using the EIR software to a) register a new patient; b) complete a set of other data retrieval and interpretation tasks relating to immunization coverage and defaulters; and c) manage vaccine stock (including recording receipt of stock, checking stock balances and making stock adjustments). We found good overall levels of EIR competency at the end-of -intervention, with 86% of nurses (n=20) assessed being fully or highly competent in registering a new patient, and 82% (n=24) being fully or highly competent in other data use tasks. Notably, scores were weaker on stock management[21] with only 59% of nurses (n=22) assessed as fully or highly competent – this was mostly due to weak skills in making stock adjustments.

At the **post-program evaluation** in Arusha Region, scores for using the EIR to register a new patient were still very good, with 74% of nurses we assessed (n=20) showing full or high levels of competence. However, by this stage, there had been a marked decline in other areas of competence. For the second task set (data use tasks on coverage and defaulters), only 30% of nurses assessed (n=21) were scored as fully or highly competent. The decline was most notable in Karatu and Longido Districts of Arusha Region. Similar findings emerged for competency scores in managing stock. Qualitative investigations confirmed that this decline was mostly because nurses were not confident in using the TImR update and were waiting for refresher training from the DIVO (who, being overstretched, has not managed to reach all facilities). We noted, however, that declines were somewhat less in Arusha City, and greatest in rural Karatu District.

Progressions in data use in Kilimanjaro Region

For the **end-of-intervention evaluation** in Kilimanjaro Region (June 2018), we used the same methodology and standardized assessment tools to score user EIR competencies. We found good overall levels of EIR competency at the end-of -intervention, with 74% of nurses assessed (n=14) being fully or highly competent in registering a new client. Overall, 47% of nurses assessed (n=16) were scored as fully or highly competent in other data use tasks. At this stage, 47% of nurses were scored as fully or highly competent in EIR stock management skills. These findings were consistent with our qualitative findings

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[21] Not shown in these graphs.

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that training by mentors in both Moshi Municipal and Mwanga District was recent but, according to users, had focused mostly on client registration skills.

We repeated these assessments for the **post-program evaluation** in Kilimanjaro Region (April 2019). We found that there were still very good overall scores for competencies in registering a new client, with 84% of nurses assessed (n=12) being fully or highly competent. However, as in Arusha Region, skills in other EIR task areas had declined considerably, with only 2 nurses (n=12) in Moshi Municipal able to demonstrate high levels of competency in data retrieval, interpretation and defaulter tracing. Notably, stock management skills were considerably better with, overall, 46% of nurses assessed (n= 13) showing high levels of competency – although the majority of these were in Moshi Municipal.

These findings were consistent with our qualitative findings that at the post-program stage in Kilimanjaro Region, nurses were still not using the EIR for recording immunization data on every eligible client and, when they did so, were mostly using the EIR for client registration activities only. Users were still finding data retrieval slow, especially where internet connections were poor in the mountainous areas of Mwanga District. There were also significant problems with the supply of internet bundles (although this was expected to improve as facilities learnt to budget for these supplies). Since the replacement of the DVD-MT with VIMS in December 2018, DIVOs were asking facilities to submit vaccine stock orders using the EIR. The Moshi Municipal DIVO was especially committed to this, accounting for the relatively good stock management competency scores.

Data use in Dodoma Region

In Dodoma Region, sample sizes for competency assessments were reduced because some tablets were not working (especially in Dodoma Urban) or were not available at time of visit (in Bahi District. Among nurses who could be assessed, 100% (n=8) in Bahi District were scored as fully competent in using the EIR to register a new client; this compared to just 33% (n=7) in Dodoma Urban. Similarly, for other data use tasks, 100% (n=8) of assessed nurses in Bahi District were fully/mostly competent, compared to 43% (n=7) in Dodoma Urban. Although, it was difficult to make direct connections to the IMPACT Team approach, we noted that nurses had better all-round skill sets in Dodoma Region.

Qualitative investigations suggested that, once again, the differential findings between the case study districts were linked to continuity of DIVO and management support. There was no evidence that district IMPACT Teams were meeting as expected to review/use immunization data, but there were relevant WhatsApp exchanges amongst IMPACT Team members.

Additional findings on data use for decision making

At district levels, it was evident that, by the post-program evaluation, DIVOs were still not using EIR data, other than to cross-check data from other data sources and for intermittent monitoring of EIR usage. DIVOs in our sample preferred to populate VIMS using monthly IVD reports from facilities, rather than EIR data. This was mostly because they perceived the EIR data to be incomplete or unreliable. As indicated above, some DIVOs were promoting use of the EIR for stock management, but this appeared to depend on the motivation of individual DIVOs.

5.3.3   Outcome 3: implementation at scale and country ownership

Implementation at scale

BID's Outcome 3 logical framework indicators relate to implementation of BID solutions at scale, country buy-in, incorporation of BID interventions into country strategies and the contributions of the BID Learning Network. To assess progress from the baseline, the evaluators conducted desk reviews, key informant interviews, verification exercises at facility and district level and reviewed BLN postings and online events.

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At baseline, the evaluators found that Tanzania had a comprehensive policy and legal framework covering immunizations and vaccine procurement in Tanzania. Following falling rates of immunization coverage over the period 2011-2013, there had been intensified efforts to improve immunization coverage, and rates had reached around 90% for most antigens by 2015. These improvements were attributed to: a) investments from Gavi in immunization service support, injection safety and new vaccines; b) additional investments in cold chain capacity and logistics management; and c) a World Bank-funded Performance-Based Financing (PBF) initiative that has incentivized increased EPI activity at district and facility levels.

By 18 months, the BID Initiative had reached 285 health facilities in Arusha Region. PATH had shifted to the DDUM rollout strategy and this was showing good signs of increasing skills transfer and country ownership. Accelerated progress in the VIMS initiative had catalysed a wider strategic vision on the part of government for an EIS, with back-to-back electronic immunization reporting from facility to national levels. By the end of the program in June 2018, PATH had completed rollout to all eligible facilities in Arusha, Tanga and Kilimanjaro Region using the upgraded EIR software. PATH had also supported the JSI/InSupply rollout of BID Initiative in Dodoma Region.

After the end of the program, PATH aimed to ensure that BID beneficiaries had access to ongoing technical support. DIVOs were instructed to submit requests for technical support to a trained district or regional ICT officer. PATH staff also monitored issues arising through district virtual forums. Problems that are not resolved regionally were referred to the national level where PATH staff and MoHCDGEC ICT teams worked collaboratively to resolve issues arising. PATH reports that ongoing system maintenance costs have been covered under the Gavi HSS grant until 2022. In addition, a number of policy and governance issues continue to be addressed as part of PATH's support to MoHCDGEC and PORALG through the Data Use Partnership.

At the end of the program, PATH extended the contract of the MEDIC design team until November 2018 to ensure residual software design issues were fixed and the MoHCDGEC ICT unit could assume responsibility for TImR system monitoring and maintenance. Contract extension activities included training and capacity building inputs and further revisions to the technical documentation and operational tools.[22]

At the post-program evaluation (April 2019), the evaluators found that MEDIC's contract had concluded but, unfortunately, all the national-level ICT staff trained in TImR monitoring and maintenance had been appointed to new positions. As a result, there remain significant concerns about how this technical support will be provided, both for the period of scale-up to other regions, and for longer-term system maintenance. The National IVD Program Manager reports that MoHCDGEC is planning to establish a new in-house digital design and support unit, but the timeframes for this are uncertain.

Country ownership

Our regular key informant interviews with the National IVD Program Manager and other IVD Program officers confirmed that there was good national level buy-in for the BID Initiative from the outset – although this was driven by a vision for integrated EIR and VIMS information systems in the form of the EIS. This strategic vision underpinned government's efforts to advance paperless reporting in some facilities in Tanga Region.[23] It also informed the government's 2017 HSS application to Gavi, the Vaccine

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[22] MEDIC will continue to manage and maintain the underlying Open IZ platform.

[23] Although evaluation of the BID Initiative in Tanga Region is beyond the scope of work of this evaluation, we have been informed by the National IVD Program Manager that, following a positive trial in six facilities of Tanga Region, the Tanga RIVO has recommended that paperless reporting be expanded to all facilities in the region.

Alliance,[24] and its support for rollout in Dodoma and scale-up to all regions in Tanzania by the end of 2019. At the post-program evaluation, the National IVD Program Manager observed that she would like to see the EIS extended to incorporate all aspects of reproductive and child health reporting.

Although the National IVD Manager remained very supportive, she had some concerns about the speed of progress to date, issues of staff turnover (hampering training), slow internet connections, and the long-term sustainability/affordability for government. She was also concerned that challenges in the procurement of tablet computers had slowed the pace of EIR scale-up to new regions. She observed that government would need ongoing assistance from development partners to negotiate discounts in the bulk procurement of hardware. She also acknowledged there would need to be significant investments in country server capacity for hosting the EIR and VIMS at scale.

At district and regional levels, there was good support for the EIS endeavour, and the EIR as part of this. However, by the post-program evaluation, there were also widespread concerns about the slow speed of the EIR application and recognition that some elements needed to be improved or enhanced (especially with respect to the stock management component). Some DIVOs reported they had made requests for ICT support to the district or region, with mixed success. In addition, there were persistent concerns about budget allocations for internet bundles (at regional, district and facility levels) and the potential costs of replacing and repairing tablet computers (many of which were now several years old).

Role of the BID Learning Network

The evaluators note that the BLN had been extremely productive and well-managed over the course of the BID program. Since program closure in mid-2018, the BLN remained active and has continued to generate a considerable number of informative blogs, postings and webinars, some of which reflect recent Gavi investments to the BLN platform. Blog posts over the period July-October 2018 captured useful links to PATH's BID tool-kits, a Gavi blog on outreach work with EIR in Ngorongoro Region, and a South-South exchange visit between Tanzania and Vietnam. Although these blogs have leaned towards positive messaging, there have also been salutary webinars highlighting real-world issues, such as the challenges of scaling up from EIR pilots in low-resource environments.[25]

Over the course of the program, the National IVD Manager has been an active participant in BLN meetings and events. She has participated as a facilitator and as a contributor to BLN discussions and suggests these engagements have been useful for updating her technical knowledge and for networking with peers from other countries.

Despite positive feedback on BLN resources from multiple stakeholders, the evaluators observed that the most active participation was by senior post-holders, national-level officers and policy-makers – especially those with access to fast, affordable internet connections. Participation by stakeholders at district and facility levels was less frequent, although many of these stakeholders had established active and productive peer support networks through WhatsApp groups.

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[24] The evaluators note that in Tanzania's 2017 HSS application to Gavi, VIMS is mentioned on multiple occasions as government's strategy for addressing the objective of improving data management and quality of routine immunization data. Conversely, the BID Initiative only receives one small mention, suggesting VIMS is seen as the priority intervention. See Tanzania's proposal at: https://www.gavi.org/country/tanzania/documents/proposals/proposal-for-cceop-support-2017--tanzania/

[25] See the BLN Webinar: Identifying and Addressing Challenges in Deploying an Electronic Registry – The Ghana Health Service Experience. Available at: http://bidinitiative.org/resource-library/posts/bln-webinar-identifying-and-addressing-challenges-in-deploying-an-electronic-registry-the-ghana-health-service-experience/

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5.3.4 Outcome 4: resource commitments

Review of the costing information

As in Zambia, the PATH team in Tanzania aimed to measure the TCO to provide potential funders with relevant information. However, once again, in practice PATH was only able to capture its own costs and was not able to conduct a comprehensive analysis of future costs and costs for scaling up to new regions. Also, the costs were not compared with outcomes, which would have helped create a business case for further investment.

Despite being incomplete, the PATH work on costs has generated some interesting reflections. The following discussion refers specifically to PATH's costing work in Tanzania and is informed by two useful publications produced by WHO and PATH (2013)[26] and PAHO (2017).[27]

The costing information shared by PATH has helped us identify some of the cost drivers for the program in the Northern Zone – i.e. the items which account for most of the costs. However, the information provided does not tell us much about total future recurring costs, as most of these were not estimated.

Table 2 below shows expenditure on the BID Initiative in the Northern Zone of Tanzania from the PATH report on costs.[28] From Table 2, it appears that the main cost drivers are:

● System design and development – 21% of total, or 33% when development of the system which had to be abandoned is included
● BID Initiative staff – 39% of total
● Rollout costs – 23% (of which just under half was for hardware).

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[26] WHO and PATH (2013). Planning an Information Systems Project: A Toolkit for Public Health Managers. Available at:
https://path.org/resources/planning-an-information-systems-project-a-toolkit-for-public-health-managers/
[27] PAHO (2017). Op. cit.
[28] Mvundura M, Di Giorgio L and Werner L (2019). *Evaluating the expenditures for developing, deploying and maintaining electronic immunization registries in Tanzania and Zambia: evidence from the BID Initiative.* Draft.

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Table 2: Expenditure by PATH for development and rollout of the BID Initiative package of interventions in the Northern Zone of Tanzania (2013-2018)

System design and development			
System design and development costs of electronic immunization registry (in use)			US$867,851
Learning costs (electronic immunization registry which was shelved)			US$527,644
Other costs			
Back entry costs			US$84,441
Peer learning and printing of guidelines			US$6,242
Labor costs			
BID Initiative staff			US$1,648,484
Region-specific costs			
	Arusha	**Tanga**	**Kilimanjaro**
Rollout costs			
Hardware	US$187,232	US$158,588	US$93,289
Meetings	US$8,728	US$9,783	US$7,097
Training	US$33,232	US$20,686	US$17,148
Deployment	US$146,701	US$162,353	US$103,617
Annual recurrent costs			
Internet connectivity	US$16,930	US$19,807	US$16,301
Data hosting	US$9,086	US$10,630	US$8,308
Supportive supervision	❖	US$6,178	US$8,786
Printing (e.g. barcodes)	US$4,702	US$5,501	US$4,300
Total costs over project period			**US$4,193,647**

❖   Not tracked separately in the financial records but included in the rollout costs.

In PATH's estimates, annual recurrent costs accounted for only 2%, although, of course, these would occur every year. The label "annual recurrent cost" is rather misleading because in fact this is just the known costs of keeping the technical system working: it does not include recurrent staff or transport costs, nor does it include system updates and refresher training. Most of the future recurrent costs are unknown for the reasons given above: the analysis was time-limited and only considered costs incurred by PATH.

Notably, these costs are for just three regions, whereas Tanzania has 31 regions in total (with an average of 6 districts per region). If we scale up the costs for the three regions based on this information, the picture becomes very different. The average rollout and annual recurrent costs for a region is US$352,994. Multiplying this up for 31 regions and rounding gives an approximate cost of US$10.943

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million for the nationwide rollout and recurrent costs. Add this to the US$3.135 million for start-up costs (taken to be the non-specific regional costs in the table) and this gives a grand total of just over US$14 million. System design and development accounts for 6% of this total (or 10% when development of the system which had to be abandoned is included). Rollout and annual recurrent costs account for 78% of total expenditure.

There are many caveats to this estimate of US$14 million – including the fact that the so-called "annual recurrent costs" are considerably under-estimated and have just been included for one year, while the significant "labor cost" item was not only for start-up. However, the figure is a start as a working estimate. Nevertheless, we should note that the figure is likely to be a fairly significant under-estimate, as it does not include government staff time and the BID labor costs were not counted as region-specific costs. We note, too, that WHO and the International Telecommunication Union estimate that eHealth projects typically allocate 60-70% of their budget to human resources (especially for training) in the implementation/operating phase.[29]

While recognizing the limitations, these figures demonstrate that:

- System design and development costs seem very significant at the start, but in the context of overall implementation they can be a relatively small proportion. The design of the system has implications for future costs (e.g. in terms of how user-friendly it is and inter-operability with other systems) and it can be worth using resources upfront to get these things right. Whilst shelving an unsuccessful design may seem expensive and wasteful at the time, it can be a wise long-term decision that saves money.

- Whilst digital information systems are generally thought of in terms of hardware and software, they also require considerable human resources. Individual staff are often involved in a variety of types of activity (e.g. management, training and visits to facilities), so it can be difficult to assign staff costs to different stages of implementation. A problem with this is that, in the longer-term, it is government staff who will perform many of these roles, and the costs of government workers are often lost in budgets because they are not an additional project cost if activities are expected to take place using existing staff. It is therefore important to think in terms of human resource capacity - the quantity and quality (i.e. skills) required – as well as direct project costs. The project will stall if the required staff are not available.

- Rollout costs are crucial in a national program. This is partly a matter of what hardware for facilities is selected and partly a matter of the training/deployment model used. As was demonstrated in Dodoma Region (see below), training and deployment costs can be substantially reduced (though this in turn may have an effect on quality). Investments in making systems as user-friendly as possible can pay dividends because they can reduce the amount of time required to train each user.

Putting the costs of scaling up in perspective

The analysis above puts the total rollout costs at almost US$11 million, which could be spread out over several years. To put this into some kind of perspective, about US$124 million was spent on routine immunization in Tanzania in 2016, of which 21% came from government. 41% of the total spending was on vaccines. So, if we thought of the US$11 million as a one-year expenditure, that would account for 9% of total immunization spending, 15% of non-vaccine immunization spending, 43% of total government spending on immunization or 63% of government non-vaccine immunization spending.[30]

We can make some predictions of future costs:

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[29] WHO and PATH (2013). Op. Cit.
[30] Figures on immunization spending in Tanzania *from Co-financing information sheet for Tanzania, 2018.* Gavi, the Vaccine Alliance. Available at: https://www.gavi.org/country/tanzania/documents/

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As seen from Table 2, the PATH assessment of future annual recurrent costs per region is about US$36,850, which would work out at US$1,142,350 each year for 31 regions. The PATH estimates do not include central recurrent costs.

The line items included in the BID costing are internet connectivity, data hosting, supportive supervision and printing, plus equipment replacement at a rate of 5%.. However, we know that the following also need to be considered:

- Investments in ICT capacity for additional deployment;
- System enhancement, upgrades and data protection measures (all levels);
- Refresher/advanced training for DIVOs/mentors/IMPACT Teams;
- Helpdesk/focal point support at regional/national levels (for operational guidance, troubleshooting support and system maintenance);
- Procurement of in-country servers at regional and national level (needed to meet data processing requirements at scale);
- Replacement/additional tablets (more durable high spec with built-in scanner now being recommended; most facilities need 1-3 tablets rather than just 1 to manage workflows, outreach etc);
- Replacement solar panels (possible).

These are all items which should be included in a study of the total costs of ownership.

The WHO/PATH (2013) manual[31] includes the graph shown below (Figure 10). It says that this is a "hypothetical but representative cost profile that clearly highlights that the largest costs will not be incurred in the development phase, but in the consecutive scale and sustain phases of the system's lifecycle".

Figure 10: Cost profile for a typical information system
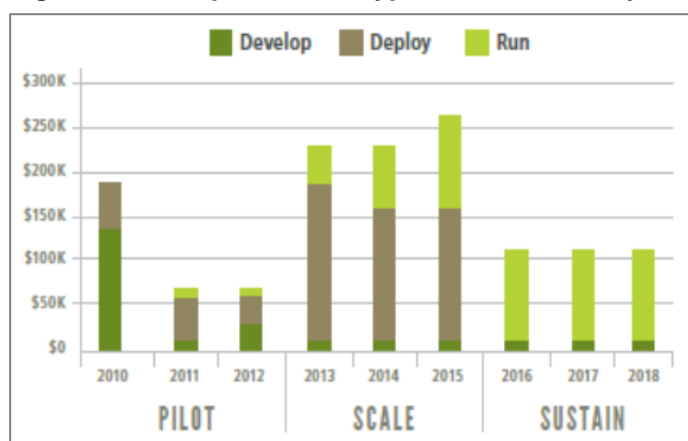
According to this graph, 19% of costs are incurred in the development phase, 42% during deployment and 39% for running the system. Although we do not have the complete picture for BID, the overall shape may well be similar to Figure 10. We know that deployment will cost considerably more than development, and we also know that more work needs to be done to capture the full costs of running the system.

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[31] WHO and PATH (2013). Op. Cit.

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The PAHO toolkit[32] emphasises the importance of estimating future costs: "failure to consider the human resource costs and requirements of system maintenance can cause the system to fail. When support actions are not carried out for lack of planning, the system promptly becomes obsolete."

However, combining the cost information with information on outcomes raises some more issues. Cost data needs to be considered in the context of outcomes – in other words, what was achieved for the money spent. As explained in Section 5.3 above, findings on BID intended outcomes remain inconclusive. It is also apparent that more needs to be done in terms of training or supervision to promote consistent use of the EIR, as well as data use for decision-making. We also know that there is still a need for system updates and enhancements, especially to improve data exchanges between the EIR and VIMS – this will cost money, including for technical support. None of these additional costs are included in the estimates, unless they can be implemented as part of existing activities.

Cost implications of the alternative rollout strategy

As part of a wider evaluation of resource commitments, we also reviewed available financial data on costs associated with the InSupply-led IMPACT Team approach to rollout. We compared this data with costing data provided by PATH on the DDUM rollout strategy, with Kilimanjaro selected as the most comparable region. Although alignment of budget lines and the scale of rollout was not straightforward, the available data indicated that the estimated cost of rollout (i.e. excluding original system design and hardware costs) in Kilimanjaro Region was US$136,648 using the DDUM strategy, while the estimated cost of rollout in Dodoma Region using the IMPACT Team approach over a similar timeframe was US$89,795. This equates to US$438 per facility in Kilimanjaro Region (312 health facilities) and US$260 in Dodoma Region (345 facilities). It, therefore, appeared there were considerable cost savings associated with the IMPACT Team approach. These savings were likely to be due to delivery by a smaller [InSupply] team that provided highly structured inputs at defined intervals over shortened timeframes (see Annex 3).

We must caution, however, against drawing definitive conclusions about the cost-effectiveness of the IMPACT Team approach because, like for the DDUM approach, it was not possible to align inputs to convincing outcome-level results.

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[32] PAHO (2017). Op.Cit.

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6 Discussion

The Mott MacDonald evaluation design aimed to complement PATH's own survey-based monitoring and evaluation to confirm, explore and explain differential outcomes from the BID Initiative across two demonstration countries and 60 health facilities in 10 case study districts. We placed comparison of program processes and results across implementation settings at the heart of the evaluation enquiry. Our methodology deployed mixed methods to respond to the complexity of interactions between context, mechanisms and outcomes over time.

The focus on **context** allowed us to identify several infrastructure and health systems factors that influenced program development in each country. In both countries, EIR software developers had to apply 'frugal design' methods to accommodate the constraints of unreliable power supplies, nascent internet connectivity and limited server capacity. In Zambia, the fact that immunization reporting was fully integrated into HMIS/DHIS2 systems, combined with the prevalence of outreach services, the use of volunteer cadres and presence of several other digital health initiatives made design of the BID solution an especially complex task. Conversely, in Tanzania, the presence of a relatively discrete IVD immunization and vaccine stock reporting system and the presence of a dedicated cadre of DIVOs and RIVOs, may have been an advantage.

Our reviews of the program **mechanism** considered both the design and implementation themes. Although the BID Initiative had several components, in practice, these all hinged on development of a robust EIR solution. In both Zambia and Tanzania, it proved difficult to identify a software developer who could respond to the technical and operational challenges of delivering bespoke EIR solutions – indeed, in both cases, the original sub-contractors had to be replaced. The new sub-contractors were recruited internationally. Consequently, they mostly operated remotely and needed to work with PATH to acquire the necessary understanding of user workflows, data reporting needs, data dependencies and the system governance environment.

In both demonstration countries, key design challenges related to: provision for offline working; data warehousing; evolving system integration requirements; scalability; data security with multiple users of single (mobile) tablet devices. In both countries, it was also difficult to find cost-effective solutions for: a) the "denominator problem" - which required a combination of data sourcing on home births, data back-entry solutions and policy changes; and b) integrated vaccine stock management - that allowed reliable batch/distribution tracking at each system level, timely wastage adjustments etc. In both countries, collaborations with other initiatives (e.g. mVacc and Logistimo in Zambia, and VIMS in Tanzania) appeared to be the most feasible way to address some of these challenges.

With regards implementation, the evaluators observed the evolution of rollout strategies across the case study sites in Zambia and Tanzania. This evolution started with the PATH-led touch strategy in Zambia and the Arusha Region of Tanzania – this strategy had the advantage of high quality technical support from the PATH team in the early stages of the program. The touch strategy was then adapted in the Northern Zone of Tanzania to become the DDUM strategy; this was more suited to rapid and efficient scale-up and increasing government ownership. In Dodoma Region, InSupply and PATH developed the IMPACT Team approach for scale-up; this more rationalised trainer-of-trainer approach emphasised data use for progressive quality improvement. Each of these approaches had relative benefits and cost implications. However, we found that none of these strategies was able to deliver results in the absence of a fully functional (and updated) EIR application; adequate supplies of data bundles; and/or a critical mass of trained users with ongoing access to timely ICT and follow-up support.

In Tanzania, where the program ran over a longer duration, the evaluators observed that users in rural and low-volume facilities were often the strongest adopters of the system. Our qualitative investigations suggested this was because these users had less time pressures and more time to practice using the tablet device; in addition, they were often highly motivated by potential time savings in travel to submit monthly reports. However, we also noted that these effects could be dependent on DIVO support and

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user aptitude - with older, less 'tech savvy' nurses being among the slowest adopters. We suggest these themes are key areas for further investigation.

In their analysis, the evaluators gave particular attention to measuring how effective the BID package of interventions was in delivering intended **outcomes**. Figure 11 below summarizes key outcome level findings for each case study region over successive milestone evaluations.

Figure 11: Summary of evaluation findings over successive milestone evaluations, 2016-2019
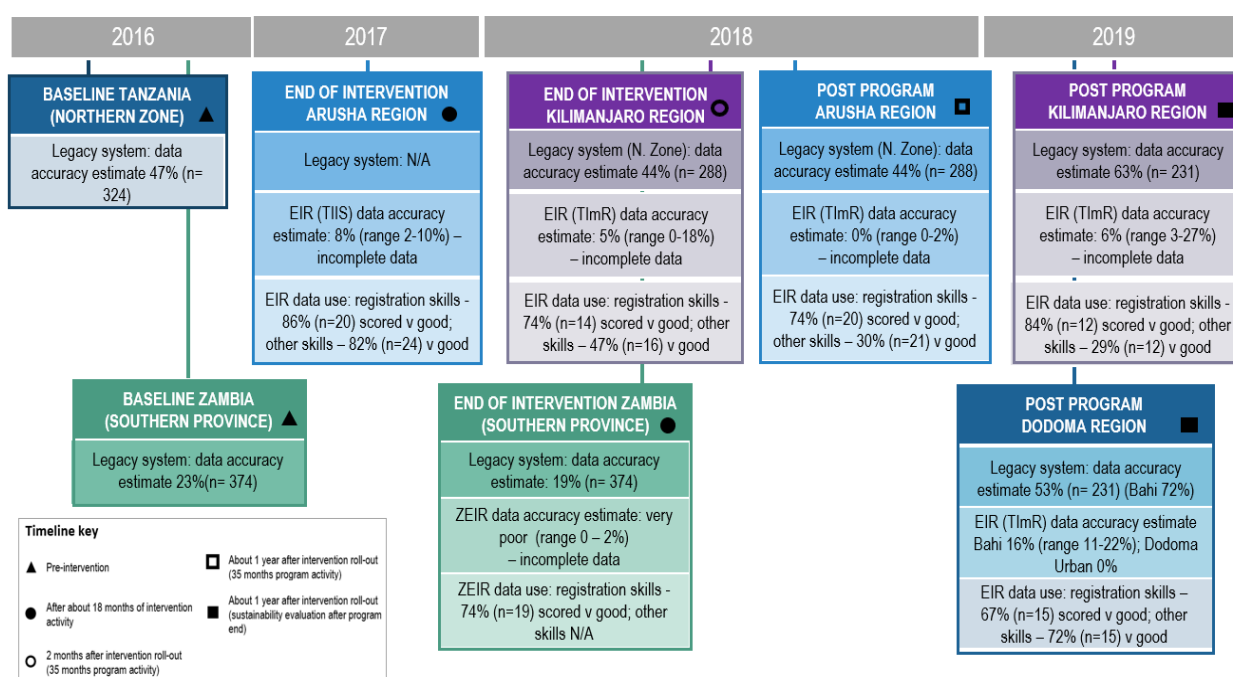
From the focus on outcomes, we found that in both demonstration countries, ongoing usage issues meant that, even once a fully functional EIR became available, this did not translate directly into improved data quality in the immunization and stock logistics system. In all case study districts, the core problem was that the EIR was not used for every new client. This, in combination with data upload issues, meant that EIR master data remained incomplete, and could not practically be used for district-level reporting and decision-making.

The PATH team argued, quite plausibly, that while the legacy systems remained in place, health care workers in Zambia and Tanzania would have neither the time nor the motivation to use the EIR consistently, and would not experience the benefits of electronic reporting. This led to something of a 'results paradox' where governments were reluctant to sanction the shift to paperless reporting in the absence of measurable results - yet results were unlikely to be demonstrated while the paper-based legacy system remained in place. In Tanzania, the government's trial of paperless reporting in Tanga Region must, therefore, be seen as a significant step. However, we suggest this trial needs to be monitored carefully and credibly to inform decisions on future scale-up.

As shown in Figure 11, data use competency skills were strongest immediately after intervention training, but then showed signs of decline – with more advanced stock management skills and data interpretation skills deteriorating fastest. We were able to track this decline over a longer period in Tanzania. Here, the tail off in skills was compounded by uncertainty in supplies of data bundles and barcodes, as well as hardware servicing problems, all of which prevented regular EIR usage. However, there was some circumstantial evidence (e.g. from Dodoma Region) that user performance and commitment were linked to the quality of ongoing supportive supervision from DIVOs and mentors, and effective communication of government's strategic vision.

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In Tanzania, we noted good levels of government buy-in from the outset. This appeared to be linked to earlier commitments to the VIMS initiative, and the potential to incorporate the EIR into a back-to-back Electronic Immunization System from facility to national level. PATH's role in the Data Use Partnership to support government in developing a coherent digital heath roadmap for Tanzania may also have been a contributing factor. Both these observations underscore the importance of a wider health systems perspective in interpreting the role and potential sustainability of the BID Initiative in each country setting.

Ultimately, important decisions will need to be made on the sustainability of BID package of interventions and the case for further investment by government and development partners. Estimates of total cost of ownership and cost-effectiveness in delivering improved immunization and health outcomes must be at the heart of these decisions. We have seen, however, that there is still a need for consensus-building on the appropriate scope and timeframes of TCO analysis and the interpretation of findings for multifaceted digital health interventions of this nature. Importantly, however, appropriate costing data needs to be collected from the outset to support open and transparent discussions on cost implications down the line.

Development of the BID Initiative was based on PATH's comprehensive theory of change which articulated underlying hypotheses and assumptions to provide a framework for ongoing 'collaboration, learning and adaptation' cycles. PATH has done well in documenting the lessons learnt from implementing the BID Initiative in Zambia and Tanzania.[33]

The BID Initiative theory of change was based on an overarching primary hypothesis that the BID package of interventions would lead to improved immunization data quality and use at scale in two demonstration countries, and these outcomes would, in turn, lead to country commitments and additional resources for further scale-up. The evaluators have systematically reviewed the BID Initiative theory of change and its associated hypotheses in Annex 4. Based on the evaluation work, we have also identified six supplementary hypotheses that could usefully tested through future collaboration, learning and adaptation cycles to strengthen the theory of change (Box 6 below).

Box 6: Six Supplementary Hypotheses for strengthening the BID Initiative Theory of Change

- **Hypothesis 1:** It is better to recruit early adopters in low volume facilities. In these settings, users have more time to practice and work through operational issues; users in high volume facilities are already over-burdened.
- **Hypothesis 2:** Premature rollout of the EIR solution risks demotivating users and policy makers. It can be counterproductive to move to scale-up before the EIR app is fully developed and successfully piloted – data use interventions can be an interim measure.
- **Hypothesis 3:** Take-up of EIR and data use solutions is more successful in strong health systems. Alternatively, these solutions need to be introduced as part of coherent health systems strengthening (and eHealth) approaches that engage with all system levels and 'building blocks'.
- **Hypothesis 4:** If technical and workflow constraints prevent nurses using the EIR for every client, designers should consider a mixed digital-paper solution that is tailored to workplace realities and allows gradual transition to e-reporting.
- **Hypothesis 5:** If immunization reporting is fully integrated in the RMNCH continuum of care (as in Zambia), it is more efficient to introduce an integrated approach to electronic data reporting from the outset (rather than expand from a vertical immunization reporting solution).
- **Hypothesis 6:** The IMPACT Team approach offers a cost-effective rollout strategy that brings additional benefits for a sustainable culture of data use, if introduced as part of a more extensive quality improvement initiative.

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[33] See PATH's Lessons Learned Encyclopaedia. Available at: http://bidinitiative.org/wp content/uploads/FINAL_LessonsLearned_Encyclopedia_6July2018-Logo.pdf

7   Conclusion and recommendations

7.1   Conclusion

Across Sub-Saharan Africa, there is growing momentum around the use of digital health solutions to drive improved data quality and use. As our evaluation work has shown, there are multiple factors that may determine the effectiveness of these solutions – some of these are about the design, deployment and maintenance of the technology, and some are about the wider health systems environment. Processes for finding the most appropriate digital health solutions for different settings can take time; they also require an openness to adaptation and course-correction.

We note that, over the timeframes of this evaluation work, a body of evidence has emerged that supports our somewhat equivocal findings. Reviews of the evidence on EIRs in low- and middle-income countries are increasingly showing that: a) the effectiveness of EIRs depends on how well they are designed, developed, implemented and used; b) achieving consistent EIR use is the greatest barrier to success; c) consistent EIR use is significantly undermined by weak health worker capacity, parallel data entry, administrative burden, limited internet connectivity and frequent power outages; and d) data use is undermined by health worker motivations and perceptions of data quality.[34] Although more data is still needed on the effectiveness, cost-effectiveness and sustainability of EIR-based solutions, program evidence does suggest that the more EIRs can alleviate service provider workloads and leverage additional training and on-the-job support for data use, the more successful they will be. Ultimately, however, like all digital health initiatives, EIR-based solutions must be measured against their cost-effectiveness in delivering improved health outcomes when compared to other health interventions.

7.2   Recommendations

Based on findings from the milestone evaluations of the BID Initiative in Zambia and Tanzania, we have identified a number of recommendations for: a) donors and development partners and b) governments and implementing partners considering scale-up of the BID package of interventions.

Recommendations for donors and development partners

- **Continue to build the evidence base** on the effectiveness of EIRs and data use interventions for strengthening immunization programs in low- and middle-income countries. Ensure there is adequate provision for credible, independent evaluations of other initiatives aiming to improve immunization data quality and use through combined EIR and data use approaches. Commission periodic evidence reviews to identify factors in success and, if necessary, the need for course correction.

- **Systematically test emerging hypotheses** on how to improve program design. Enrich the evidence-base by seeking opportunities to test the hypotheses listed in Box 6 above – ensure the evidence is robust, is fully shared with key stakeholders. Incorporate evidence from hypothesis-testing into revised program theories of change.

- **Generate robust data on the cost implications** by making provision for full TCO analyses that can be used by government for cost-effectiveness assessments. Build consensus on a standard TCO methodology that takes account of direct and indirect costs over short and longer (sustainability) timeframes within a health systems framework.

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[34] See for example, Immunization Data: Evidence for Action. A Realist Review of What Works to Improve Data Use for Immunization, Evidence from Low- and Middle-Income Countries. Seattle: PATH; Washington, DC: PAHO; 2019.

Recommendations for governments and implementing partners

Should the Governments of Zambia and Tanzania choose to work with implementing partners to scale-up of the BID interventions, they should consider the following recommendations:

- **Ensure national-level ICT capacity gaps are addressed.** This is needed for EIR scale-up, monitoring, maintenance, upgrades and system enhancements. As digital health solutions expand, ensure there is also appropriate ICT support at regional/provincial and district levels.

- **Consider investing in high-specification tablet computers** with built-in scanners to ensure durability, easier data retrieval from barcodes and optimal data processing speeds in challenging environments.

- **Consider investing in local Focal Points** to provide rapid technical, troubleshooting, and operations support to assist system monitoring. District and facility staff often need specialist refresher training, accessible technical inputs (e.g. for tablet set-up and configurations and managing updates), Helpdesk support and guidance on back-up measures. There is also scope for improving the data use skills of users over time.

- **Strengthen in-country server capacity**. The EIR currently uses a cloud-based server. However, as the system goes to scale it will be necessary to invest in improved local server capacity to maintain data processing speeds at scale, and accommodate future digital health initiatives.

- **Commission regular data security assessments.** Personal health data is potentially highly sensitive, and requires advanced data protection measures. Governments will need to ensure that appropriate data security measures are in place at each system level, and that health care workers are trained to observe the highest standards of data privacy.

- **Commission a robust evaluation study of paperless reporting in Tanga Region** to review progress, assess feasibility and identify lessons for scale-up.

- **Commission studies to identify the most cost-effective implementation strategy** for scale-up in each country setting. The Mott MacDonald evaluation team has assessed the DDUM and IMPACT Team implementation strategies; however, the most recent approach (based on training of champions from targeted health facilities) has yet to be evaluated.

- **Think critically about short-term and long-term costs**. Experience from the two demonstration countries has shown that if the transition to electronic reporting becomes protracted, input costs can accumulate (e.g. for refresher training and follow-up support), while the time burden for health care workers managing parallel systems can be high. In addition, the health system will need to absorb recurrent costs (e.g. for internet bundles and barcode printing) and, over the longer term, capital costs (e.g. for procurement of additional/replacement tablet computers), along with system development costs (e.g. for strengthening ICT and server capacity). These cumulative costs need to be monitored and weighed against the potential benefits and cost-savings associated with electronic reporting.

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ANNEXES

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Annex 1: Full evaluation report Zambia

Introduction

This annex presents the detailed findings of the independent evaluation of the BID Initiative in Zambia. The BID Initiative was implemented in Southern Province of Zambia from early 2016. This end-of-intervention report was completed following 18 months of program implementation. It focuses on a purposeful sample of three case study districts in Southern Province (Livingstone, Kazangula and Sinazongwe), but also examines effects at higher levels of the health system.

The report begins with a description of the evaluation methodology. Next, the report presents the evaluators' findings in two sections. Findings I describes findings on the context and mechanisms, along with achievements and challenges. Findings II systematically evaluates progress towards results through reference to the BID logical framework and indicators -this covers evaluation of results relating to immunization data quality and data use, country buy-in and scale-up, and resource commitments.

Evaluation rationale and methodology

Evaluation design

The design of the Zambia evaluation is consistent with the wider evaluation design for the BID Initiative. This design is based on a non-experimental, theory-based approach that involves testing the program theory of change, assessment of the relationship between context, 'mechanisms' [interventions] and outcomes,[35] and 'plausibility analysis' to assess the likely contribution of the program to final results. To support this approach, the evaluators identified a purposeful sample of three case study districts in Zambia to illustrate a range of implementation contexts. These case study districts complemented a purposeful sample of five case study districts in Tanzania. Within each of the case study districts, the evaluators have tracked a 'panel sample' of six health facilities over time to support a longitudinal, interrupted time series analysis.[36]

Purpose and objectives of the Zambia end of intervention evaluation

The overall **purpose** of the evaluation in Zambia was to review progress in implementing the BID Initiative and delivering results since baseline and, through explanatory and comparison work, to identify key lessons and factors in success to inform future program design.

The **principal objectives** of the evaluation were to:

- Assess the implementation context and mechanisms by examining the context of the three case study districts (Livingstone, Kazangula and Sinazongwe) and reviewing progress in implementing the BID Initiative in a panel sample of 18 health facilities in the three districts.
- Assess (and explain) progress towards intended outcome level results.
- Review the prospects for sustainability and scale-up in Zambia.
- Review the BID Initiative in Zambia against the program theory of change and identify themes and lesson that will support comparisons with BID program experience in Tanzania.

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[35] This approach to theory-based evaluation work has its roots in "realist" approaches to evaluation - see the Better Evaluation publication: http://betterevaluation.org/en/approach/realist_evaluation ; also the Governance and Social Development Resource Centre publication (2012): http://www.gsdrc.org/docs/open/hdq872.pdf

[36] Where possible, we have examined the strength of attribution by reviewing the relationship between outcomes and duration of exposure to BID interventions and considered the potential effects of other initiatives in the area.

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Methodology

Data collection strategy

The data collection strategy for the evaluation was generated from an 'evaluation framework'. The evaluation framework defined the principal evaluation questions associated with the evaluation objectives and themes. These were then aligned to specific data collection methods and tools for each level of the health system. The mixed method approach included key informant and stakeholder interviews, data quality assurance reviews, direct observation and a standardized competency assessment of health care workers using the Zambia Electronic Immunization Registry (ZEIR).[37]

In addition, the evaluators conducted a data quality assurance (DQA) review of immunization data in: a) the 'legacy' paper-based DHIS2 and vaccine stock management system; and b) in ZEIR. This exercise focused on data for six proxy vaccines[38] over a period of three consecutive months. To assess data quality, the evaluators compared the data reported by facilities monthly against primary records and examined immunization and stock data based on the data quality criteria of availability, timeliness, completeness and accuracy.[39]
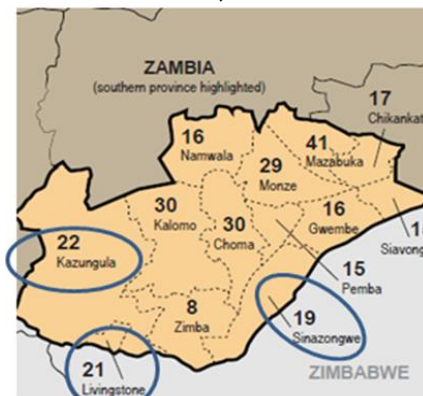
As far as possible, all data collection methods were triangulated to support validation of findings. The methodology and data collection tools developed for the end-of-intervention evaluation were substantively similar to those used at baseline. The evaluation protocol and data collection instruments all received research and ethical clearance under the procedures set by the Zambia National Health Research Ethics Committee.[40]

Sampling strategy

The purposeful sample of case study districts was selected at baseline using selection criteria relating to location, immunization coverage characteristics and likely duration of exposure to the BID Initiative. The sampling exercise aimed to capture a range of urban, rural and border locations, immunization coverage trends and length of exposure to BID interventions. The case study districts selected using this process were: Livingstone; Kazangula and Sinazongwe in Southern Province (Figure 12).

Figure 12: Case study districts and number of facilities, Southern Province

The panel sample of health facilities was also selected at baseline by first stratifying health facilities by facility type (hospital, health centre or dispensary) and patient volume (high or low volume facilities), then randomly sampling six facilities per district across these stratification groups to ensure all categories were appropriately represented. This panel sample was also used for the end-of -intervention evaluation to allow a comparison against baseline findings.

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[37] A standardized competency assessment was administered to one-two regular users of ZEIR in each of the sampled facilities.

[38] These vaccines were: Bacille Calmette Guerin (BCG); Oral Polio Vaccine (OPV) 2, Pentavalent, Pneumococcal Conjugate Vaccine (PCV) 2, Rotavirus (RV) 2, Measles 2

[39] This DQA method is similar to that used by PATH in its baseline and follow-up surveys and is consistent with the methodology recommended by the World Health Organization (WHO) see WHO. 2003. The immunization data quality audit procedure. Geneva: WHO, Vaccines and Biologicals.

[40] These were administered by the agency, ERES Converge.

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Data analysis

The evaluation analysis was based on a health systems view and made systematic reference to the intended outcomes of the BID Initiative, as defined in the BID results framework. Our evaluation of Outcome 1 required a particular focus on improvements in immunization data quality at scale. To assess changes in immunization data quality within the health system over time, we reviewed DQA data from both the 'legacy' IVD reporting system and the EIR (ZEIR) reporting system at each evaluation milestone. It is important to note that, although we used the IVD legacy system as a reference point for assessing EIR data quality, we did not assume data in the legacy system was correct; rather, the legacy data was simply used to *reflect* on data quality in the EIR system.

Immunization data for the six proxy vaccines were collected from all the sampled facilities in the case study districts. Data were recorded in a Microsoft Excel (2016) template and exported to a Stata 15 statistical software package for comparative analysis.

For Outcome 2 on data use for decision-making, data on competency scores from standardized user assessments on the use of the EIR were recorded and analyzed in Microsoft Excel (2016).

As part of our triangulated, mixed method approach, qualitative data was collected for each expected outcome. Structured and unstructured qualitative data from interviews and direct observation were entered into pro-forma templates and organized around outcome-level themes. These data were analyzed manually, so the evaluators could iteratively cross-reference themes emerging from the DQA findings and explore associations and sub-themes by stakeholder type. Once preliminary findings had been identified, the evaluators explored and confirmed these through follow-up key informant interviews. Key stakeholders also provided feedback on successive drafts of evaluation reports.

Findings I: Context and Mechanisms

Findings on context

The evaluators have found it useful to focus on some key features of context in the three case study districts of Southern Province. These features cover the wider health system and health indicator reporting, the EPI program and its reporting systems, infrastructure and the specific features of the district and its health facilities. Generic findings for these dimensions are presented in Table 3.

Table 3: Review of the BID operational context

Feature	Findings
Health system	**Decentralized health structure** under the national Ministry of Health. Includes provinces and districts (managed by District Health Management Teams), district hospitals, health centres and health posts. Health facilities may be managed by the public sector, faith-based organisations (e.g. the Churches Health Association of Zambia -CHAZ), NGOs or the private sector. **Each health centre** is responsible for running key health programs, which include maternal, newborn and child health, communicable and non-communicable diseases, environmental, water and sanitation, school health and nutrition, and epidemic preparedness (NHSP, 2012). Routine service provision is commonly supplemented by outreach activities and campaigns. **Human resources** for primary health care are stretched. Health facilities are commonly supported by community health workers and assistants with inputs from Neighbourhood

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	Health Committees. Hierarchical management structure. No dedicated EPI officers at district level.
DHIS2 reporting	• **DHIS2:** Zambia's Health Management Information System has recently been upgraded to a web-based system District Health Information System (DHIS2). The Health Information Aggregation 2 (HIA2) paper report is compiled monthly by facilities to submit data on maternal and child health (MCH) services to the district. These data are entered into the DHIS2 web-based system by a District Health Information Officer (DHIO). Access codes for exporting data to Zambia's DHIS2 are closely protected. Governance is complex with multiple stakeholders and a rigid legal and regulatory environment. • **eHealth Strategy:** Zambia's recently updated eHealth Strategy (2017-2021) outlines the government's approach to digital solutions for telemedicine; information systems; health promotion; mHealth; eLearning and capacity building.
EPI program	• In Zambia, the Expanded Program of Immunization (EPI) sits within Maternal and Child Health (MCH) directorate of the Ministry of Health (MoH). There is also a multi-stakeholder EPI Technical Working Group under the overarching the Child Health Technical Working Group. At district level, EPI services are delivered through district hospitals, health centres and some health posts. There is also a large cadre of community-level role-players involved in immunization work.
EPI reporting	• **Immunization reporting:** Immunization data is recorded at facilities in the child health card, child register and immunization tally sheets. Immunization data is submitted as one component of the HIA2 report to the district level by the 7th of each month. District data is consolidated at the provincial level by the Senior Health Information Officer (SHIO). At national level, the M&E Unit of the MoH monitors performance and shares data reports with the MCH Directorate and EPI Program. • **Vaccine Stock reporting:** The Chief EPI Officer oversees central vaccine procurement and distribution of vaccine stocks to provincial and district storage hubs based on availability and expected demand. These are overseen by the Provincial/District Pharmacist. Facilities use stock control cards to record vaccines received and used/wasted; they submit monthly returns to the MCH Coordinator and District Pharmacist, and use stock vouchers to request stock-ups.
Infrastructure	• **Accessibility:** In Southern Province, populations are concentrated in urban centres along the line or rail/road. Urban health facilities are generally high-volume, and often serve border communities and traders. In rural areas, population density is relatively low; agricultural, pastoralist and fishing communities can be highly dispersed and may be inaccessible in rainy season. • **Electricity supply and internet connectivity** is patchy; there are frequent power outages (although this is improving). Connectivity is generally slow/unreliable – health facilities depend on the distribution of data bundles for internet access.

The evaluators' review of context also identified some **other initiatives** being implemented in Southern Province that could have implications for the uptake of the BID Initiative. The most important (SmartCare, mVacc and Logistimo) are described below. The Government of Zambia has recently requested more collaborative working between the BID Initiative and these programs.

• **SmartCare:** Since 2005, several international development partners (e.g. CDC, EGPAF) have been working with the Government of Zambia to develop an electronic (web-based) health record system. SmartCare has recently been extended to cover immunization reporting; a community module for birth registration has recently been piloted in Livingstone.

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- **mVacc**: UNCEF has been piloting mobile phone technology in Southern Province for recording child vaccination and health data in immunization registers. This initiative is primarily intended for data sharing by Community Health Workers at Health Posts.
- **Logistimo**: This stock management system is using web and mobile phone technology. It is being piloted at scale with support of WHO and UNICEF.

Findings on Mechanisms

The main elements of the BID intervention included development of the Zambia Electronic Immunization Registry (ZEIR) with a stock management component. This was rolled out to facilities and districts using a 'touch strategy' that included support for change management and data use for decision-making. Rollout had been completed in all 298 facilities in Southern Province by mid-March 2018 (PATH Progress Report, April 2018). Key milestones in the implementation of the BID program implementation in Zambia are shown in Figure 13 below.

Figure 13 : Milestones in PATH's delivery of the BID program in Zambia

The 'mechanisms' of the BID Initiative in Zambia can also be described around three dimensions, namely design of ZEIR solution, rollout through the implementation or 'touch' strategy and the final exit phase of sustainability planning.

A key event in the **design of the ZEIR solution** was the replacement of the original software developer – University of Oslo (UiO) with a new sub-contractor (Ona) in October 2016. Unfortunately, UiO had not been able to resolve key requirements relating to data security, offline functionality and provision for multiple users of single devices at facility level. Ona proposed to advance the design of ZEIR and address the design challenges by adapting Open Smart Register Platform (SRP) software and building on experience of WHO-funded initiatives elsewhere (e.g. Kenya and Pakistan). Although Ona made commendable progress, they were hampered by the limited time available and additional challenges,

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such as: retrospective User Advisory Group (UAG) requests to add extra fields (e.g. for administration of Vitamin A and deworming medication and growth monitoring); defining workable data entry validations; and exporting data to DHIS2 (due to government restrictions). In addition, the Ona team was Kenya-based, so had to test new releases through intermediary Zambia-based PATH staff. Development of the stock module and community birth registration component were put on hold due to governments request to work with other initiatives (Logistimo and mVacc respectively). Nevertheless, there is general consensus that the ZEIR user interface is appealing and well-designed and Open SRP software has good potential for regional scale-up.

PATH's four-touch **implementation strategy** for rolling out ZEIR to facilities and districts was delivered over three phases. Stage1: involved preliminary data use interventions in two districts (while the ZEIR solution was being re-designed); Stage 2: involved classroom-style ('Group Touch') training of 'champions' (representatives from each facility in the same district and district leadership) and trainer of trainer (ToT) support to the initial implementation districts; Stage 3 (from late 2017) involved the PATH team scaling-up and completing touch visits to ensure all 290 eligible facilities in Southern Province had received training in ZEIR and data use support.

Key challenges from the implementation phase included the need to:

- Actively facilitate version updates via Google Play Store for all facilities.
- Find a workable strategy for back-entry of data
- Extend training and supervision support to include non-core facility staff (such as CHWs).
- Develop strategies for outreach activities (given that government only mandated one table per facility and difficulties with syncing tablets had not been overcome).
- Address user workflows when working with multiple reporting systems (often the legacy system, ZEIR and SmartCare).
- Address procurement and logistics issues relating to QR codes and data bundles.
- Security concerns and community perceptions relating to the use of child photos.
- In addition, solutions relating to secure use of single devices by multiple user and offline working were still proving problematic by the end of the implementation period.

Given these challenges, the progress made by the implementation team over short timeframes was impressive. However, some important lessons from this implementation experience were:

- Pressure to meet program targets meant that the ZEIR solution was rolled out before the software was fully functional and all 'bugs' had been fixed. Since later updates were not widely downloaded (see below), this had implications for user experience and competency.
- Early training needed to include how to download ZEIR upgrades from Google Play Store.
- There was limited ongoing use of data use tools such as micro-training videos, video games, posters, and institutionalisation of data use guide remained weak.

In the final phase of program delivery there has been greater emphasis on **sustainability planning**. Some stakeholders observed that this could have begun earlier and the initiative would have benefited from stronger and more consistent buy-in from the national leadership from the outset.

In the final phase of the program, the PATH team did well in recruiting a local sub-contractor (Blue Code) to provide ongoing technical support for rollout of ZEIR, including making improvements to data visualization dashboards. The PATH team also worked with the government of Zambia to submit applications to the World Bank (to support scale-up to 5 provinces) and to Gavi to for an EPI Optimization (EPI Opt) initiative to strengthen linkages between ZEIR and mVacc (for rollout in Southern and Western Provinces). Nevertheless, the evaluators found that at sub-national levels there remained considerable uncertainty about future of ZEIR and the extent to which budget allocations needed to be made.

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Notably, PATH has secured a no-cost extension for final activities in Southern Province. These activities were reported to include:

- Training of EPI focal points in supportive supervision for consistent ZEIR use
- Intensive work with district staff to increase competency and use
- Completion of version updates and strengthen user competency + data use skills
- Further work on strengthening linkages to other initiatives

Findings II: Outcome Results

## Outcome 1: Improved data quality at scale

Preamble

To establish the evidence for improved immunization data quality at scale (Outcome 1), the evaluators first assessed whether there had been changes in data quality in the legacy DHIS2 reporting system since baseline. As indicated in the methodology section, we assessed data quality using the criteria of availability, timeliness, completeness and accuracy by reviewing reported data against primary source records for six proxy antigens over a three-month period (January-March 2018). We then reviewed data quality in the ZEIR database by examining recorded data for the sampled facilities for the same six antigens over the same three months. We reviewed the ZEIR data against source documents, data in monthly HIA2 reports and the district database. While none of these data records was considered definitive in terms of data quality, the differences between the records were informative in highlighting the points of divergence in each reporting system.

Data quality in the legacy system

Review of the legacy system showed that there had been no significant change in the timeliness, availability and completeness of source documents and reported data (HIA2 and stock returns) since baseline (October 2016).[41] Review of the accuracy of immunization data in the legacy system suggested that the accuracy (consistency) of reporting between the source documents (immunization tally sheets) and monthly HIA2 was poor at both baseline and at the end-of-intervention evaluation point, but there had been a small deterioration in the accuracy of immunization reporting over time, with overall accuracy falling from 24% (n=374 paired data points) at baseline to 19% at end-of-intervention. Figure 14 below shows the baseline and end-of-intervention (endline) findings for each antigen over a three-month period for all 18 sampled facilities combined.

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[41] Full details of the evaluators' baseline findings can be found in Mott MacDonald's final baseline report (February 2017).

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Figure 14: Accuracy of immunization data at facility level at baseline and end of intervention (endline)
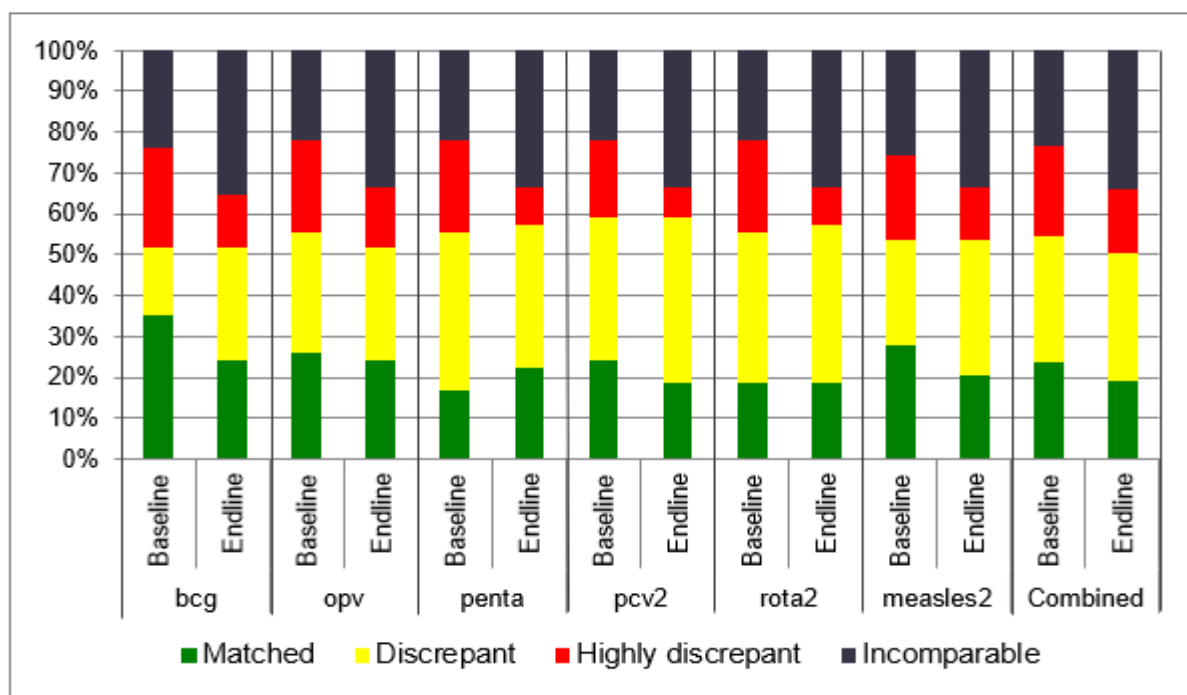

Qualitative investigations (health care worker interviews and direct observation) suggested the slight deterioration in data accuracy in the legacy system since baseline was related to the multiplicity of parallel reporting systems (DHS2, ZEIR and SmartCare), since these added to the reporting burden of health care workers.

The accuracy of data reporting in Livingstone was considerably better than in other districts, and urban health centres performed slightly better than hospitals. Our qualitative investigations suggested that this could be related to the presence of a dedicated data entry clerk in urban health centres.

The completeness and accuracy of stock records was very poor in all districts at baseline and at end-of-intervention evaluation. As at baseline, stock record keeping was *ad hoc* and focused on submission of timely requisitions to maintain stock levels.

At district level, comparison of data in district databases for Livingstone, Kazangula and Sinazongwe against facility HIA2 reports pointed to a slight deterioration in accuracy (with 46%, n=288 paired data points, matching at baseline compared to 41% at end-of-intervention) (Figure 15). Again, this appeared to be related to an increased reporting burden associated with a number of new initiatives. Notably, Livingstone performed better than the other districts at both baseline and the end-of-intervention evaluation point, possibly due to the higher capacity of health information officers in this major urban centre.

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Figure 15: Accuracy of immunization data in the district database at baseline and end of intervention (endline)
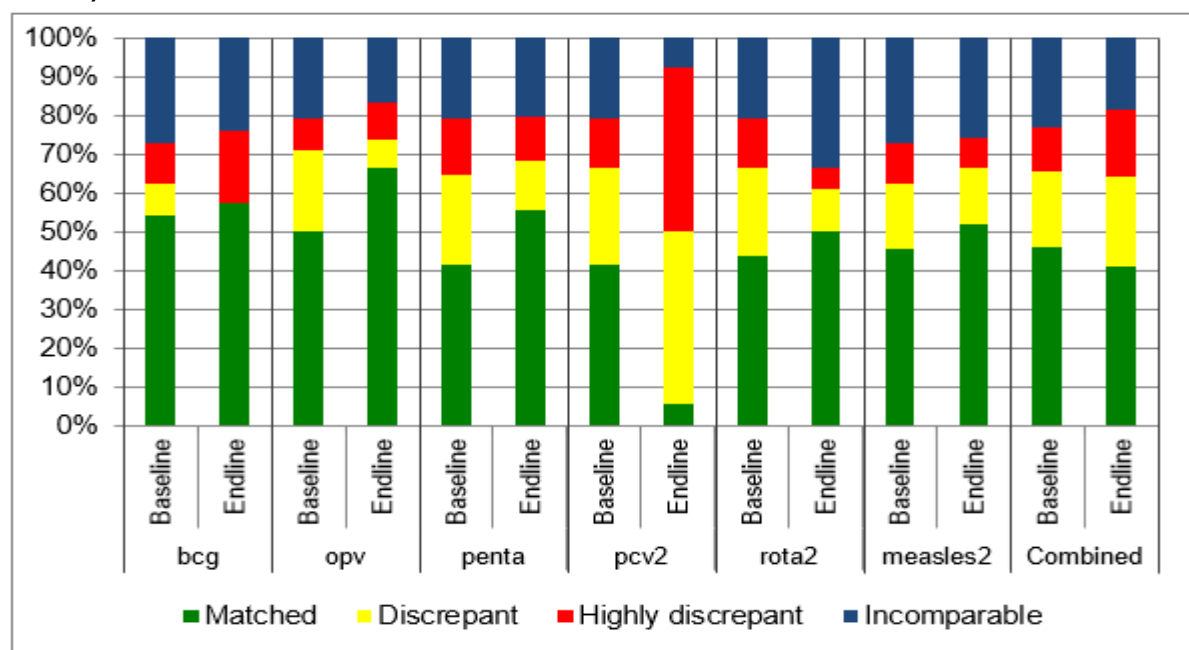
Data quality in the ZEIR system

At the end-of-intervention evaluation point, the data in the ZEIR master database did not compare well to source data for immunizations or stock for the sampled facilities. Figure 16 below shows how immunization data in the ZEIR master database compared to primary source data in tally sheets over the three-month review period.

Figure 16: Comparison of immunization data in the ZEIR master database against primary source data for sampled facilities at end of intervention

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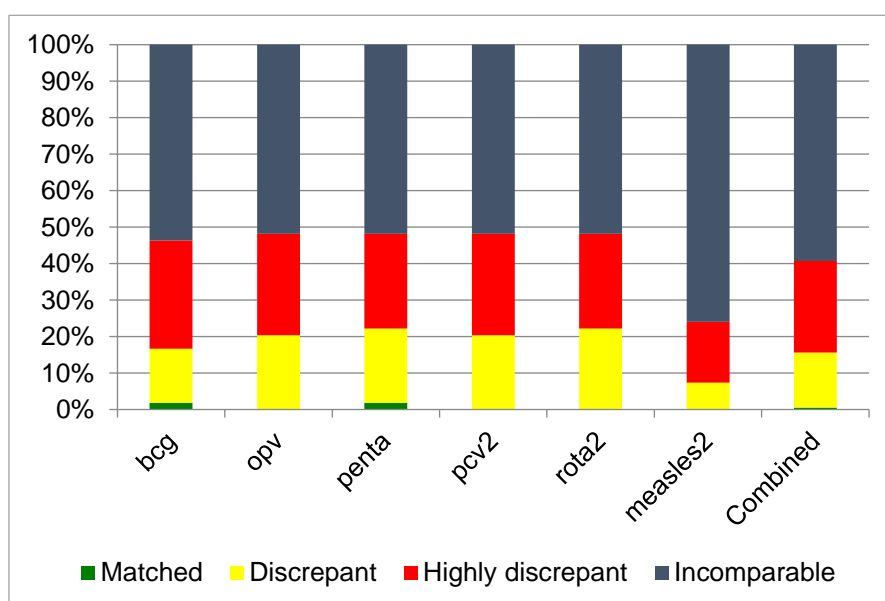
Although ZEIR data appeared less accurate than the legacy system, our direct observations suggested that this was likely to be due to the fact that ZEIR was not being used consistently for every patient (usually due to user capacity issues, slow functioning of the tablet and the demands of busy clinics and parallel reporting systems). This was the case in all facilities visited -although we found that accuracy and ZEIR use was somewhat better in Kazangula.

The evaluators also observed some attempts to use the ZEIR system for outreach work. Since there was only one tablet per facility, this meant the tablet was taken to the field and any health centre registrations/immunizations had to be added later. Outreach work was generally very busy and connections were slow, so entries were sometimes incomplete (and the intention to complete the entry later from the paper records was not generally acted upon).

Since the stock component of ZEIR was on hold at the time of the evaluation, it was not being used in any of the facilities/districts observed.

Outcome 2: Improved data use for decision-making

Preamble

The BID results framework indicates that the BID Initiative should lead to improved data use for decision-making at scale (Outcome 2). For the final evaluation, the evaluators first used standardized assessments to determine health care workers' competency in using the ZEIR system to enter, retrieve and interpret immunization and stock data. The evaluators then used qualitative enquiries to determine whether, by the end of the program, there had been a change in data use for decision-making or the institutional environment for data use. This was assessed at both facility and district levels through in-depth semi-structured interviews. Reference was made to both ZEIR data and data in the legacy system – with the latter allowing comparison against the baseline.

Competency in using ZEIR

At each facility visited, we asked 1-2 MCH nurses[42] trained in using the ZEIR to demonstrate registration of a new patient using the ZEIR tablet. In sites where it was possible to conduct this assessment, overall scores were high, with 74% of users assessed (n=19) found to be fully or mostly competent in registering a new child. The evaluators also intended to assess levels of competency in retrieving ZEIR data and interpreting dashboard reports. Unfortunately, none of the sites sampled had downloaded the ZEIR upgrade that allowed these activities to be performed. Given the lack of exposure to a fully functioning version of ZEIR, the evaluators suggest health care worker competency levels for these more advanced tasks was likely to be low.

Data use for decision making at facility and district levels

In keeping with the logical framework indicators for Outcome 2, the evaluators focused on changes in data use for decisions relating to immunization coverage, defaulter tracing and stock management. The evaluators' qualitative baseline findings on data use for decision-making are described in full in their baseline report.[43] In short, the evaluators found that, at baseline, district officers used coverage and stock data for planning and stock distribution purposes. At facility level, data use was *ad hoc* and informal and there was little incentive for service providers to use immunization data, other than for reporting and stock accounting/replenishment purposes.

For the end-of-intervention evaluation, the evaluators repeated their triangulated semi-structured interviews with District Officers, Heads of Facilities and MCH nurses, and conducted direct observation of

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[42] This was convenience sampling and depended on nurse availability at the time of the assessment.

[43] See the final version of the Zambia baseline report submitted to BMGF in January 2017.

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immunization sessions. From this qualitative assessment, there was little convincing evidence of improvements in data use for decision making, either using the legacy system or ZEIR (although several nurses reported that access to a parent's contact details through ZEIR made defaulter tracing easier). The evaluators were also unable to identify evidence for improved data use in Livingstone where data use interventions were introduced prior to ZEIR.

At the time of the evaluation, district officers (DHIOs, MCH Coordinators and District Pharmacists) in the three case study sites had not been fully engaged in the BID Initiative and were not actively accessing or using ZEIR data. Again, there appeared to be little change in data use for decision-making since baseline; there were some reports of more frequent data quality review meetings, but these could not be clearly linked to the effects of the BID Initiative.

The evaluators' findings diverge somewhat from PATH's midline survey findings on data use (March 2018). PATH's findings (from self-reported survey responses four months after the commencement of BID interventions) indicated improved use of coverage, defaulter and stock data by health care workers at facility and district levels for decision-making; there were also positive findings relating to the culture of data use at district and facility levels. It is important to note, however, that the evaluators' data collection methodology was rather different from PATH's – although the evaluators' review was conducted by an independent team, it was based on a qualitative methodology with a small sample size and use of triangulation methods for validation. It is, therefore, difficult to make direct comparisons between respective findings. Rather, the two sets of findings should be seen as complementary and contributing to critical dialogue. It should also be noted that the SmartCare initiative (present in 83% of the facilities sampled by the evaluators), was also associated with data use training, so any positive findings might not be entirely attributable to the BID Initiative.

Outcome 3: implementation at scale and country ownership

Findings on implementation at scale

BID's Outcome 3 logical framework indicators relate to implementation of BID solutions at scale, country buy-in, incorporation of BID interventions into country strategies and the contributions of the BID Learning Network. To assess progress from the baseline, the evaluators conducted desk reviews, key informant interviews, verification exercises at facility and district level and participant observation exercises at BLN events.

At baseline, the evaluators found that Zambia has a comprehensive policy and legal framework covering immunizations and vaccine procurement in Zambia. Following falling rates of immunization coverage over the period 2011-2013, there had been intensified efforts to improve immunization coverage and rates had reached around 90% for most antigens by 2015. These improvements were attributed to: a) investments from Gavi in immunization service support, injection safety and new vaccines; b) additional investments in cold chain capacity and logistics management; and c) a World Bank-funded Performance-Based Financing (PBF) initiative that has incentivized increased EPI activity at district and facility levels.

At the end-of-intervention evaluation point, the evaluators established that by mid-March 2018, PATH had completed rollout to some 298 facilities in Southern Province. Despite challenging time constraints, the Kenya-based developer for the ZIER software solution (Ona) had successfully adapted the Open SRP software to address many of the challenges of the original design. The new design had a user-friendly, icon-based interface and was well-aligned to the variables in the statutory HIA2 monthly reports, patient data could be retrieved from child health cards using QR codes, and multiple users could access the system using personalised user names and passwords. Although there were still some small adjustments required (to dashboards etc), all the design specifications had been met and a functioning version was ready for rollout in early 2018.

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PATH's four-touch implementation strategy was delivered by PATH team itself. This touch strategy had been rolled out in 3 stages, with Stage1 covering introductory data use interventions in Livingstone and Mazabuka Districts; Stage 2 covering group training of implementation champions and facility representatives and some initial 'touch' visits by the PATH team; and Stage 3 covering rollout of the BID Initiative to all facilities under the leadership and support of the PATH team.

It is reasonable to conclude that the PATH team was successful in implementing the BID solutions at scale in Southern Province within the agreed timeframes. However, as noted in previous sections, there were a number of challenges that could not be addressed within the program timeframe (e.g. rolling out the updated version of ZEIR and improving the system of user passcodes). With more time, it is likely that the quality of the interventions can be strengthened, including improving processes for engaging district and provincial officers and improving alignment to other digital health initiatives.

Country ownership

Our interviews with national and provincial EPI officers and M&E officers suggested considerable interest in the potential time savings associated with ZEIR and the accessibility of aggregated and facility-level data, but there was concern about the long development/rollout timeframes needed, the failure to demonstrate the operationalization of fully functioning and integrated model by the end of the program, as well as the budget and management implications. The difficulties experienced in exporting data to DHIS2 were acknowledged, but national officers suggested that this might proceed more quickly once integration with other related initiatives had been achieved – since there was a need to avoid fragmentation of reporting systems. The National EPI Manager remains fully supportive of the BID Initiative and suggests that its effectiveness will be demonstrated through further scale-up to other provinces.

The BID Learning Network: Building a community of practice

Over the duration of the program, the BLN component for the sub-Saharan Africa was led and coordinated from Lusaka in Zambia. The evaluators were able to confirm that meetings and events were productive and supported a dynamic community of practice. Online events (such as webinars on EIRs and immunization challenges) generated participation from 115 members in the last quarter of 2017 and first quarter of 2018. PATH itself has provided comprehensive documentation of the strategic value of BID that is consistent with the findings of the evaluators.

The evaluators note that, while the BLN has created considerable engagement and exchange of experience and lessons across the region, it has also required a significant investment of resources, coordination and strategic support from a dedicated and experienced team. PATH's Seattle-based communications team has also provided regular inputs of technical expertise.

In Zambia, itself, there has some good participation in face-to-face meetings by a cross-section of EPI representatives, but there was little evidence of consistent participation in online events and social media, especially at sub-national levels (where connectivity is generally a constraint). From desk review work and key informant interviews, it was difficult to infer any direct links between BLN activities and program outcomes in Zambia.

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Outcome 4: resource commitments

Review of the costing information

In the context of information systems, "total cost of ownership" (TCO) means all the costs incurred to design, set up, operate and maintain a system. As recommended by the Pan American Health Organization (PAHO)[44] for an *economic* assessment (as opposed to simply a costing exercise), the TCO should be discussed alongside the outcomes (benefits) of the system to inform decisions about whether or not the information system is a priority for resource allocation.

When the BID Initiative started, the aim was to measure the TCO to provide government and potential funders with relevant information. In practice, only some of the costs were documented, namely those incurred by PATH. This was not a complete description of the TCO because:

● Other role-players, such as the Government of Zambia, incurred costs relating to staff time etc
● The cost analysis only covered the time period of the BID Initiative (with a little work done on estimating future costs). Clearly there are ongoing costs for the Southern Province, as well as costs for scaling up to new provinces.

Also, the costs were not compared with outcomes, which would have helped create a business case for further investment.

The costing information shared by PATH has helped us identify some of the cost drivers – i.e. the items which account for most of the costs. However, the information provided does not tell us much about total future recurring costs, as most of these were not estimated.

Table 4 below shows expenditure on BID in Zambia from the PATH report on costs.[45] From Table 4, it seems the main cost drivers were:

● System design and development – 14% of total, or 26% when development of the system which had to be abandoned is included
● BID Initiative staff – 52% of total
● Rollout costs – 21% (of this, 58% was deployment costs and 33% was for hardware).

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[44] PAHO (2017). Electronic Immunization Registry: Practical Considerations for Planning, Development, Implementation and Evaluation. Available at: http://iris.paho.org/xmlui/handle/123456789/34865
[45] Mvundura M, Di Giorgio L and Werner L (2019). *Evaluating the expenditures for developing, deploying and maintaining electronic immunization registries in Tanzania and Zambia: evidence from the BID Initiative.* Draft.

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Table 4: Expenditure by PATH for development and rollout of the BID Initiative package of interventions in Southern Province, Zambia

System design and development	
System design and development costs of electronic immunization registry (in use)	US$486,965
Learning costs (electronic immunization registry which was shelved)	US$427,407
Other costs	
Back entry costs	US$21,086
Labor costs	
BID Initiative staff	US$1,851,105
Province-specific costs, Southern	
Rollout costs	
Hardware	US$254,424
Meetings	US$32,470
Training	US$29,368
Deployment (per diems, transport and accommodation to access health facilities etc.)	US$445,655
Annual recurrent costs	
Internet connectivity	US$20,007
Data hosting (server)	US$8,000
Printing (e.g. QR codes + ZEIR resource materials	US$2,926
Total costs over project period	US$3,579,413

In PATH's estimates, annual recurrent costs accounted for less than 1% although, of course, these would occur every year. The label "annual recurrent cost" is rather misleading because in fact this is just the known costs of keeping the technical system working: it does not include recurrent staff or transport costs, nor does it include system updates and refresher training. Most of the future recurrent costs are unknown for the reasons given above: the analysis was time-limited and only considered costs incurred by PATH.

Notably, these costs are for only 1 province, whereas Zambia has 10 provinces in total. An extremely crude way of estimating scale up costs would be to take the province-specific costs for Southern (US$792,850, rounded to US$800,000) and multiply it by 10, giving US$8 million. So, US$2,786,563 start-up costs (from Table 4), plus the US$8 million provincial rollout costs, gives a national total of US$10.8 million. System design and development accounts for 4% of this total, or 8% when the

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"learning" costs for the system which was shelved are included. Rollout and annual recurrent costs account for 74%.

There are many caveats to this estimate of US$10.8 million – including that the so-called "annual recurrent costs" are a significant under-estimate and have just been included for one year, while the significant "labor cost" item was not only for start-up – but the figure is a start as a working estimate. It is however, likely to be a fairly significant under-estimate, as it does not include government staff time and the BID labor costs were not counted as region-specific costs. WHO and the International Telecommunication Union estimate that eHealth projects typically allocate 60-70% of their budget to human resources (especially for training) in the implementation/operating phase.[46]

Having explained that this estimate, is likely to be an under-estimate overall, there are also factors which could reduce some of the line items. As Mvundura et al explain,[47] rollout in Southern province had to be done within compressed timeframes, so more PATH staff and fewer government staff were involved compared to implementation in Tanzania. Moreover, there were likely to be lessons learnt from the rollout in Southern Province which could be used to reduce costs in subsequent provinces.

The cost figures demonstrate that:

● System design and development costs seem very significant at the start, but in the context of overall implementation they can be a relatively small proportion. The design of the system has implications for future costs (e.g. in terms of how user-friendly it is and inter-operability with other systems) and it can be worth using resources upfront to get these things right. Whilst shelving an unsuccessful design may seem expensive and wasteful at the time, it can be a wise long-term decision that saves money.

● Whilst digital information systems are generally thought of in terms of hardware and software, they also require considerable human resources. Individual staff are often involved in a variety of types of activity (e.g. management, training and visits to facilities), so it can be difficult to assign staff costs to different stages of implementation. A problem with this is that, in the longer-term, it is government staff who will perform many of these roles, and the costs of government workers are often lost in budgets because they are not an additional project cost if activities are expected to take place using existing staff. It is therefore important to think in terms of human resource capacity - the quantity and quality (i.e. skills) required – as well as direct project costs. The project will stall if the required staff are not available.

● Rollout costs are crucial in a national program. This is partly a matter of what hardware for facilities is selected and partly a matter of the training/deployment model used. Investments in making systems as user-friendly as possible can pay dividends because they can reduce the amount of time required to train each user.

Putting the costs of scaling up into perspective

The analysis above puts the total rollout costs at about US$8 million, which could be spread out over several years. To put this into some kind of perspective, about US$54 million was spent on routine immunization in Zambia in 2017, of which 17% came from government. 29% of the total spending was on vaccines. So, if we thought of the US$8 million as a one-year expenditure, that would account for 15% of total immunization spending, 21% of non-vaccine immunization spending, 86% of total government spending on immunization or 109% of government non-vaccine immunization spending.[48]

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[46] WHO and PATH (2013). Op. Cit.

[47] Mvundura et al. (2019) Op cit.

[48] Figures on immunization spending in Zambia *from Co-financing information sheet for Zambia, 2018.* Gavi, the Vaccine Alliance. Available at https://www.gavi.org/country/zambia/documents/

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Whilst these overall cost estimates are very crude, they do provide food for thought. At 21% of a year's total (government and others) non-vaccine immunization expenditure, the information system is not cheap, though of cost in practice spending would be spread out over several years. Moreover, the cost needs to be seen in the context of how many additional immunizations will be generated by better information. Decision-makers from government and international agencies should be furnished with as complete costing information as possible to inform their choices. It certainly cannot automatically be assumed that investing in an immunization information system is a "good buy".

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Annex 2: Full evaluation report for the Northern Zone of Tanzania

Introduction

This annex presents the detailed findings from the independent evaluation of the BID Initiative in the Northern Zone of Tanzania. The BID Initiative was implemented in the Northern Zone of Tanzania since early 2015. This evaluation report primarily focuses on a purposeful sample of five case study districts in two of the implementation regions, namely Arusha Region and Kilimanjaro Region. It also examines effects at higher levels of the health system.

This report is the final report in a series of milestone evaluation reports that have followed the phased rollout of the BID Initiative in Tanzania. Mott MacDonald has conducted evaluations at three program stages - baseline, end-of-intervention and post-program - in each case study district of the implementation regions. This report summarizes the main evaluation findings from each milestone evaluation in the two implementation regions of the Northern Zone.

In keeping with the overarching analytical framework for this evaluation assignment, we have used the themes of context, mechanism and outcomes to present our findings. In this consolidated report, Findings I describe findings on the context and mechanisms of the BID Initiative in the Northern Zone, along with achievements and challenges. Findings II evaluates progress towards outcome-level results through reference to the BID logical framework and indicators. This covers evaluation of results relating to immunization data quality and data use, country buy-in and scale-up, and resource commitments. This report concludes with a short commentary on Mott MacDonald's evaluation findings from the Northern Zone.

Evaluation rationale and methodology

Evaluation design

The design of the evaluation for Tanzania is consistent with the wider evaluation design for the BID Initiative. In line with this approach, the evaluators identified a purposeful sample of five case study districts in Arusha and Kilimanjaro Regions to represent a range of implementation contexts. These case study districts complemented a purposeful sample of three case study districts in Zambia. Within each of the case study districts, the evaluators have tracked a 'panel sample' of six health facilities over time to support a longitudinal, interrupted time series analysis.[49]

Purpose and objectives of the evaluation

The overall **purpose** of the evaluation in Tanzania was to review progress in implementing the BID Initiative and assess achievement of intended results by program end.

We conducted evaluations at successive program milestones in each case study region. The **principal objectives** of these milestone evaluations are summarized below:

- **Baseline:** The pre-intervention baseline aimed to establish a benchmark for assessing the BID Initiative's contribution to intended results in each of the case study sites. The baseline evaluations

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[49] Where possible, we have examined the strength of attribution by reviewing the relationship between outcomes and duration of exposure to BID interventions and considered the potential effects of other initiatives in the area.

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included formative assessments to map features of the intervention context that might influence or explain outcome level results at a later stage.

- **End-of-intervention:** These evaluations were completed close to the end of the intervention period in each case study. They aimed to review the process of implementing the intervention package, cost drivers and immediate output and outcome-level results.

- **Post-program:** These evaluations were conducted approximately one year after the package of BID interventions was delivered. They aimed to: assess the sustainability of the intervention package and outcome results; review factors in the 'total cost of ownership'; identify lessons for scale-up; and reflect on the BID Initiative's theory of change.

Methodology

Data collection strategy

In line with the standardized methodology developed for the BID evaluation work, the data collection strategy for the Tanzania evaluations was based on a mixed method approach. Data collection included key informant and stakeholder interviews, data quality assurance reviews, direct observation and a competency assessment of health care workers using the finalised version of the EIR solution (the Tanzania Immunization Registry).[50]

In addition, the evaluators conducted a data quality assurance (DQA) review of immunization and vaccine stock data in: a) the 'legacy' paper-based IVD reporting system; and b) in the EIR master database. This exercise focused on data for six proxy vaccines[51] over a period of three consecutive months. To assess data quality, the evaluators compared the data reported by facilities monthly against primary records. This exercise involved review of immunization and vaccine stock data against the data quality criteria of availability, completeness and accuracy.[52]

As far as possible, all data collection methods were triangulated to support validation of findings and mitigate against potential biases associated with user self-reporting.[53] The methodology and data collection tools were similar for each data collection round; however, slight changes were made to interview schedules to elicit qualitative data that was pertinent to each milestone evaluation. For each successive evaluation, the evaluation protocol and data collection instruments received research and ethical clearance under the procedures set by the National Institute for Medical Research (NIMR).

Sampling strategy

We selected a purposeful sample of case study districts at baseline using selection criteria relating to location (urban, rural or border) and immunization coverage characteristics. The case study districts we selected using this process were: Arusha City, Karatu and Longido Districts in Arusha Region, and Moshi Municipal and Mwanga District in Kilimanjaro Region (Figure 17).

We also selected a panel sample of health facilities at baseline by first stratifying health facilities in each case study district by facility type (hospital, health centre or dispensary) and patient volume (high or low

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[50] As in Zambia, the standardized competency assessment was administered to one-two regular users of ZEIR in each of the sampled facilities.

[51] These vaccines were: Bacille Calmette Guerin (BCG); Oral Polio Vaccine (OPV) 2, Pentavalent, Pneumococcal Conjugate Vaccine (PCV) 2, Rotavirus (RV) 2, Measles 2.

[52] This DQA method is similar to that used by PATH in its baseline and follow-up surveys and is consistent with the methodology recommended by the World Health Organization (WHO) see WHO. 2003. The immunization data quality audit procedure. Geneva: WHO, Vaccines and Biologicals.

[53] This was a limitation of PATH's own survey work on data use and time savings.

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volume facilities); we then randomly selected six facilities per district across these stratification groups to ensure all categories were appropriately represented. This panel sample (see Annex 5) were then used for each successive evaluation to allow comparisons against the baseline status.[54]

Figure 17: Case study districts and number of facilities, Northern Zone
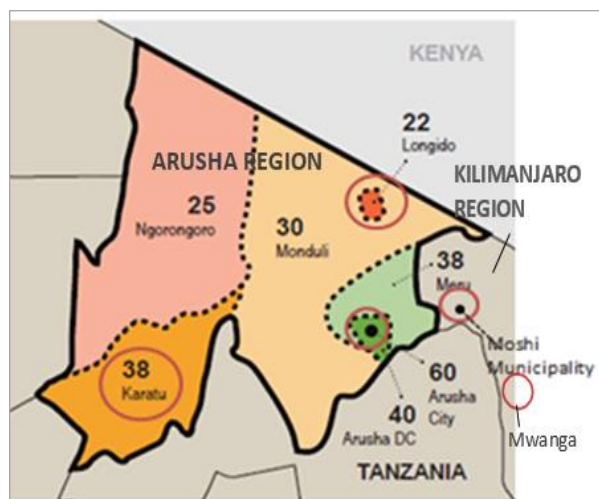
Data analysis

The evaluation analysis was based on a health systems view and made systematic reference to the intended outcomes of the BID Initiative, as defined in the BID results framework. Our evaluation of Outcome 1 required a particular focus on improvements in immunization data quality at scale. To assess changes in immunization data quality within the health system over time, we reviewed DQA data from both the 'legacy' IVD reporting system and the EIR reporting system at each evaluation milestone. It is important to note that, although we used the IVD legacy system as a reference point for assessing EIR data quality, we did not assume data in the legacy system was correct; rather, the legacy data was simply used to *reflect* on data quality in the EIR system.

Immunization data for the six proxy vaccines were collected from all the sampled facilities in the case study districts. Data were recorded in a Microsoft Excel (2016) template and exported to a Stata 15 statistical software package for comparative analysis.

For Outcome 2 on data use for decision-making, data on competency scores from standardized user assessments on the use of the EIR were recorded and analyzed in Microsoft Excel (2016).

Analysis of costing data for Outcome 4 was conducted by our health economist using standard data aggregation and benchmarking techniques.

As part of our triangulated, mixed method approach, qualitative data was collected for each expected outcome. Structured and unstructured qualitative data from interviews and direct observation were entered into pro-forma templates and organized around outcome-level themes. These data were analyzed manually, so the evaluators could iteratively cross-reference themes emerging from the DQA findings and explore associations and sub-themes by stakeholder type. Once preliminary findings had

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[54] We also used this method for randomly selecting 12 facilities for the special study in the two case study districts of Dodoma Region.

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been identified, the evaluators explored and confirmed these through follow-up key informant interviews. Key stakeholders also provided feedback on successive drafts of evaluation reports.

Findings I: Context and Mechanisms

Findings on context

In keeping with the conceptual framework for the evaluation, the evaluators examined the key dimensions of the operational and institutional context that were likely to influence outcomes. A summary of findings on these dimensions for the Northern Zone of Tanzania (including any developments over the duration of the program) are presented in Table 5.

Table 5: Review of the BID operational context

Feature	Findings
Health system	• **Tanzania's new Health Policy 2017** is aligned to the National Development Vision 2025, the National Five-Year Development Plan 2016/17 – 2020/21; the Sustainable Development Goals 2030; and the Health Sector Strategic Plan 2015 – 2020. The policy aims to engage with issues of equitable service provision and universal health coverage consistent with the objectives of the SDGs. It identifies emerging priorities such as health financing, population-based immunization coverage and integrated, cost-effective approaches to new health technologies. Regarding ICT initiatives, the policy highlights issues of capacity, infrastructure, coordination, maintenance and sustainability and realizing value for money as important challenges. • **A decentralized health structure** sits under the shared leadership of the national MoHCDGEC and the Prime Minister's Office, Regional Authority Local Government (PORALG). While the MoHCDGEC manages tertiary hospitals, zonal training centres and special programs, PORALG is responsible for regional and district health services, including implementation of plans developed by Council Health Management Teams (CHMTs). The latter also oversees service delivery by not-for-profit and private providers. • **Health facilities** include hospitals, health centres and dispensaries are responsible for providing immunization services. Services are generally offered daily. Outreach services are sometimes offered for remote communities but are not common in the Northern Zone. In keeping with Tanzania's recent 'decentralization through devolution' initiatives, health facilities are increasingly responsible for managing their own budgets. • **Human resources:** immunization services are provided by trained RCH nurses only, with supportive supervision from the Head of Facility, RCH Coordinator and RIVO/DIVO. RCH nurses have other maternal and child health responsibilities, such as family planning, obstetric care, and may be rotated to other service areas in the health facility. They are often stretched, especially in busy urban clinics. Certification reviews under the current dispensation have recently led to acute staff shortages.
DHIS2 reporting	• **DHIS2:** Since 2010, Tanzania's HMIS has been transitioning to a web-based DHIS2 system. Facilities submit monthly HMIS (Mtuha) reports to districts on all RCH and primary health care services – this includes data on immunization coverage (Mtuha 7 report); data is manually entered into web-based system by dedicated DHIS2/HMIS team. • **eHealth Strategy and ICT Policy:** Tanzania eHealth Strategy (2012-2018) highlights the principles of interoperability, scalability and building local capacity. It also refers to challenges of system fragmentation, system infrastructure and effective system governance and recommends coordination through the National E-Health Steering Committee. The National ICT policy was updated in 2016 and makes recommendations for an ICT-driven development agenda.
IVD program	• In Tanzania, the National IVD Program recognises the need to address immunization needs beyond childhood. The IVD Program sits within RCH Section of MoHCDGEC under Directorate of Preventive Services. The Program is responsible for policy, strategy, budgeting, vaccine procurement, training and supervision. Program delivery is supported by a network of RIVOs and DIVOs, but these are primarily accountable to Regional and District Medical Officers (R/DMO) within the PORALG administration.
EPI / IVD reporting	• **Immunization reporting:** At health facility level, the IVD reporting system runs in parallel with the HMIS reporting system (and, more recently, the EIR system). Health facilities submit IVD reports on immunization

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	coverage and vaccine stock data to the DIVO at beginning of each month. Until December 2018, the DIVO manually entered data into the Excel-based DVD-MT system; this included a Stock Management Tool (SMT) and the Cold Chain Inventory Tool (CCIT). Since December 2018, DVD-MT reporting has been replaced by the web-based VIMS system (see below). • **Vaccine stock management** is managed by the IVD program. Facilities maintain stock record in Kitabu 4 books and submit data on stock balances to the DIVO using their IVD report form. Stock vouchers can be used for additional requisitions. Since December 2018, DIVOs have been using VIMS for stock management, including ordering and distribution (in some cases, facilities are encouraged to use the EIR for ordering replenishment stock).
Infrastructure	• **Accessibility:** some health facilities in the Northern Zone are remote, serving pastoralist Maasai populations. There are high population densities in urban/tourist/border areas. Health facilities can be difficult to access in the highland areas of Kilimanjaro Region where infrastructure is limited. • **Electricity supply and internet connectivity** is patchy; power outages are common and health facilities in rural areas are often dependent of solar panels and generators for electricity. Internet connectivity can be slow/unreliable, especially in rural areas – generally, health facilities can only access the internet using data bundles and the mobile phone network.

We noted that there were some other health-related initiatives in the Northern Zone, but none of these had a particular focus on immunization or data quality and use, so are unlikely to affect program outcomes. However, of note are two other complementary initiatives where there is significant PATH involvement. These two initiatives, the Vaccine Immunization Management System (VIMS) and the Data Use Partnership (DUP), are outlined below.[55]

- **Vaccine Immunization Management System:** The VIMS initiative was launched in Tanzania in 2015. This collaborative initiative is funded by USAID and BMGF and implemented by JSI, CHAI, PATH and VillageReach. VIMS aims to bring together three stand-alone systems that operate from district to national levels namely, the district vaccine data management tool (DVD-MT), the stock management tool (SMT), and cold chain inventory tool (CCIT). It also aims to ensure interoperability with District Health Information Software (DHIS2). In 2016, VIMS moved into a phased deployment and is now reported to be in all regions of Tanzania.
- **Data Use Partnership:** Through this partnership, the Government of Tanzania has been working with a number of international development partners (such as PATH, CHAI and Jhpiego) to develop a harmonized investment road map for improving health data in Tanzania.

Findings on Mechanism

The main elements of the BID Initiative in Tanzania included development of an EIR solution with a stock management component. The final version of this solution was called the Tanzania Immunization Registry (EIR); this was a successor to an earlier version known as the Tanzania Immunization Information System (TIIS). Following piloting of the successive versions in Arusha Region, the EIR solution was rolled out to all eligible facilities in Arusha, Tanga and Kilimanjaro Regions from October 2017. PATH's rollout strategy has evolved into the participatory District Data Use Mentors (DDUM) strategy and includes support for change management and data use for decision-making. Implementation was successfully completed in all three regions by April 2018.[56] Key events in the phased implementation of the BID Initiative in the Northern Zone of Tanzania are shown in Figure 18 below.

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[55] For more information on VIMS see here. For more information on the DUP see here .

[56] PATH's Progress Report, April 2018.

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Figure 18 : Key stages in PATH's delivery of the BID Initiative in Tanzania

The package of BID Initiative interventions implemented in Tanzania (the 'mechanism') can also be described around three dimensions, namely design of EIR solution, rollout through the DDUM strategy and the final exit phase of sustainability planning.

A key event in the **design of the EIR solution** was the replacement of the original software developer with a new subcontractor (MEDIC, based in Mohawk College, Canada) in October 2016. This was because the first developer was unable to respond to the scale, specifications and secondary reporting requirements of the Tanzania context. To address the earlier design challenges, the MEDIC team introduced the Tanzania Immunization Registry (TImR) application as the EIR solution. TImR was built on an established electronic medical records (EMR) platform, known as Open IZ. The Open IZ platform allowed for scalable, agile design-working and offline functionality that could be customized to the Tanzania health systems context.

The MEDIC team made good progress in developing the EIR solution. However, along the way, the team had to address a number of challenges:

- Internet constraints: The EIR solution needed to function within the constraints of limited bandwidth and data bundle allowances. Poor internet connectivity and the need for "over the air" updates meant that new configurations and partial updates could corrupt the software. This was solved through better compression, error correction and automatic backup/recovery mechanisms.
- Issues of data synchronization: Since users sometimes worked offline, there were a series of challenges (inherited from the earlier TIIS set-up) relating to data synchronization and potential data conflicts once users were back online. MEDIC did considerable work on the 'multi-master replicated database' to ensure data conflicts could be resolved in a way that was effective and transparent to the user.
- Additional secondary use functions: The MEDIC team was not fully sighted on all the reporting requirements and secondary use functions of the IVD immunization information system from the outset. It took additional time to accommodate these as the system was field-tested and the team received additional requests from PATH and end users.

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- Integration with VIMS: The VIMS initiative gained momentum and took on new importance as the EIR design was in progress. As subcontractors, the MEDIC team had little direct contact with Ministry staff, so were not fully aware of government's strategic vision relating to VIMS and the EIS. The need for integration with VIMS was thus a late requirement and required several further development cycles.
- Rapid rollout: Pressure to rapidly rollout EIR meant that MEDIC had to accommodate an additional role as a technical support entity for operations. This role included testing and deployment of the 'new features' requested and software maintenance. Since MEDIC was based in Canada, it was necessary to develop very detailed maintenance and deployment manuals and guidelines for the PATH team.

PATH's **implementation strategy** for rolling out package of interventions evolved from PATH-led 'touch strategy' to a more government-led DDUM strategy. The DDUM strategy involved training selected members for the CHMT to become mentors for implementing the package of BID interventions in health facilities. The mentors were selected by the District Medical Officer, and included the DIVO and district ICT personnel. District mentors were given intensive training by the PATH team, as well as ongoing technical support. PATH also assisted the mentors with transport and per diem allowances for the rollout period (generally six weeks). Thereafter, the DIVO and district ICT officer provided ongoing assistance to users, in person, by phone or through a WhatsApp group. Users at facility level were, in turn, encouraged to extend training to their peers.

By 18 months, the evaluators found that, the DDUM approach was yielding clear benefits for local buy-in, country ownership, sustainability and efficient scale-up. However, some challenges were noted e.g. ensuring selection of high-calibre mentors, performance management and quality assurance of the training given to end users.

In the course of piloting in Arusha Region, the demands of scale-up and pressure on resources led to several management decisions that had implications for the package of BID interventions. These included:

- Data back-entry: Although the EIR would not be fully functional until data on all children receiving a course of immunizations was entered into the database, it was decided to focus on new registrations, as the strategies used for data back-entry were neither reliable nor cost-effective.

- Paper-based solution: In the first part of the program, PATH trialled a modified paper-based approach for low volume facilities. This allowed paper forms to be scanned to populate the EIR database. However, logistical problems, equipment failures and stakeholder preferences for an electronic reporting solution, led to a decision to provide low volume facilities with mini-tablets. Although this proved an adequate solution, MEDIC designers have reported some challenges with under-powered tablets.

- Denominator tools: PATH's original package of interventions included tools for improving denominator estimates in facility catchment areas. These included RapidPRO solution for short message service (SMS) reporting of home births, and a 'maternity app' for recording maternity ward registrations and first vaccinations. In practice, each of these tools proved complex and costly to implement so were shelved for later investments. Notably, it was also found that the 2015 National Statistics Act placed significant limits on use of denominator estimates not generated by the National Bureau of Statistics.

In March 2017, PATH commissioned the development of a **sustainability strategy** for the Tanzania BID Initiative. This strategy listed a number of actions to promote the technical, policy and financial sustainability of the program in Tanzania. These primarily focused on: intensified stakeholder engagement with the PORALG; additional capacity building for data use, ICT, data security and user

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support; development of a roadmap for the transition to paperless reporting; and a financial transition plan to secure resource commitments for scale-up.

Findings II: Outcome Results

Outcome 1: Improved data quality at scale

Preamble

To establish the evidence for improved immunization data quality at scale (Outcome 1), the evaluators first assessed whether there had been changes in data quality in the legacy IVD reporting system over the duration of the program since baseline. As indicated in the methodology section, we assessed data quality using the criteria of availability, completeness and accuracy by reviewing reported data against primary source records for six proxy antigens over a three-month period.

Next, we reviewed data quality in the EIR database by examining recorded data for the sampled facilities for the same six antigens over the same three months. For this exercise, we reviewed the EIR data against primary immunization records and monthly IVD reports for the sampled facilities.[57]

Progression in data quality in the legacy system

At **baseline**, the evaluators found there was considerable scope to improving the quality of data in the IVD (legacy) system. Across the five case study districts, there was reasonable availability of the documents required for preparing monthly IVD reports (although around 40% of IVD books were still at the district office at the time of our visit). Timeliness of report submissions by facilities was mixed and completeness was partial - with just 69% (n=120) of documents required for IVD reporting assessed as being fully complete. The accuracy of immunization data reported in IVD reports over a three-month period[58] was 47% (n=324 paired data points), based on consistency between reported immunization data (for six proxy antigens) and primary source documents across 30 health facilities (Figure 19 below). The accuracy of stock data was similar (62%, n=324) but there were often significant calculation errors. At district level, from the limited data we could access in DVD-MT databases, it appeared the completeness and accuracy of DVD-MT data was also rather poor - there were many data gaps and it was common to find formula errors embedded in the district Excel spreadsheets.

At the 35-month evaluation point, the accuracy of facility immunization reporting for the Northern Zone was estimated to be 44% (n=288 paired data points), that is, similar to baseline.

At the final Post Program evaluation in Kilimanjaro Region (only) in April 2019 the evaluators observed a small improvement in the accuracy of legacy system reporting (Figure 19 below); however, nurses and DIVOs interviewed attributed this to improvements in the IVD reporting format.

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[57] Although we aimed to review EIR data against district data in the DVD-MT tool or VIMS, it proved difficult to access and isolate this data during the evaluation visits. We were, therefore, only able to make general and opportunistic observations on the completeness and consistency of district level data.

[58] Baseline data collection was staggered to follow the phased implementation. In Arusha Region, baseline data on the legacy system was reviewed over consecutive 3-month periods between November 2015 and March 2016. In Kilimanjaro Region, baseline reviews in Moshi Municipal covered January-March 2016; in Mwanga District, they covered February-April 2017.

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**Figure 19: Accuracy of immunization reporting in the legacy system
in the Northern Zone at Baseline, 35 months and at the Kilimanjaro Post Program evaluation**
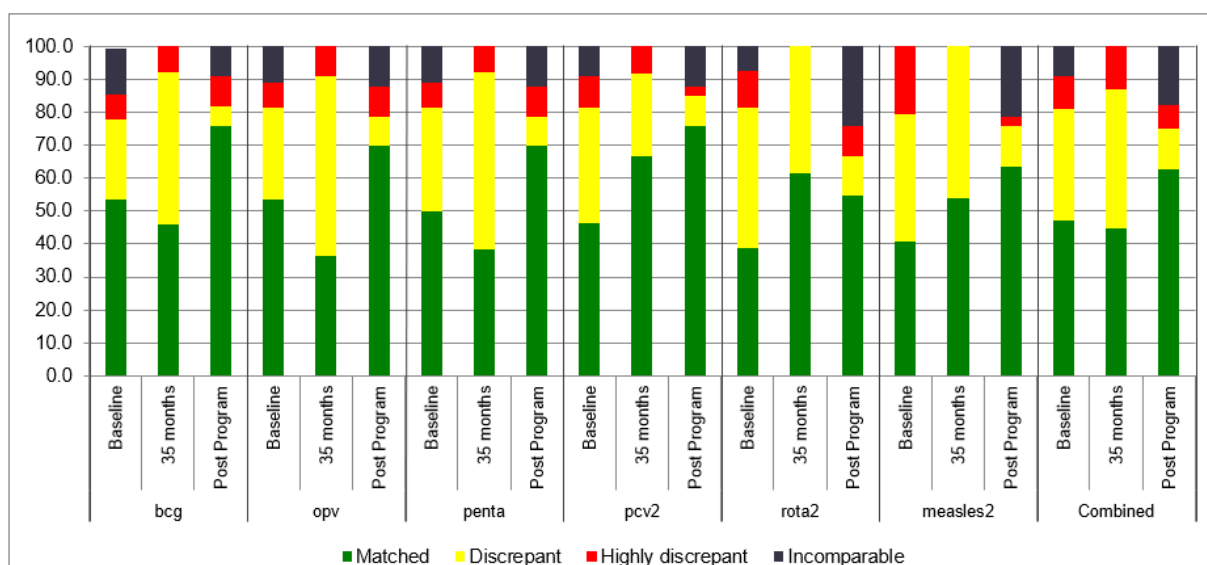
Overall, this analysis suggests that there has been little significant change in data quality in the IVD *legacy* system in the two case study regions over evaluation period 2016-2019 – despite some evidence of improvements in Kilimanjaro Region at the final evaluation visit. This, in turn, suggests that, based on our small sample, implementation of the BID Initiative had not had a detrimental effect on data quality in the legacy system.[59]

Progression in data quality in the EIR in Arusha Region

Due to the initial software design challenges, the piloting and implementation period in Arusha Region was extended. This meant the **end-of intervention evaluation for the EIR** was completed a little early in June 2017. At this stage, implementation had been completed in all districts of Arusha Region, but the EIR was still running on the TIIS software, rather than the new TImR software. Notably, the upgrade for the TImR software was only launched in September 2017, so the functioning of the EIR had not been fully optimized at the time of the evaluation. Nevertheless, the evaluation proceeded in order to document progress at this milestone.

For this end-of-intervention in Arusha Region, we examined the accuracy of the immunization data in the BID master database for the 18 facilities in the three case study districts by comparing immunization totals against primary records at facility level (tally sheets). Of 288 paired data points examined for the six proxy antigens over a three-month period (February-April 2017), only 8% of BID EIR records matched the primary records (Figure 20). Notably, the primary records consistently recorded more immunizations administered than the EIR database, suggesting EIR data was incomplete. There was very little consistent use of the EIR for stock management at this stage because the TIIS was not well designed for this function so, predictably, accuracy scores for EIR stock data were very weak.

Qualitative investigations (direct observations and user interviews) suggested that the EIR was incomplete (and so inaccurate) because it was not being used to register and record the immunizations of every eligible client. The main reasons given by RCH nurses were: the time required to enter EIR data in busy clinics; a shortage of data bundles; lack of trained/confident users and perceptions of malfunctions (either of the software or tablet). In addition, some nurses believed they should not register patients from

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[59] Some key informants were concerned that the time demands of maintaining parallel systems could negatively impact on the legacy system.

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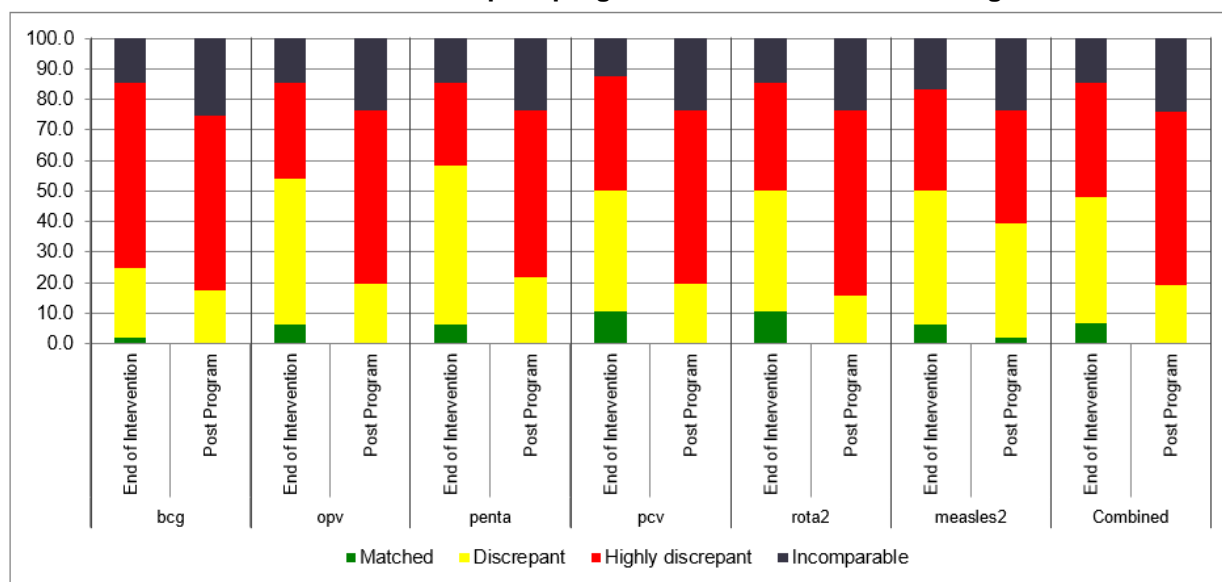
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outside their catchment area as this would result in "false defaulters" in the system. Some nurses observed that, if stock records were not up to date, and EIR records indicated a stock out, the system would not accept any immunizations against the antigen.

We completed the **post-program evaluation of the EIR in Arusha Region** just over a year later in July/August 2018. At this stage, there was a particular focus on whether the launch of the new TImR software had led to improved and sustained EIR data quality. When we compared immunization data in the BID EIR to primary records (tally sheets) as before, we found even lower levels of matching data (Figure 20). Once again, tally sheet data was always considerably higher, indicating that EIR data was incomplete.

From qualitative investigations, we found that nurses were still not using the EIR for every client; indeed, there had been a decline in use because nurses trained in using the TIIS version of the EIR did not feel confident using the TImR update – which has a rather different interface. DIVOs for the region had not been able to reach every facility (or a critical mass of nurses) to provide training in the update. There also seemed to be some small bugs in the system – for example, we observed a common problem with EIR advancing the start date of immunization schedules if nurses did not follow the correct sequence of data entry exactly. There were also growing concerns about an adequate supply of internet bundles.[60]

Many nurses still found EIR data entry time consuming. At some busy clinics, we observed examples of nurses keeping child health cards until the child's next visit, or recording patient information in a note book, so they could retrospectively enter data into EIR after hours (notably if this was not done on the day of the child's immunization, this also had implications for the schedule created in EIR). We noted that not all nurses are using the hand-held scanners for retrieving client data – some found them awkward to use and a few nurses suggested they "drained the bundle" unnecessarily and preferred to enter barcodes manually. A few nurses also mentioned experiences of duplicated barcodes.

Figure 20: Accuracy of immunization data in the EIR master database at the end of intervention and post-program evaluations in Arusha Region

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In May 2019, the evaluators conducted further key informant interviews in Arusha City to assess whether there had been any change since the post-program evaluation. We were informed that the availability of internet bundles and tablet maintenance remain the main constraints to EIR usage – it was reported that, of the 49 facilities in Arusha City, only 35 now have functioning tablet computers and only 14 can recharge their bundles on a regular basis.

Progression in data quality in the EIR in Kilimanjaro Region

Following implementation in Tanga Region, PATH led rollout of the BID package of interventions in Kilimanjaro Region over the period January-April 2018 using the DDUM approach. The evaluators conducted an **end-of-intervention evaluation for the EIR in Kilimanjaro Region** in June 2018. We used the standard methodology to assess the quality of data in the EIR over the period February- April 2018. For Kilimanjaro Region, we found that of 231 EIR data points, 5% matched primary records across all antigens combined over a three month period - although the accuracy of BCG and measles 2 data was considerably higher at 18% and 12% respectively (Figure 21).

Qualitative investigations suggested that, while many of the operational problems with the EIR remained an issue in Kilimanjaro Region, users in this region had been trained in using the TImR update. The training by mentors was still relatively recent, but many users felt that they still needed more practice in using the system.

We returned to Kilimanjaro Region in April 2019 to conduct the **post-program EIR evaluation**, with a focus on sustainability. We repeated the accuracy assessment using the standard methodology. Overall findings were very similar to those from the previous evaluation, but still weak. Overall accuracy scores were 6% (n=231) across all antigens, and scores for BCG records remained relatively good with 27% of paired data points matching (Figure 21)

From qualitative enquiries, we found that EIR usage was still inconsistent and this continuing to be the main factor in incomplete/inaccurate EIR data. There were still problems with supplies of internet bundles and, although some of the TImR bugs had been fixed, very few users had updated the software, so were still experiencing challenges. Overall, usage in Moshi Municipal appeared better than in Mwanga, probably due to the commitment and active follow-ups of the DIVO in the urban center (see next section). We also noted that, at this stage, there were growing reports of hardware problems – either due to loss, damage or missing power cables, or due to wear, tear, malfunctions and reduced battery life.

For the post-program evaluation in Kilimanjaro Region, we were also able to make some comparisons between data stored on the tablet and data uploaded onto the master database. In several cases there were considerable differences, suggesting that data entered into the tablet computer was not always being uploaded in a complete or timely way. We also used the tablet computers to compare EIR stock data to the stock ledgers at health facilities. Once again, there were considerable inconsistencies, confirming our qualitative findings that use of the EIR for stock management was variable, with failure to acknowledge receipt of stock and to make stock adjustments (for wastage etc) in the EIR being the most common source of error.

Figure 21: Accuracy of data in the EIR database for at the end of intervention and post-program evaluations in Kilimanjaro Region
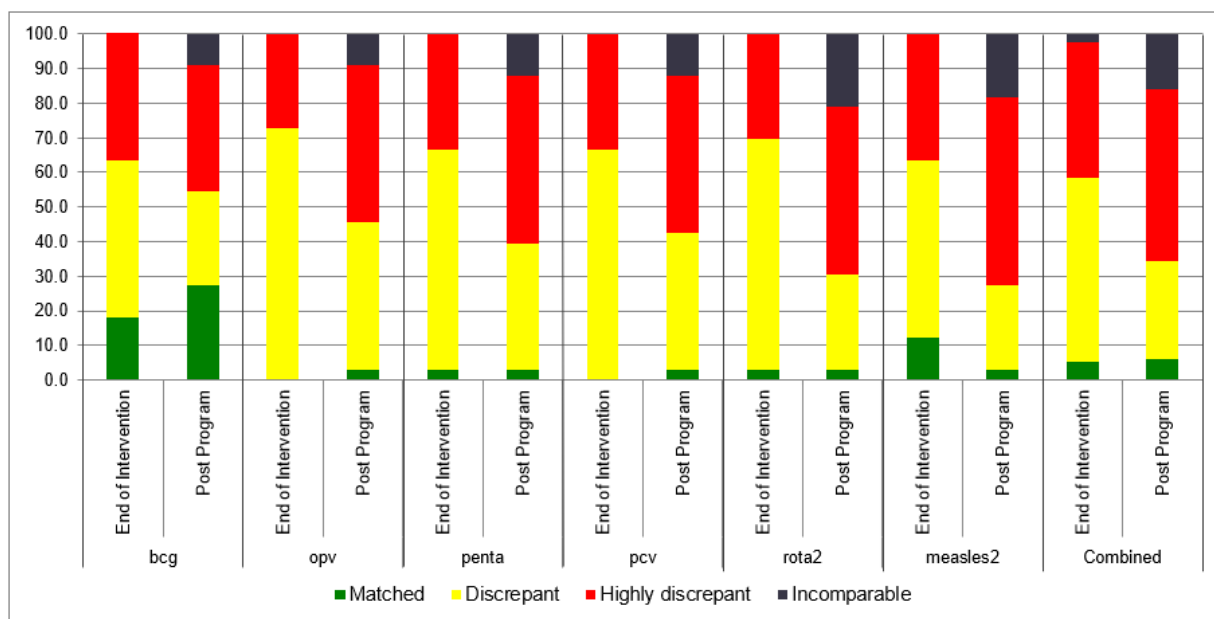
Outcome 2: Improved data use for decision-making

Preamble

The BID results framework indicates that the BID Initiative should lead to improved data use for decision-making at scale (Outcome 2). For the end-of-intervention evaluation and the post-program evaluation, we used standardized assessments to determine health care workers' competency in using the EIR to enter, retrieve and interpret immunization and stock data. For each evaluation milestone, we assessed one to two nurses trained in the EIR per facility. Following these assessments, the evaluators used triangulated in-depth interviews at facility and district levels to determine whether there had been a change in data use for decision-making or the institutional environment for data use. In keeping with the logical framework indicators for Outcome 2, the evaluators focused on changes in data use for decisions relating to immunization coverage, defaulter tracing and stock management.

Data use at baseline

At baseline, the evaluators found some evidence of data use practices at facility level based on hand drawn graphs and charts. Nurses were aware that official coverage targets could be misleading and described methods such as immunization campaigns for boosting coverage rates when necessary. Defaulter follow-ups were *ad hoc* and informal, and the emphasis in reporting was on calculating drop-out rates. There were regular physical counts to monitor vaccine stocks, and stock outs were avoided by borrowing from other clinics or direct local procurements.

Progressions in data use in Arusha Region

For the end-of-intervention evaluation in Arusha Region (June 2017), we assessed user skills in using the EIR software to a) register a new patient; b) complete a set of other data retrieval and interpretation tasks relating to immunization coverage and defaulters; and c) manage vaccine stock (including recording

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receipt of stock, checking stock balances and making stock adjustments). Figures 22 and 23 summarize key findings from these assessments. As shown in Figure 22, we found good overall levels of EIR competency at the end-of -intervention, with 86% of nurses (n=20) assessed being fully or highly competent in registering a new patient, and 82% (n=24) being fully or highly competent in other data use tasks (Figure 23). Notably, scores were weaker on stock management[61] with only 59% of nurses (n=22) assessed as fully or highly competent – this was mostly due to weak skills in making stock adjustments.

Figure 22: Overview of user competency scores for 'registering a new client' at the end-of-intervention evaluation in Arusha Region (June 2017)
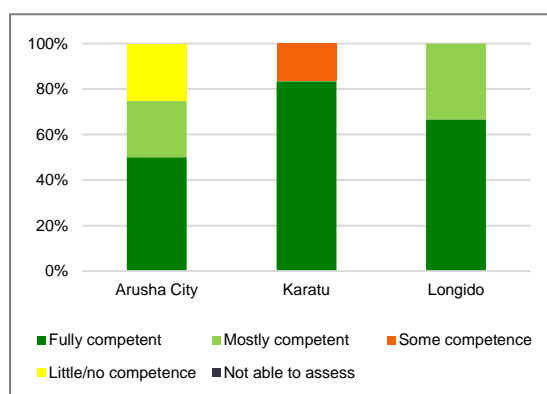
Figure 23: Overview of user competency scores for other data use tasks at the end-of-intervention evaluation in Arusha Region (June 2017)
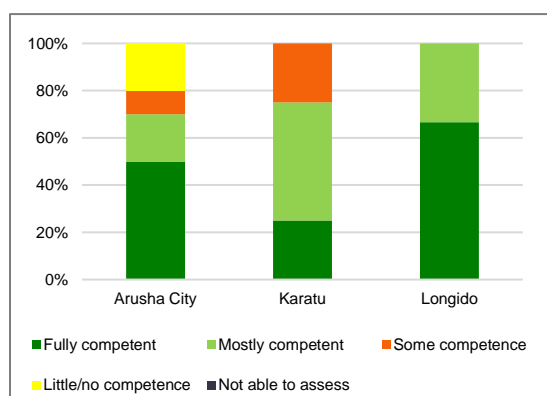
For the **post-program evaluation in Arusha Region**, we revisited the panel sample of health facilities. We repeated the standardized assessments using the three competency task sets (Figures 24-25). As shown in Figure 24, scores for using the EIR to register a new patient were still very good at the post-program evaluation, with 74% of nurses we assessed (n=20) showing full or high levels of competence. However, by this stage, there had been a marked decline in other areas of competence. For the second task set (data use tasks on coverage and defaulters), only 30% of nurses assessed (n=21) were scored as fully or mostly competent (Figure 25). The decline was most notable in Karatu and Longido Districts of Arusha Region. Similar findings emerged for competency scores in managing stock. For this task set,

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[61] Not shown in these graphs.

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only 24% of nurses assessed (n=17) were found to be fully or highly competent. Qualitative investigations suggested this decline was mostly because nurses were not confident in using the TImR update and were waiting for refresher training form the DIVO (who, being overstretched, has not managed to reach all facilities). We noted, however, that declines were somewhat less in Arusha City, and greatest in rural Karatu District.

Figure 24: Overview of user competency scores for registering a new client at the post-program evaluation in Arusha Region (August 2018)


Figure 25: Overview of combined user competency scores for other data uses tasks at the post-program evaluation in Arusha Region (August 2018)
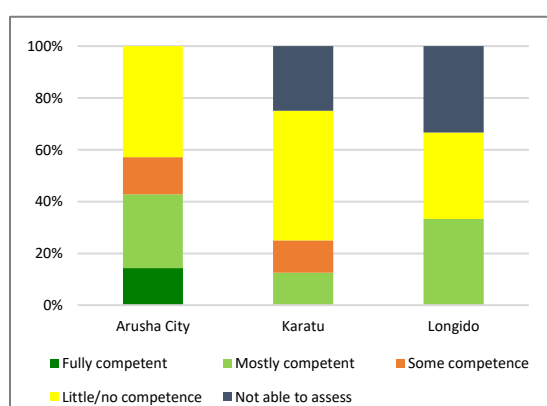
Progressions in data use in Kilimanjaro Region

For the **end-of-intervention evaluation** in Kilimanjaro Region (June 2018), we used the same methodology and standardized assessment tools to score user EIR competencies. Figures 26 and 27 summarize key findings from these assessments. As shown in Figure 26, we found good overall levels of EIR competency at the end-of -intervention, with 74% of nurses assessed (n=14) being fully or highly competent in registering a new client. Overall, 47% of nurses assessed (n=16) were scored as fully or highly competent in other data use tasks. These findings were consistent with our qualitative findings that

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training by mentors in both Moshi Municipal and Mwanga District was still fairly recent but, according to users, had focused mostly on client registration skills.

Figure 26: Overview of user competency scores for 'registering a new client' at the end-of-intervention evaluation in Kilimanjaro Region (June 2018)

Figure 27: Overview of combined user competency scores for other date use tasks at the end-of-intervention evaluation in Kilimanjaro Region (June 2018)
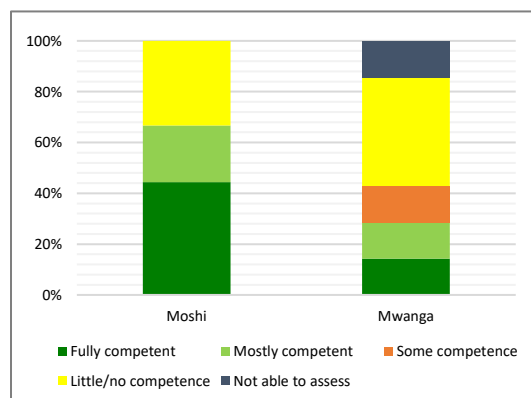
We repeated these assessments for the **post-program evaluation** in Kilimanjaro Region (April 2019). Figures 28 and 29 summarize key findings from these assessments. We found that there were still very good overall scores for competencies in registering a new client, with 84% of nurses assessed (n=12) being fully or highly competent. However, as in Arusha Region, skills in other EIR task areas has declined considerably, with only 2 nurses (n=12) in Moshi Municipal able to demonstrate high levels of competency in data retrieval, interpretation and defaulter tracing.

These findings were consistent with our qualitative findings that at the post-program stage in Kilimanjaro Region, nurses were still not using the EIR for recording immunization data on every eligible client, and when they did so they were mostly using the EIR for client registration activities only. Users were still finding data retrieval slow, especially where internet connections were poor in the mountainous areas of Mwanga District. There were also significant problems with the supply of internet bundles (although this was expected to improve as facilities learnt to budget for these supplies). Since the replacement of the DVD-MT with VIMS in December 2018, DIVOs were asking facilities to submit vaccine stock orders using

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the EIR. The Moshi Municipal was especially committed to this, and this seems to have reflected in competency scores.

Figure 28: Overview of user competency scores for 'registering a new client' at the post-program evaluation in Kilimanjaro Region (April 2019)
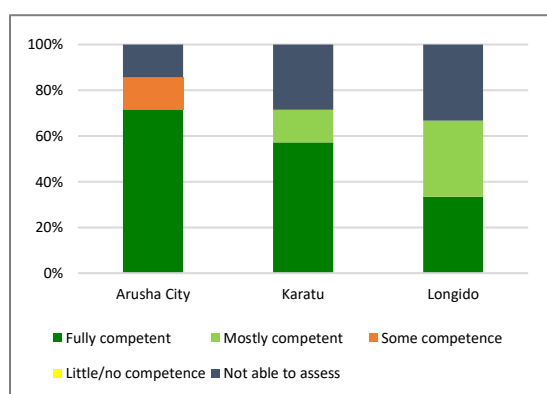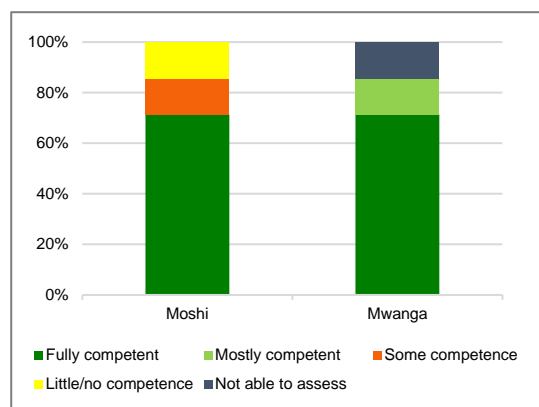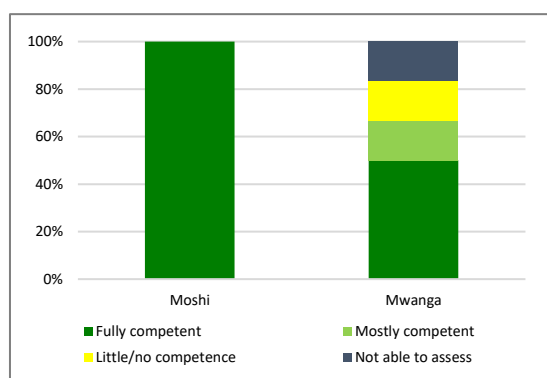

Figure 29: Overview of user competency scores for other data use tasks at the post-program evaluation in Kilimanjaro Region (April 2019)
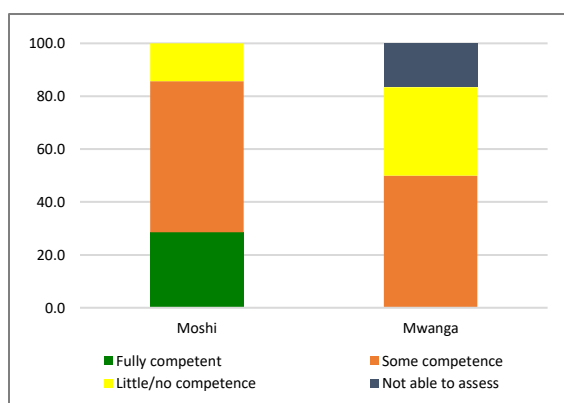
Additional findings on data use for decision making

Our field team noted that across districts in both Arusha and Kilimanjaro Regions, there was a distinct spectrum of competency skills, among DIVOs and nurses. This spectrum ranged from clear 'super-user' to users who were somewhat wary of using the electronic reporting system. Within our small sample, there was a tendency for super-users to be young and urban, while wary users tended to be older, rural and mostly female.

We also used qualitative enquiry to explore data use for decision-making. Although RCH nurses interviewed were generally able to describe, *in theory*, how the EIR could help them determine levels of scheduled coverage and identify defaulters, very few were able to provide concrete examples of using EIR data for these tasks in the preceding three months. In discussions on defaulters, it was commonly assumed that most defaulters were not 'true defaulters' because they understood that the EIR is not being used comprehensively and patients could be registered elsewhere. Moreover, very few nurses

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knew how to conduct a global search of registered clients and, indeed, are not able to retrieve data from outside their catchment area when they are using the EIR offline – a common practice due to bundle shortages and unreliable internet connections in rural areas. It was understood, however, that the EIR system sends automated SMS reminders to mothers with cell phones. Nurses interviewed regarded this as a very useful benefit of the EIR to assist with defaulter follow-up.

At district levels, it was evident that DIVOs are still not using EIR data, other than to cross-check data from other data sources and for intermittent monitoring of EIR usage. Across the board, DIVOs continue to populate VIMS using monthly IVD reports from facilities, rather than EIR data – but mostly because they still perceive the EIR data to be incomplete and unreliable if data has not been fully uploaded. As indicated above, some DIVOs are promoting use of the EIR for stock management, but this appears to depend on the motivation of the DIVO.

At the post-program evaluation, we found that RIVOs and DIVOs remain enthusiastic about opportunities for electronic reporting and evidence-based decision making (e.g. for planning based on more realistic coverage targets). Since baseline, we noted some improved fluency on data use themes at district level – although key informants suggest this may also due to VIMS and CHAI initiatives.

Outcome 3: implementation at scale and country ownership

Implementation at scale

BID's Outcome 3 logical framework indicators relate to implementation of BID solutions at scale, country buy-in, incorporation of BID interventions into country strategies and the contributions of the BID Learning Network. To assess progress from the baseline, the evaluators conducted desk reviews, key informant interviews, verification exercises at facility and district level and reviewed BLN postings and online events.

At baseline, the evaluators found that Tanzania has a comprehensive policy and legal framework covering immunizations and vaccine procurement in Tanzania. Following falling rates of immunization coverage over the period 2011-2013, there had been intensified efforts to improve immunization coverage, and rates had reached around 90% for most antigens by 2015. These improvements were attributed to: a) investments from Gavi in immunization service support, injection safety and new vaccines; b) additional investments in cold chain capacity and logistics management; and c) a World Bank-funded Performance-Based Financing (PBF) initiative that has incentivized increased EPI activity at district and facility levels.

By 18 months, the BID Initiative had reached 285 health facilities in Arusha Region. PATH had shifted to the DDUM rollout strategy and this was showing good signs of increasing skills transfer and country ownership. Accelerated progress in the VIMS initiative had catalysed a wider strategic vision on the part of government for an EIS, with back-to-back electronic immunization reporting from facility to national levels.

By the end of the program in June 2018, PATH had completed rollout to all eligible facilities in Arusha, Tanga and Kilimanjaro Region using the upgraded EIR software. PATH had also supported the JSI/InSupply rollout of BID Initiative in Dodoma Region.

Interviews with the MEDIC software design team confirmed that development of the EIR for Tanzania had required considerable investments of time, effort and technical skill. The MEDIC team has recommended that, as the system matures, it would be advisable to consider more sophisticated data security measures for the EIR (e.g. more secure tablet access, advanced data encryption techniques and more restricted

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administrator access). In addition, the team notes that the cloud-based server hosting capacity (currently Amazon Elastic Compute Cloud - EC2) is potentially underpowered for the size of this deployment. The evaluators understand development partners are in discussion with government and related institutions (e.g. Tanzania Communications Regulatory Authority) to increase in-country server capacity; however, this is likely to take time and could have significant cost implications.

After the end of the program, PATH aimed to ensure that BID beneficiaries had access to ongoing technical support. DIVOs were instructed to submit requests for technical support to a trained district or regional ICT officer. PATH staff also monitored issues arising through district virtual forums. Problems that are not resolved regionally were referred to the national level where PATH staff and MoHCDGEC ICT teams worked collaboratively to resolve issues arising. PATH reports that ongoing system maintenance costs have covered under the Gavi HSS grant for a period of five years. In addition, a number of policy and governance issues are being addressed as part of PATH's support to MoHCDGEC and PORALG through the Data Use Partnership.

At the end of the program, PATH extended the contract of the MEDIC team until November 2018 to ensure residual software design issues were fixed and the MoHCDGEC ICT unit could assume responsibility for TImR system monitoring and maintenance. This extended role included training and capacity building inputs and updates to the technical documentation and operational tools.[62]

At the post-program evaluation (April 2019), the evaluators found that MEDIC's contract had indeed come to an end but, unfortunately, all the national-level ICT staff trained in TImR monitoring and maintenance had been appointed to new positions. As a result, there are now significant concerns about how this technical support will be provided, both for the period of scale-up to other regions, and for longer-term system maintenance. The National IVD Program Manager reports that MoHCDGEC is planning to establish a new in-house digital design and support unit, but the timeframes for this are highly uncertain.

Country ownership

Our regular key informant interviews with the National IVD Program Manager and other IVD Program officers confirm that there has been good national level buy-in for the BID Initiative from the outset – although this is driven by a vision for integrated EIR and VIMS information systems in the form of the EIS. This strategic vision has underpinned government's efforts to advance paperless reporting in some facilities in Tanga Region.[63] It has also informed the government's 2017 HSS application to Gavi, the Vaccine Alliance,[64] and it's support for rollout in Dodoma and scale-up to all regions in Tanzania by the end of 2019. At the post-program evaluation, the National IVD Program Manager also observed that she would like to see the EIS can be incrementally extended to incorporate all aspects of reproductive and child health reporting, with back-to-back electronic reporting from facility to national levels.

Although the National IVD Manager remains highly supportive, she does have some concerns about the speed of progress to date, issues of staff turnover (hampering training), slow internet connections, and the long-term sustainability/affordability for government. She has some concerns that challenges in the bulk procurement of tablet computers have slowed the pace of scale-up and suggests that government will continue to requirement the support of external partners for negotiating discount in the procurement of

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[62] MEDIC will continue to manage and maintain the underlying Open IZ platform.

[63] Although evaluation of the BID Initiative in Tanga Region is beyond the scope of work of this evaluation, we have been informed by the National IVD Program Manager that, following a positive trial in six facilities of Tanga Region, the Tanga RIVO has recommended that paperless reporting be expanded to all facilities in the region.

[64] The evaluators note that in Tanzania's 2017 HSS application to Gavi, VIMS is mentioned on multiple occasions as government's strategy for addressing the objective of improving data management and quality of routine immunization data. Conversely, the BID Initiative only receives one small mention, suggesting VIMS is seen as the priority intervention. See Tanzania's proposal at: https://www.gavi.org/country/tanzania/documents/proposals/proposal-for-cceop-support-2017--tanzania/

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hardware. She also acknowledges that there will need to be significant investments in country server capacity for hosting the EIS at scale.

At district and regional levels, there remains almost unanimous support for the EIS endeavour, and the EIR as part of this. However, there are also widespread concerns that the EIR software is often slow and there are still aspects that need be improved or enhanced (especially with respect to the stock management component). There were several comments that the developers need to do more work on the EIR. Some DIVOs reported they had made requests for ICT support to the district or region, with mixed success. In addition, there are persistent concerns about budget allocations for internet bundles (at regional, district and facility levels) and the potential costs of replacing and repairing the tablet computers (many of which are now several years old).

Role of the BID Learning Network

The evaluators note that the BLN has been extremely productive and well-managed over the course of the BID program. Since program closure in mid-2018, the BLN has remained active and has continued to generate a considerable number of informative blogs, postings and webinars, some of which reflect recent Gavi investments to the BLN platform. Blog posts over the period July-October 2018 captured useful links to PATH's BID tool-kits, a Gavi blog on outreach work with EIR in Ngorongoro Region, and a South-South exchange visit between Tanzania and Vietnam. Although these blogs have leaned towards positive messaging, there have also been salutary webinars highlighting real-world issues (see, for example, Dominic Kwabena Atweam's webinar on the challenges of scaling up from electronic registry pilots in low-resource environments).

Over the course of the program, the National IVD Manager has been an active participant in BLN meetings and events. She has participated as a facilitator and as a contributor to BLN discussions and suggests these engagements have been useful for updating her technical knowledge and for networking with peers from other countries.

Despite positive feedback on BLN resources from multiple stakeholders, the evaluators note that the most active participation was by senior post-holders, national-level officers and policy-makers – especially those with access to fast, affordable internet connections. Participation by stakeholders at district and facility levels was unusual, although many of these stakeholders had established active and productive peer support networks through WhatsApp groups.

Outcome 4: resource commitments

Review of the costing information

In the context of information systems, "total cost of ownership" (TCO) means all the costs incurred to design, set up, operate and maintain a system. As recommended by the Pan American Health Organization (PAHO) [65] for an *economic* assessment (as opposed to simply a costing exercise), the TCO should be discussed alongside the outcomes (benefits) of the system to inform decisions about whether or not the information system is a priority for resource allocation.

When BID started, the aim was to measure the TCO to provide potential funders with relevant information. These funders included the governments of Tanzania and Zambia, which would ultimately be responsible for scaling up and maintaining the intervention, as well as potential funders in other countries. The TCO was intended to contribute to Outcome 4 of the BID logical framework.

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[65] PAHO (2017). Electronic Immunization Registry: Practical Considerations for Planning, Development, Implementation and Evaluation. Available at: http://iris.paho.org/xmlui/handle/123456789/34865

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In practice, only some of the costs were documented, namely those incurred by PATH. This was not a complete description of the TCO because:

● Other organizations incurred costs. The main costs fell to the Government of Tanzania, but other funders were also involved (e.g. Gavi, the Vaccine Alliance).

● The cost analysis only covered the time period of the BID Initiative (with a little work done on estimating future costs). Clearly there are ongoing costs for the BID regions, as well as costs for scaling up to new regions.

Also, the costs were not compared with outcomes, which would have created a business case for further investment.

Despite being incomplete, the BID work on costs has generated some interesting reflections. The following discussion refers specifically to PATH's costing work in Tanzania and is informed by two useful publications produced by WHO and PATH (2013)[66] and PAHO (2017).[67]

The costing information shared by PATH has helped us identify some of the cost drivers for the program in the Northern Zone – i.e. the items which account for most of the costs. However, the information provided does not tell us much about total future recurring costs, as most of these were not estimated.

Table 6 shows expenditure on BID in Tanzania from the PATH report on costs.[68] From Table 4, it appears that the main cost drivers are:

● System design and development – 21% of total, or 33% when development of the system which had to be abandoned is included

● BID Initiative staff – 39% of total

● Rollout costs – 23% (of which just under half was for hardware).

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[66] WHO and PATH (2013). Planning an Information Systems Project: A Toolkit for Public Health Managers. Available at: https://path.org/resources/planning-an-information-systems-project-a-toolkit-for-public-health-managers/
[67] PAHO (2017). Op. cit.
[68] Mvundura M, Di Giorgio L and Werner L (2019). Evaluating the expenditures for developing, deploying and maintaining electronic immunization registries in Tanzania and Zambia: evidence from the BID Initiative. Draft.

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Table 6: Expenditure by PATH for development and rollout of the BID Initiative package of interventions in Tanzania (2013-2018)

System design and development			
System design and development costs of electronic immunization registry (in use)			US$867,851
Learning costs (electronic immunization registry which was shelved)			US$527,644
Other costs			
Back entry costs			US$84,441
Peer learning and printing of guidelines			US$6,242
Labor costs			
BID Initiative staff			US$1,648,484
Region-specific costs			
	Arusha	**Tanga**	**Kilimanjaro**
Rollout costs			
Hardware	US$187,232	US$158,588	US$93,289
Meetings	US$8,728	US$9,783	US$7,097
Training	US$33,232	US$20,686	US$17,148
Deployment	US$146,701	US$162,353	US$103,617
Annual recurrent costs			
Internet connectivity	US$16,930	US$19,807	US$16,301
Data hosting	US$9,086	US$10,630	US$8,308
Supportive supervision	❖	US$6,178	US$8,786
Printing (e.g. barcodes)	US$4,702	US$5,501	US$4,300
Total costs over project period			**US$4,193,647**

❖   Not tracked separately in the financial records but included in the rollout costs.

In PATH's estimates, annual recurrent costs accounted for only 2%, although, of course, these would occur every year. The label "annual recurrent cost" is rather misleading because in fact this is just the known costs of keeping the technical system working: it does not include recurrent staff or transport costs, nor does it include system updates and refresher training. Most of the future recurrent costs are unknown for the reasons given above: the analysis was time-limited and only considered costs incurred by PATH.

Notably, these costs are for only 3 regions, whereas Tanzania has 31 regions in total (with an average of 6 districts per region). If we scale up the costs for the 3 regions based on this information, the picture becomes very different. The average rollout and annual recurrent costs for a region is US$352,994. Multiplying this up for 31 regions and rounding gives an approximate cost of US$10.943 million for the

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nationwide rollout and recurrent costs. Add this to the US$3.135 million for start-up costs (taken to be the non-specific regional costs in the table) gives a grand total of just over US$14 million. System design and development accounts for 6% of this total, or 10% when development of the system which had to be abandoned is included. Rollout and annual recurrent costs account for 78%.

There are many caveats to this estimate of US$14 million – including the fact that the so-called "annual recurrent costs" are a considerable under-estimate, while the significant "labor cost" item was not only for start-up – but the figure is a start as a working estimate. It is however, likely to be a fairly significant under-estimate, as it does not include government staff time and the BID labor costs were not counted as region-specific costs. WHO and the International Telecommunication Union estimate that eHealth projects typically allocate 60-70% of their budget to human resources (especially for training) in the implementation/operating phase.[69]

These figures demonstrate that:

● System design and development costs seem very significant at the start, but in the context of overall implementation they can be a relatively small proportion. The design of the system has implications for future costs (e.g. in terms of how user-friendly it is and inter-operability with other systems) and it can be worth using resources upfront to get these things right. Whilst shelving an unsuccessful design may seem expensive and wasteful at the time, it can be a wise long-term decision that saves money.

● Whilst digital information systems are generally thought of in terms of hardware and software, they also require considerable human resources. Individual staff are often involved in a variety of types of activity (e.g. management, training and visits to facilities), so it can be difficult to assign staff costs to different stages of implementation. A problem with this is that, in the longer-term, it is government staff who will perform many of these roles, and the costs of government workers are often lost in budgets because they are not an additional project cost if activities are expected to take place using existing staff. It is therefore important to think in terms of human resource capacity - the quantity and quality (i.e. skills) required – as well as direct project costs. The project will stall if the required staff are not available.

● Rollout costs are crucial in a national program. This is partly a matter of what hardware for facilities is selected and partly a matter of the training/deployment model used. As was demonstrated in Dodoma Region (see Section 6), training and deployment costs can be substantially reduced (though this in turn may have an effect on quality). Investments in making systems as user-friendly as possible can pay dividends because they can reduce the amount of time required to train each user.

Putting the costs of scaling up in perspective

The analysis above puts the total rollout at almost US$11 million, which could be spread out over several years. To put this into some kind of perspective, about US$124 million was spent on routine immunization in Tanzania in 2016, of which 21% came from government. 41% of the total spending was on vaccines. So, if we thought of the US$11 million as a one-year expenditure, that would account for 9% of total immunization spending, 15% of non-vaccine immunization spending, 43% of total government spending on immunization or 63% of government non-vaccine immunization spending.[70]

We can make some predictions of future costs:

As seen from Table 4, the BID assessment of future annual recurrent costs per region is about US$36,850, which would work out at US$1,142,350 each year for 31 regions. The BID estimates do not include central recurrent costs.

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[69] WHO and PATH (2013). Op. Cit.
[70] Figures on immunization spending in Tanzania *from Co-financing information sheet for Tanzania, 2018.* Gavi, the Vaccine Alliance. Available at: https://www.gavi.org/country/tanzania/documents/

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The line items included in the BID costing are internet connectivity, data hosting, supportive supervision and printing, and equipment replacement at the relatively low rate of 5%. However, we know that the following also need to be considered:

- Investments in ICT capacity for additional deployment;
- System enhancement, upgrades and data protection measures (all levels);
- Refresher/advanced training for DIVOs/mentors/IMPACT Teams;
- Helpdesk/focal point support at regional/national levels (for operational guidance, troubleshooting support and system maintenance);
- Procurement of in-country servers at regional and national level (needed to meet data processing requirements at scale);
- Replacement/additional tablets (more durable high spec with built-in scanner now being recommended; most facilities need 1-3 tablets rather than just 1 to manage workflows, outreach etc);
- Replacement solar panels (possible).

These are all items which should be included in a study of the total costs of ownership.

The WHO/PATH (2013) manual[71] includes the graph shown below (Figure 30). It says that this is a "hypothetical but representative cost profile that clearly highlights that the largest costs will not be incurred in the development phase, but in the consecutive scale and sustain phases of the system's lifecycle".

Figure 30: Cost profile for a typical information system
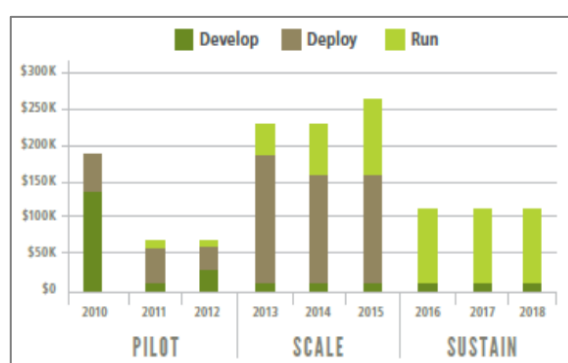
According to this graph, 19% of costs are incurred in the development phase, 42% during deployment and 39% for running the system. Although we do not have the complete picture for BID, the overall shape may well be similar to Figure 30. We know that deployment will cost considerably more than development, and we also know that more work needs to be done to capture the full costs of running the system.

The PAHO toolkit[72] emphasises the importance of estimating future costs: "failure to consider the human resource costs and requirements of system maintenance can cause the system to fail. When support actions are not carried out for lack of planning, the system promptly becomes obsolete."

However, combining the cost information with information on outcomes raises some more issues. Cost data needs to be considered in the context of outcomes – in other words, what was achieved for the money spent. As explained in Section 5.3 above, findings on BID intended outcomes remain inconclusive.

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[71] WHO and PATH (2013). Op. Cit.

[72] PAHO (2017). Op. Cit.

It is also apparent that more needs to be done in terms of training or supervision to promote consistent use of the EIR, as well as data use for decision-making. We also know that there is still as need for system updates and enhancements, especially to improve data exchanges between the EIR and VIMS – this will cost money, including for technical support. None of these additional costs are included in the estimates, unless they can be implemented as part of existing activities.

It was decided at an early stage not to link the BID initiative to impact in terms of immunization numbers. Thus, it is not possible to develop a full business case from the information available.

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Annex 3: Full report on the special study in Dodoma Region

Background

For the final phase of the BID evaluation, BMGF requested Mott MacDonald to extend its scope of work to review an alternative implementation strategy for the BID package of interventions. This alternative strategy (known as the IMPACT Team approach) was developed by JSI/InSupply in collaboration with PATH. It was developed to support efficient scale-up to Dodoma Region and was implemented in the first part of 2018. This report presents the findings of Mott MacDonald's special study to evaluate the IMPACT Team approach.

Methodology

The special study aimed to address four evaluation questions. These related to: the distinctive features of the IMPACT Team approach; how the approach contributed to intended results; the relative costs of the approach and emerging lessons for scale-up. To enable comparisons with PATH's earlier implementation strategy, the District Data Use Mentors (DDUM) approach, the evaluators adapted the evaluation methodology used for the Northern Zone. This methodology was based on a health systems perspective, and mixed methods were used in two case study sites to generate evidence for assessing progress towards intended results. The evaluators also applied a 'realist' analytical framework to structure and explain their findings through reference to the themes of **context**, **mechanisms** and **outcomes**.

Limitations of the methodology (e.g. the small sample size, and the absence of a baseline and control sites) were mitigated through retrospective questioning and use of triangulation techniques to ensure findings were robust.

Findings I: Context

Dodoma Region is located in the center of Tanzania (Figure 31) and shares many of the features of urban and rural settings in the Northern Zone, although outreach and satellite services appear to be more common in this region (Table 5). With an estimated population of 2,083,588, Dodoma Region has a relatively low population density of around 50 people/km^2.[73] Available immunization data indicate that, across the region, immunization coverage rates are 85%+ (2011).[74]

Dodoma Region has seven districts.[75] Dodoma Urban and Bahi Districts were selected as case study districts based on the purposeful sampling criteria.

Dodoma Urban includes Dodoma City. There has recently been considerable investment in this area to establish its status as the national capital, following the formal relocation of the National Assembly to the city in 1996. This means that

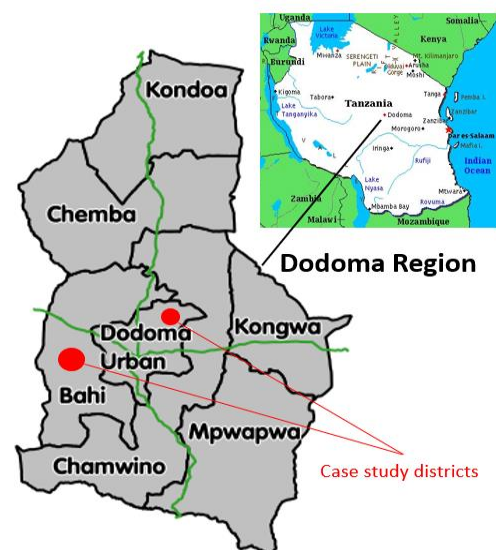**Figure 31: Case study districts in Dodoma Region**

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[73] Based on 2012 national census figures. See Population Distribution by Administrative Units, United Republic of Tanzania, 2013.

[74] This figure is taken from the most recent regional data available in the public domain. These data are contained in Government of Tanzania's

[75] Some references slit Kongwa to make a total of eight districts in the region.

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infrastructure is good and an imperative for government to showcase progress. However, population growth and movement is high and there are reported high levels of staff turnover in the health sector. Dodoma Urban also has a relatively high presence of private and non-governmental service provision, with 38% of health services being provided by the non-state sector.[76]

The rural district of Bahi has a small population of some 221,645 people,[77] with higher concentrations of people along the line of rail and in the administrative center of Bahi town. The local economy is based on agriculture and infrastructure (including internet connectivity) is patchy. Bahi District has 41 health facilities that offer immunization services and 37 communities receive outreach services.

The evaluators used retrospective questioning of key informants and other stakeholders to establish a **qualitative baseline** for the month prior to the JSI/InSupply intervention (January 2018). The evaluators confirmed that the baseline status was very similar to the baseline in the Northern Zone.[78] All health facilities were using the standard paper-based IVD reporting system to report immunization and vaccine data, with strategic, coordination and supportive supervision support provided by District and Regional Immunization and Vaccine Officers (DIVOs and the RIVO). Upwards reporting from district to national levels took place using the Excel-based District Vaccination Data Management Tool (DVD-MT) that included a Stock Management Tool (SMT) and Cold Chain Inventory Tool (CCIT). By the end of 2017, some progress had been made in introducing the digital VIMS system and in December 2018 DVD-MT reporting was formally phased out. Vaccine distribution was managed by the RIVO and DIVOs using a 'push' oriented top-up system that sometimes resulted in over-stocking. At facility level, Reproductive and Child Health (RCH) nurses were responsible for delivering immunization services and also reported immunization and child health data through the paper-based Health Management Information System (HMIS). Weaknesses in this 'legacy' system were acknowledged to be common, with the most common errors at facility level due to transcription errors, mis-counting of immunization tallies, failure to maintain the stock ledger, and miscalculation of vaccine stock balances associated with unit errors and wastage estimates. At district level, common weaknesses were associated with lack of completeness and data inconsistencies in the DVD-MT spreadsheets (which were prone to becoming corrupted and embedded formula errors).

Table 7: Context summary for the case study districts in Dodoma Region

Feature	Findings
Health system features	• **The decentralized health structure** under the shared leadership of the national MoHCDGEC and the Prime Minister's Office, Regional Authority Local Government (PORALG). While the MoHCDGEC manages tertiary hospitals, zonal training centres and special programs, PORALG is responsible for regional and district health services, including implementation of plans developed by Council Health Management Teams (CHMTs). The latter also oversees service delivery by non-governmental and private providers (38% service providers in Dodoma Urban). • **Health facilities** include hospitals, health centres and dispensaries are responsible for providing immunization services. Immunization services are offered daily in busy facilities (with sessions in urban facilities often receiving 50->100 clients); quieter rural facilities and private facilities may only offer immunization service 1-3 weekly, with only periodic BCG sessions. Outreach services are provided for remote communities. Some non-governmental providers also run satellite clinics. Health facilities are increasingly responsible for managing their own budgets

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Comprehensive Multi Year Plan (2010-2015). Notably, the challenges of establishing an accurate denominator are fully acknowledged in this plan.

[77] Based on 2012 national census figures. *Op. cit.*

[78] See Mott MacDonald's 2016 baseline study report (DEL 12).

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	• **Human resources:** immunization services are provided by trained RCH nurses only, with supportive supervision from the Head of Facility, RCH Coordinator and RIVO/DIVO. RCH nurses are often stretched, especially in busy urban clinics. Recent certification reviews under the current dispensation have led to acute staff shortages and frequent re-location of staff. These issues also affect DIVOs, with the Dodoma Urban DIVO having changed four times in the past year.
Data reporting	• **Immunization and stock reporting:** Health facilities are required to submit monthly IVD reports on immunization coverage and vaccine stock data to the DIVO at beginning of each month. These reports are compiled from primary records (e.g. the child health register, immunization tally sheets and the stock ledger). This IVD reporting system runs in parallel to the HMIS/DHIS2 reporting system. The BID EIR system is currently operating alongside the IVD and HMIS reporting systems at facility level. Until December 2018, DIVOs manually entered reported IVD data reported into the DVD-MT. Although the DVD-MT has now been replaced by the web-based VIMS, DIVOs are still populating this manually from facility IVD reports.[79]
Population and infrastructure	• **Population:** Dodoma Region lies in the center of Tanzania. The Wami River Sub-Basin extends from the semi-arid Dodoma Region to the inland swamps of Morogoro Region. The main ethnic groups are the Gogo, the Warangi, and the Wasandawi and the local economy is based on agriculture and cattle-rearing. According to the 2012 national census, Dodoma Region has a population of 2,083,588 and an average annual population growth rate of 2.1%. The region has a relatively low population density of 50 people/km^2.
	• **Electricity supply and internet connectivity** is patchy; health facilities in rural areas are often dependent of solar panels and generators for electricity. Internet connectivity can be slow/unreliable, especially in rural areas – generally, health facilities can only access the internet using data bundles and the mobile phone network.
Other initiatives	• **Digital initiatives:** In Dodoma Region, other electronic reporting systems have been introduced into selected health facilities, some with a tablet interface. These include systems associated with the Community Health Insurance Fund and the Government of Tanzania Hospital Management Information System (GoT- HoMIS). The Registration Insolvency and Trusteeship Agency (RITA) is also introducing a new digital birth registration system.
	• **Immunization and data initiatives:** several key informants referred to the importance of the government's Reach Every Child (REC) campaigns for improving immunization coverage. Some health care workers in Bahi District have also received training from the Clinton Health Access Initiative (CHAI) in data use.

Findings II: Mechanism

Design of the IMPACT Team approach

We note that JSI's local affiliate InSupply worked closely and collaboratively with the PATH team to develop and rollout the IMPACT Team approach. Key informant interviews suggested the approach was very similar to PATH's earlier DDUM approach, but had the following distinctive features:

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[79] Key informant interviews suggest that EIR data is not yet being used for this purpose because it is often incomplete. There is also a prevailing regulatory requirement to source data from IVD records.

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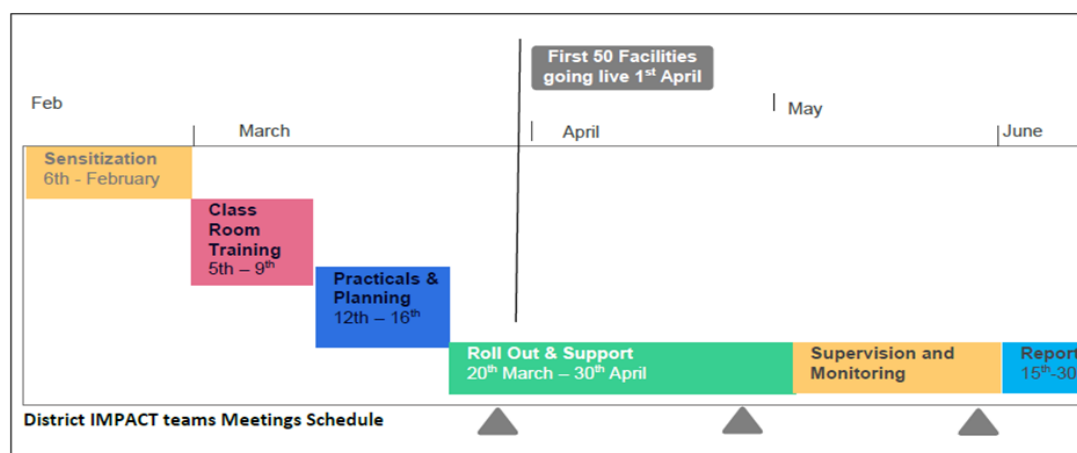
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- **Formation of IMPACT teams** from regional and district health officers. These officers were selected by Regional and District Medical Officers and included the RIVO, DIVOs and, ideally, ICT officers. IMPACT Teams were expected to be change agents trained in quality improvement methodologies, including data review, problem analysis and action planning for continuous improvement.
- **A Trainer of Trainers initiative:** the primary intervention was a classroom-based training for the IMPACT Team. The emphasis was on providing the IMPACT team with *training skills* to provide on-the-job training for facility staff. There was a particular focus on adult-learning approaches.
- **Modified training curriculum:** PATH's curriculum was slightly modified to balance technical training with more *data use* and change management content. There were also more practice sessions.
- **A systems focus**: training went beyond a focus on the EIR to include linkages to VIMS and the development of an integrated Electronic Immunization System (EIS) based on electronic reporting and data visualization at all system levels (notably, JSI was a lead partner in development of VIMS).
- **Team-building with a goal and results focus:** IMPACT Teams were expected to improve local team-work, coordination & collective problem solving, and to work towards a "common goal". Intended results were improved: a) data availability, visibility and quality; b) immunization program performance by registration of children and tracking of defaulters to reduce dropouts; c) vaccine availability and reduced wastage; d) performance monitoring skills of district teams; and e) data utilization skills at regional, district and facility levels.
- **Sustainability:** It was anticipated that the approach would be sustained by being incorporated into commodity security technical working groups and district data review meetings to improve use of data for continuous improvement. Networks of IMPACT Teams were expected to support scale-up to other regions by sharing experiences.

Implementation of the approach

Implementation of the IMPACT Team approach took place in the first half of 2018 and included the following steps:

- **Sensitization activities in February 2018 were followed by a 1-week classroom-based training of trainers session in early March.** This targeted 50 district officers and 3 regional staff and aimed to use an IMPACT team approach to equip mentors with EIS technical skills, as well as skills in adult training, change management and data use. InSupply reported an average 82% pass mark in the post-training test. At the end to this training the district IMPACT teams committed to a common goal, namely that the IMPACT Teams would work together to ensure 90% of registered children in the region were reached with immunization service and that all immunizing health facilities had a continuous supply of vaccines by reporting and using EIS for resupply.
- **Practical training and planning sessions for the IMPACT Teams.** Following the classroom based training, practice sessions were completed in 26 health facilities and a 3-month plan was developed for rollout and structured IMPACT meetings to review data and progress. Based on this plan, the InSupply team provided each IMPACT Team with a package of inputs to support rollout. This included tablet computers (1-2 per eligible health facility and 1-2 per DHMT), barcode sheets and scanners and internet bundles. In addition, provision was made for any additional costs associated with rollout activities e.g. vehicle fuel and out-of-office allowances.
- **Rollout, supervision and monitoring:** From the end of March until the end of May there was a period of rollout, supervision and monitoring to reach all 377 eligible health facilities in the region.
- **Follow up support and review:** Thereafter, InSupply provided technical and remote support and conducted a review in November 2018.

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Figure 32: IMPACT Teams implementation schedule (Source: JSI/InSupply Progress Report April 2018)

Lessons from implementation

InSupply's progress report to BMGF in April 2018 suggested that, while many aspects of the IMPACT Team's strategy received positive feedback from participants, there were still some lessons for strengthening the approach. Box 7 below presents a synthesis of lessons documented in the progress report.

Box 7: Lessons documented in InSupply's report, June 2018

- **Participation of representatives from the region and ministry improved ownership and motivation.** Involving users from other regions was also useful in supporting peer learning. It was recommended that training teams for scale-up should include: experienced representatives from IVD, PORALG, ICT and experienced mentors from other regions.

- **The best participants were those selected by DMOs to meet agreed selection criteria** and were conversant in computer/smartphone and immunization activities.

- **There was potential to improve the Quick Start Guide:** Participants needed considerable extra support with device configuration and initial setups of devices.

- **There was a need to address procurement challenges and ensure adherence to checklists:** Supervision and monitoring visits indicated there had been some delay in rollout because of hold-ups in the procurement of tablet computers. Also, trainers needed more guidance on activities to be conducted at each visit and needed to adhere to the standard checklists of topics and activities.

The pathway from the implementation to results

Findings from the follow-up review

In November 2018, the InSupply Team found that issues of ownership and leadership within Regional and District Health Management Teams were beginning to affect sustainability of the IMPACT Team

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approach – suggesting there was already a need for additional InSupply follow-up support to re-engage management structures and motivate the IMPACT Teams. In addition, there were still some technical problems in the EIS (that is the combined VIMS and EIR systems) that need to be fixed (Table 8).

Table 8: Issues and recommendations from the InSupply review (November 2018)

Issues	Recommendations
• EIS use for monitoring immunization performance and vaccine stock management was still inadequate at regional and district levels. • District [Council] Health Management Teams (DHMT) were not adequately oriented on EIS and IMPACT team activities • Several newly recruited staff at district and facility level were not well oriented to correct ways of reporting immunization activities using the EIR and VIMS. • There were a high number of defaulters recorded in EIS and low immunization coverage recorded in some districts – however, there was little certainty about how much this was due to poor usage of the new electronic reporting systems. • Plans for Councils and Facilities to take on internet bundles charges starting January 2019 were not in place. • Some users are still experiencing technical issues, and there are concerns about shared or lost login credentials.	• IMPACT teams should meet with DHMTs monthly to present status of action plans, current performance, conduct root cause analysis and plan for next month activities. • The Regional Health Management Team (RHMT) should follow up with each council to ensure a plan for recharging the devices with internet bundles from January 2019 is in place. • The RHMT should require all DIVOs to consistently and properly use the EIS for requesting vaccines from Regional Vaccine Store and issuing stock to health facilities. • The RHMT and DHMTs should make concerted efforts to orient health care workers (including new staff) on EIS and other immunization reports before January 2019. • The InSupply and PATH teams need to ensure all technical issues with the EIS are adequately addressed.

Findings from the post-program evaluation

The evaluation fieldwork was conducted in March/April 2019 - approximately one year after the primary intervention. The evaluators' investigations of the intervention mechanism focused on: stakeholder perspectives on the training provided; the status and functioning of the regional and district IMPACT Teams after one year; and additional lessons for sustainability and scale-up. We present findings from our semi-structured interviews and direct observation exercises below. We will consider contributions to results in the next section. However, we note that two potential benefits of the IMPACT Team approach over the DDUM approach need to be considered at this stage. These are:

● The establishment of dedicated local IMPACT Teams could provide facilities with better ongoing support and reduce the burden on DIVOs to provide EIS training updates and technical assistance.

● The formation of local IMPACT Teams could drive a culture of regular uses of immunization data for decision making.

Observations on these potential benefits have been incorporated into our findings on the mechanism below.

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Stakeholder perspectives on the training provided

- IMPACT Team members interviewed expressed high levels of satisfaction with the EIS training provided; however, several emphasized the importance of more refresher training to help users address issues arising and support the training of newly appointed staff.[80]

- Some key informants suggested there was a need to optimize the size and composition of the training classes to cater for a range of abilities and experience. There were some concerns about appropriate representation from the non-state sector in Dodoma Urban.

- Some key informants observed that Information Communication Technology (ICT) officers were under-represented in the classroom training. Two key informants proposed that, since ICT officers are frequently overstretched, IMPACT Team members (and especially DIVOs) need more advanced training in technical troubleshooting.

Status and functioning of the IMPACT Teams:

- Although IMPACT Team members confirmed that they had made three training visits to assigned facilities as required, several observed that this was often insufficient because staff rotations meant they did not always see the same RCH nurses to complete the training schedule. Lack of resources/transport and other professional commitments meant that additional follow-up visits were not always possible, especially to the most remote facilities.

- In our two case study districts, there were high levels of awareness of the role and objectives of the IMPACT Teams, including among Regional and District Medical Officers. However, there was little evidence that the recommendations from InSupply's review had been fully implemented. Senior key informants were unable to cite examples of regular meetings between IMPACT Teams and DHMTs within the region. Nevertheless, RIVO and DIVOs interviewed were routinely using VIMS for stock ordering and distribution. There was also some evidence that, as recommended, newly appointed DIVOs were being orientated to the EIS by their peers.

- InSupply and PATH key informants observed that key factors in the effectiveness and sustainability of the IMPACT Teams were the selection of members (including their aptitude, commitment, enthusiasm and time to dedicate to team tasks), as well as the support, encouragement and strategic vison of the senior regional/district leadership.

- Although there was little evidence of regular IMPACT Team meetings, there were reports of frequent WhatsApp communications within and between teams. The Bahi DIVO suggested that these communications do inform decision-making and observed that WhatsApp exchanges had prompted a 'Reach Every Child' campaign to address high levels of defaulters and boost immunization coverage.

- The RIVO and DIVOs interviewed all reported frequent use of the VIMS system for reviewing immunization coverage and drop-out rates, and we observed high levels of competence in system use. However, RIVO and DIVO use of EIR dashboards and reports was only intermittent, and was mostly for quality assurance and supportive supervision purposes. The DIVOs interviewed suggested that, at this stage, EIR data reports are frequently incomplete and stock balances uncertain – although they acknowledged that submissions from some facilities are more reliable than others.

- Key informant interviews indicated that all DIVOs in this region continue to enter data manually into VIMS from facility IVD reports. Senior officials at regional and district levels suggested they would be reluctant to support paperless reporting at facility level until some residual challenges with the EIS had been addressed. Reported challenges included:

  – A perception that there were still some software issues with the EIR and the transfer of immunization and stock data to and from VIMS (although it was acknowledged that some devices might not be fully updated).

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[80] We have inferred that the InSupply provided less hands on support to users than PATH teams; however, this is difficult to confirm definitively because PATH teams were more involved in 'learning by doing' development activities, feedback to the design team and testing of updates.

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– Concerns that busy facilities did not have enough tablet computers for recording data on every client. There has also been some problems with broken and malfunctioning tablets, slow repairs and lost power cables.

– Issues with sufficient procurement of internet bundles by health facilities, as well as provision of bundles for DIVOs and the RIVO -although there were assurances that budget provision was likely to improve over time. There were also concerns about the timely procurement and distribution of barcodes.

Box 8: Additional lessons for sustainability and scale-up

- Full and repeated engagement of senior leadership and careful selection of IMPACT Team members is critical. Attention also needs to be given to the optimal size and composition of training classes. There may need to be provision for refresher training and more advanced training in technical troubleshooting. The long-term burden on DIVOs is unlikely to reduce until the EIS is better established and/or the role of IMPACT Teams is institutionalised.

- Establishing a culture of data use is a continuous process. Although key stakeholders are enthusiastic about the IMPACT Team approach, the benefits for quality improvement through data use appear difficult to sustain without a wider program of follow-up support and change management. Linkages to InSupply's wider commodity security initiatives could provide an opportunity to expand the practice of data use for decision-making.

- Until some challenges with the EIS are addressed, the potential benefits of the IMPACT Team approach are unlikely to be realised. There are strong indications that the EIS (especially the EIR component) needs further investment to ensure evolving user requirements are being met at each system level. The implementation strategy loses relevance when the intervention 'product' needs further development.

Findings III: Outcomes

Aligning intended results

In the previous section, we noted an explicit goal and set of expected results from the IMPACT Team approach. These all related to improved quality of immunization and stock data and improved data use for decision-making at facility and district levels, with a particular focus on improving immunization coverage, reducing defaulters and better vaccine stock management. These results are well aligned to Outcomes 1 and 2 in the BID results framework, so will be covered in the respective sections below.

Outcome 1: Improved data quality at scale

Preamble

To establish the evidence for improved immunization data quality at scale (Outcome 1), the evaluators first reviewed whether there had been changes in data quality in the legacy IVD reporting system since the intervention was delivered. As mentioned in Section 4, the legacy system was still running alongside the EIR in Dodoma Region at the time of the evaluation. Although we did not assume the IVD records

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were accurate, they did provide a useful reference point for *reflecting* on the quality of the data in the BID EIR.

To assess data quality in the legacy system of the 12 sampled health facilities, the evaluators used criteria of availability, completeness and accuracy to review reported IVD data against primary source records for six proxy antigens over a three-month period (December 2018-February 2019). Next, the evaluators conducted a similar exercise to review data quality in the EIR (TImR) tablet and master database – i.e. the evaluators used the same criteria to examine data recorded in the EIR for the same six antigens over the same three months for the sampled facilities. Since there were no baseline measures, the evaluators used triangulated semi-structured interviews to understand the status of data quality in each system, and retrospective questioning to explore any changes that had occurred in the past year.

Data quality in the legacy IVD system

Availability and completeness:

We found excellent levels of **availability** of all IVD and HMIS7 monthly reporting documents and child registers across all facilities, along with primary source documents (IVD and HMIS7 tally sheets and stock ledgers (Kitabu 4). Only one health facility, the Dodoma Regional Referral Hospital, did not have these records as it only submits data on maternity ward immunizations (for which there is a different reporting mechanism). Of the available records, there were good levels of **completeness** over the three months reviewed – for example: all child registers were fully complete, except for two that were partially complete; all IVD reports were fully complete, except for three that were partially complete; and all stock ledgers were complete, except for one that had no records at all.

Accuracy of immunization data

To assess data accuracy in the IVD legacy system, we compared reported immunizations administered for the six proxy antigens over the three months period against primary source records in the 11 facilities where records were available (giving us 231 paired data points). We found very good levels of data correspondence in Bahi district, with an average of 72% (n= 126) paired data points matching.[81] This compared to an average of just 33% (n= 105) paired data points matching in Dodoma Urban. Notably, however, the findings from Dodoma Urban were closer to our evaluation findings on accuracy from Arusha and Kilimanjaro Regions, where an average of 45% of data points matched over the period February-April 2018 across 30 sampled facilities.

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[81] For the purposes of this analysis paired data points were defined as: matching if they were identical; discrepant if values differed by 1-9 doses; highly discrepant if values differed by 10+ doses; and incomparable if there were missing values or errors in one or both sources that made differences impossible to determine.

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Figure 33: Assessment of data accuracy in the legacy IVD system based on comparison of reported and source data for six proxy antigens over three months (Dec 2018-Feb 2019) in the 12 sampled health facilities of Dodoma Region
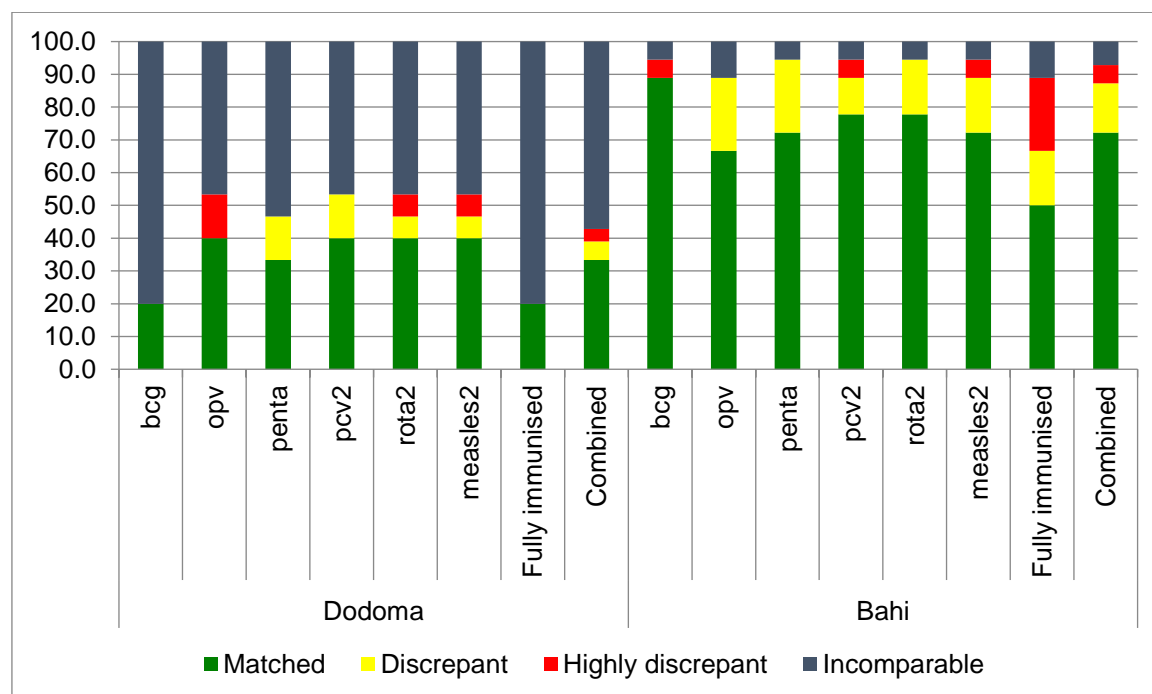
Accuracy of stock data

Our review of the accuracy of reported stock data in the legacy system showed a large range of results across facilities, depending on how diligent nurses were in maintaining the stock ledger. As in the Northern Zone, it was common to find calculation errors in the IVD reports – usually relating to wastage estimates. As for immunization reporting, our small sample of health facilities suggested Bahi District was performing somewhat better. Across the two case study districts, an average of 54% of paired data points matched for the proxy antigens. This points to relatively good performance on stock reporting compared to Arusha and Kilimanjaro Regions where, on average, only 19% of paired stock data points matched at the sampled facilities in over the period February-April 2018.

Data quality in the EIR database

Availability of EIR tablets

We found that EIR tablets were available in every health facility visited, except for the Dodoma Regional Referral Hospital where there was a different data reporting system. However, of the five other health facilities sampled in Dodoma Urban, two could not use the tablet because they did not have a power cable and two had only recently started using the tablet because of problems with the sim card.

Accuracy and completeness of EIR immunization data

To review the accuracy and completeness of the data in the EIR, we examined data in the tablet computers at facilities and in the BID master database for sampled facilities. Again, we focused on records for the six proxy antigens over the three months of December 2018-February 2019, and compared them to primary source records.

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Our findings confirmed qualitative observations that the EIR was not being used for every client in either of the case study districts. This was clearly the case in Dodoma Urban where, as noted above, several facilities in our small sample had had problems with the hardware. Figure 34 below shows how well data on immunizations administered in the BID tablets compared to tally sheets for Dodoma Urban and Bahi Districts. Bahi District has been doing relatively well, but there still seem to be large amounts of missing data (with lack of completeness affecting accuracy of the data set).

Figure 34: Assessment of data accuracy in the EIR tablets at the 12 sampled health facilities in Dodoma Region based on comparison with source data (tally sheets) for six proxy antigens over three months (Dec 2018-Feb 2019)
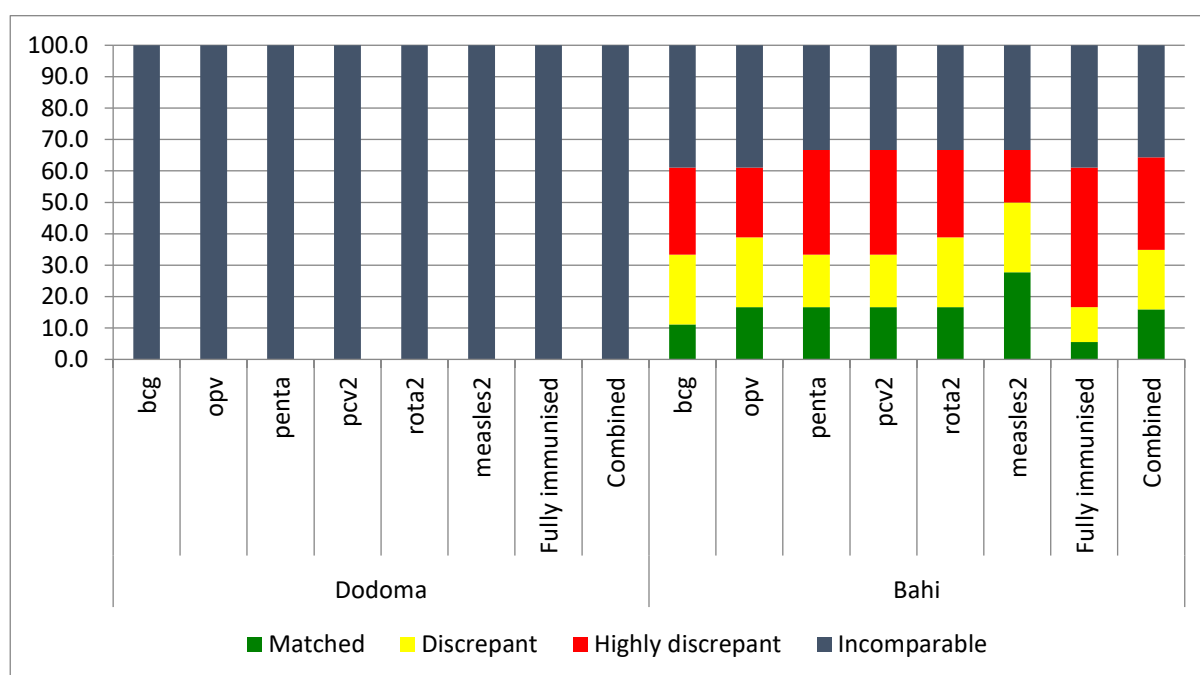
In semi-structured interviews with RCH nurses, the additional reasons given for failure to use the EIR for every client included: slow functioning of the system (especially in busy clinics); lack of internet bundles and unreliable connections and/or human resource constraints (lack of nurses trained in the system or with sufficient skills to use/maintain the system). We also observed that data from outreach activities and satellite clinics was rarely entered into the EIR, leaving the data incomplete. The high levels of turnover in the DIVO position in Dodoma Urban in the past year and the additional protocol requirements of visiting non-state clinics may also have slowed take up of the intervention in Dodoma Urban.

The evaluators also re-ran the accuracy analysis using data in the BID master database. We note that results for the sampled facilities appeared even weaker, suggesting that some data was being lost between facility tablets and the master database, or not all data was being successfully uploaded in a timely manner.

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Figure 35: Assessment of data accuracy in the BID master database based on comparison with source data (tally sheets) for six proxy antigens over three months (Dec 2018-Feb 2019) for the 12 sampled health facilities in Dodoma Region
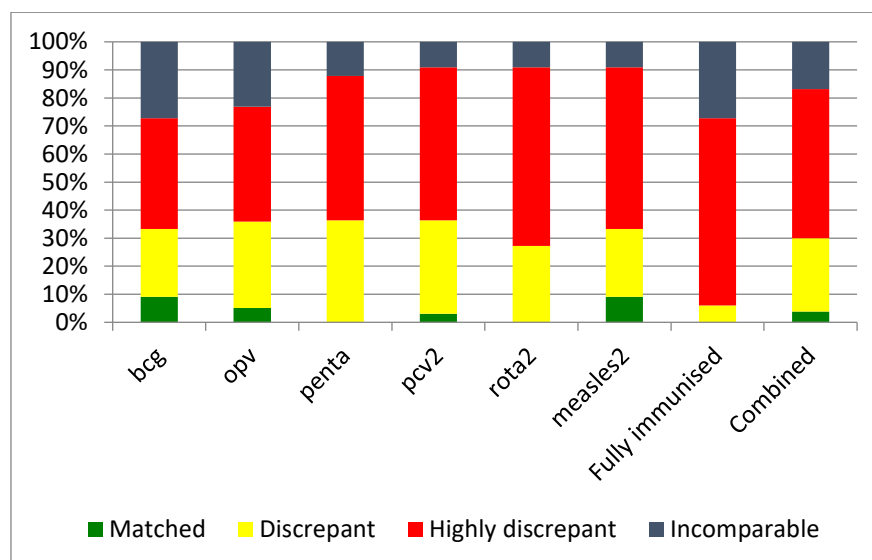
While at the health facilities, the evaluators reviewed the content accuracy of client information in the legacy and EIR systems. In each facility, we cross-checked the content of five sampled records in the child register and the EIR. For most facilities there were good levels of consistency between records; however, spelling discrepancies were fairly common. We noted that in some busy clinics, nurses preferred to retain the child health card to enter EIR data later – if this was not done on the day of the child's visit, this could lead to scheduling differences between the EIR and the child register.

We only found two examples of nurses using the hand-held scanner to read barcodes, with most preferring to retrieve data by entering the mother's name or typing in the barcode number (a potential source of error). During these direct observation checks, we also observed that there were several versions of the EIR (TImR) software in use, suggesting that some versions had not been updated. In two cases, there also seemed to be set-up and configuration issues. These factors could also have implications for the accuracy of the data in the EIR system.

Accuracy of stock data

Several facilities in our sample were not using the EIR for stock management, especially in Dodoma Urban. Interviews with RCH nurses and other key informants suggested that there was a general preference for using VIMS (only) to order and distribute vaccine stock, and uncertainty about how well data exchanges between VIMS and the EIR were working with respect to stock. Some key informants suggested that not all nurses were diligent in using the EIR acknowledge receipt of stock or in making regular stock adjustments for wastage.

Annex 1 presents some consolidated charts to reinforce our observations. These charts show the direct comparisons between accuracy findings for the legacy system and EIR systems, firstly, for immunization data and, secondly, for vaccine stock data.

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Changes in data quality over the past year

Our qualitative enquiries suggested there were perceived improvements in data quality in the overall information system over the past year. There was some suggestion that the issuing of IVD books in Swahili over the past year could have some benefits for accuracy in data records. However, the fact that the DVD-MT system had been replaced by VIMS in December 2018 was reported to be an important development that had contributed to improvements in the quality of immunization and vaccine stock data. Our observations confirmed the credibility of this perspective. DIVOs are now expected to enter complete and timely data into the new VIMS, and there is significant supervisory follow-up to ensure this happens for both immunization and stock data. Data visualisations instantly reveal data discrepancies or gaps. These are reported to prompt rapid quality assurance checks with facilities – these can now take place by SMS or WhatsApp, as well as through phone calls.

The absence of baseline measures in this special study means it is difficult to demonstrate trends in immunization and stock data quality, while the introduction of the combined EIS with back-to-back VIMS and EIR components creates difficulties for tracking pathways of attribution. However, the evidence from our data quality assurance work suggests the EIR component will need to be strengthened further if it is to produce measurable improvements in immunization and stock data quality.

## Outcome 2: Improved data use for decision-making

Preamble

As indicated in Section 5, there was evidence that VIMS data and visualisations were regularly being used at district and regional level to inform decisions on immunization coverage, drop-out rates and stock management. To further assess the IMPACT Team's contribution to data use for decision-making, the evaluators focused on health facilities and the skills acquired by Reproductive and Child Health (RCH) for using the EIR system to record, retrieve and interpret data. For this exercise, we conducted a series of competency assessments at facility level to assess whether RCH nurses were proficient in EIR use for: a) registering a new client; b) completing a set of tasks relating to retrieval and interpretation of EIR data on returning clients, defaulters and immunization coverage and c) completing a set of stock management tasks, including acknowledging receipt of stock, checking stock balances and making stock adjustments for wastage. These assessments were done using the standardized tool developed for the wider BID evaluation work to assess user proficiency. Our field team was trained to use this tool to score completion of tasks against standard criteria.[82] The team also used retrospective questioning to review perceived changes in the enabling environment for data use practices in the past year.

Competency scores on EIR data use tasks

We asked one to two RCH nurse who had received training in the use of the EIR to demonstrate registration of a new client using the EIR app on the tablet computer. As shown in Figure 36, in Dodoma Urban, a working tablet computer was only available for this task in three of the six sampled health facilities on the day of our visit; two of the nurses from the three facilities demonstrated full competence in the registration task, and one only showed some competence. In Bahi District, we were only able to conduct the assessment in five of the six sampled facilities on the day of our visit (due to nurses being unavailable for assessment in one clinic); all five nurses in the other facilities were fully competent in registering a new client.

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[82] These allow the user to be scored as fully competent, mostly competent, as having some competence or little or no competence.

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**Figure 36: Findings from EIR competency assessments on registering a new client
across 12 sampled facilities in the case study districts (March/April 2019)**
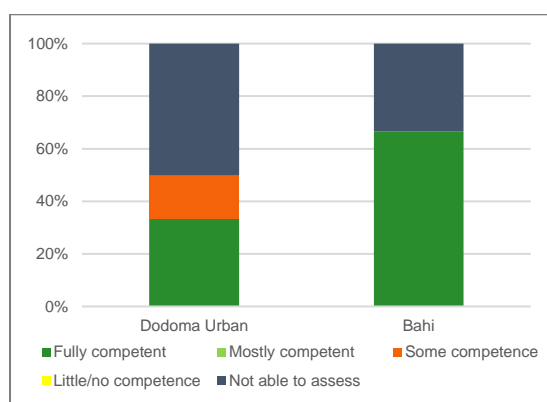
Next, we asked one to two available trained nurses to complete a set of tasks relating to retrieval and interpretation of EIR data on returning clients, defaulters and immunization coverage for the facility. Figure 37 shows that, in Dodoma Urban, in the three facilities where assessments could be completed, nurses in two facilities were fully or mostly competent across the set of tasks, and one nurse showed little or no competence. In Bahi District, it was only possible to complete this assessment in four facilities at the time of the visit, but in these four facilities nurses were found to be fully or mostly competent across the set of tasks.

**Figure 37: Findings from EIR competency assessments on other data use tasks across
12 sampled facilities in the case study districts (March/April 2019)**
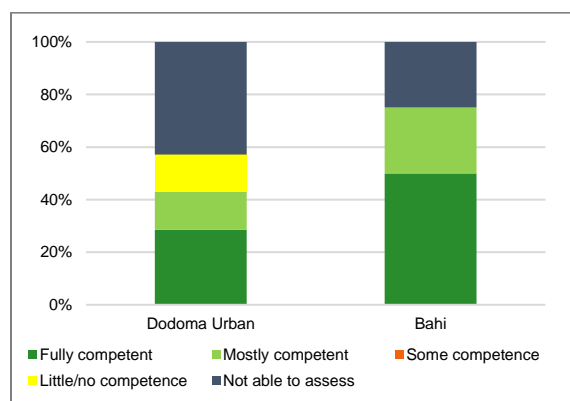
These findings from our small sample of health facilities in the case study districts, combined with findings from semi-structured interviews suggest that EIR data use competencies are relatively good in Bahi District. We note that, in Bahi District, there is also prevailing culture of good data management, as illustrated by the findings on IVD reporting. In most cases, facility staff felt well-supported by the IMPACT Team, although there were requests for more training and follow-up support. The DIVO for Bahi District acknowledged the difficulties in reaching remote facilities (e.g. in Ibugule and Mtitaa) to provide follow up support. In Dodoma Urban, the hardware challenges, prevalence of less accessible non-state providers

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and high turnover of DIVO officers may have affected EIR uptake and usage; we note that the Aga Khan facility is reported to have benefited from close proximity to the office of the DIVO and RIVO.

At facility level, our interviews elicited little evidence of regular use of the EIR for decision-making on immunization planning, defaulter tracing or stock management in the last six months. Some users have explored the system when clinics are quiet, but most users are still learning to use and manage the EIR alongside the legacy system. For defaulter tracing, there is awareness that the system will send SMS reminders to mothers with cell phones. This is much appreciated by nurses; however, it was also observed that in the remote rural areas of Bahi District, many mothers (or households) do not yet have cell phones; moreover, return visits can be challenging for mothers even when outreach services are provided. In Dodoma Urban, successive DIVOs have managed stock ordering and distribution solely through VIMS, but in Bahi District the DIVO is encouraging nurses to use the EIR for stock management.

Outcome 3: Implementation at scale and country ownership

Our interviews with the national IVD program team confirmed a strong and comprehensive understanding of the EIS – including both the VIMS and EIR components. National officers confirmed their involvement and buy-in to the process. There was also commitment to using Gavi health systems strengthening grant to scale up the initiative. The National IVD Program Manager had a good understanding of the IMPACT Team approach for scale-up and saw this as a progression from the DDUM approach as it built on lessons, built sustainable capacity at regional and district levels and maximized efficiency.

At national level, there was recognition that there would need to be significant investments in national and regional server capacity to support rapid data processing as the EIS goes to scale. It was also acknowledged that there would also need to be additional investments in building ICT capacity within the MoHCDGEC to support system design, deployment and maintenance of the EIS, as well as other digital solutions. Recent procurement of tablet computers for scale-up and replacement had also highlighted the costs associated with this; the National IVD Program Manager suggested that donors, such as Gavi, could assist countries through bulk procurements.

At regional and district level in Dodoma Region, we found unanimous support for the EIS initiative among Regional and District Medical Officers, and IMPACT Team members interviewed (including the RIVO and two DIVOs), and at facility level. All these stakeholders could see the benefits of electronic reporting and saw this as part moving forward. As one DMO said, "we cannot go backwards!") Despite these high levels of buy-in and commitment, key stakeholders saw room for improvement. With regards the EIS solution, it was observed that the developers still need to do more work on "fixing the bugs" and on and integrating the EIR with VIMS for both immunization and stock reporting. Although the IMPACT Team approach was regarded positively, there were multiple requests from IMPACT Team members for regular refresher training, more advanced training on technical troubleshooting, as well as access to timely technical support.

During our data use assessments, we observed that many facilities write the password of tablet computers on the inside of the protective cover to facilitate use by multiple users. This is understandable, but also spotlights issues of data security. The evaluators observed that there was little user awareness of this issue, so this is another area where there will need to be improved user training, as well as additional government investment at system level.

Notably, one of the indicators for this outcome relates to improvements in peer networking and peer learning. Although no stakeholders interviewed at regional and district levels had accessed the BID Learning Network (BLN) -indeed, there scant awareness of the BLN – all IMPACT Team members and some facility staff mentioned referring to WhatsApp groups in the last six months for additional information and advice relating to immunization data, stock management and issues relating to VIMS and or the EIR.

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Outcome 4: Resource commitments

For this special study, BMGF has asked us to comment on how the costs associated with the IMPACT Team implementation approach compare with the DDUM approach used in the Northern Zone. This short note will contribute to a wider review of BID Initiative costs that will form part of our final evaluation report. We gratefully acknowledge InSupply's willingness to share the budget and expenditure information used for this analysis in a timely way.

Implementation costs in Dodoma

InSupply's budget request for the Dodoma work was for US$341,461, broken down as follows.

Table 9: Breakdown of the budget request for Dodoma

Activity	US$	%
Equipment procurement – high volume facilities (70%)	147,020	43
Equipment procurement –low volume facilities (30%)	27,243	8
District trainer of trainer sessions	35,500	10
Health facility training – practical on the job training + rollout supervision	74,409	22
Continuous support and mentorship, including CHMT supervision	29,295	9
RHMT supervision	1,425	<1
Internet bundles	18,436	5
Sensitisation meeting	8,131	2
Total	**341,461**	**100**

In practice, what was actually spent was US$89,795, broken down as shown in Table 10. This shows a very substantial reduction against the budget, with actual expenditure being only 26% of the amount requested. Items that were removed from the budget include procurement of equipment and internet bundles.[83]

Table 10: Actual expenditure for InSupply's implementation in Dodoma

Activity	US$ *	%
Leadership sensitisation meeting	6,645	7
Two weeks trainer of trainer sessions for IMPACT teams and practical week	26,080	29
Rollout – health facility on job training on EIS	36,390	41
Delivery of equipment, data use and defaulter tracing supervision	11,890	13
IMPACT team meetings and RHMT supervision	8,800	10
Total	**89,795**	**100**

*Not exact as there were different categories for expenditure on IMPACT teams and JSI/PATH technical assistance (TA) inputs.

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[83] We have surmised that, in practice, these procurements were covered by PATH as key informants reported that all facilities in Dodoma Region had received the tools needed for start-up, including tablet computers, barcodes, initial internet bundles etc. At the time of preparing this report, the evaluators were waiting for JSI/InSupply to confirm this assumption.

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Comparison with program costs in the Northern Zone

We have sourced information on "expenditures" associated with implementation of the BID Initiative in the Northern Zone from PATH's manuscript, *Evaluating the expenditures for developing, deploying and maintaining electronic immunization registries in Tanzania and Zambia: evidence from the BID Initiative* (shared 27 March 2019). This manuscript helps us determine the scale of implementation in each region (Table 11). In Table 11, we have added the information available for Dodoma Region.

Table 11: Regions included in the analysis and number of facilities and children

Region/ Province	Number of districts	Number of health facilities with EIR software deployed	Number of children aged 0 to 12 months
Arusha	7	285	133,571[a]
Tanga	11	327	96,950[a]
Kilimanjaro	7	312	88,233[a]
Dodoma	7	345	*TBD*

[a] Census data on immunization target population

PATH's manuscript also provides us with information on EIR design and development costs and allows us to separate these from rollout (implementation) costs and annual recurrent costs (provision of internet bundles, server hosting, printing of barcodes, supportive supervision etc) (Table 12).

Table 12: Total financial expenditures for development and rollout of the BID Initiative for the period 2013-2018 (sourced from PATH's manuscript, March 2019)

Tanzania	
System design and development	
System design and development costs of electronic immunization registry (in use)	US$867,851
Learning costs (electronic immunization registry which was shelved)	US$527,644
Other costs	
Back entry costs	US$84,441
Peer learning and printing of guidelines (Tanzania only)	US$6,242
Labor costs	
BID Initiative staff	US$1,648,484

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Region / province -specific costs			
	Arusha	**Tanga**	**Kilimanjaro**
Rollout costs			
Hardware	US$187,232	US$158,588	US$93,289
Meetings	US$8,728	US$9,783	US$7,097
Training	US$33,232	US$20,686	US$17,148
Deployment[84]	US$146,701	US$162,353	US$103,617
Annual recurrent costs			
Internet connectivity	US$16,930	US$19,807	US$16,301
Data hosting	US$9,086	US$10,630	US$8,308
Supportive supervision	[b]	US$6,178	US$8,786
Printing (e.g. barcodes)	US$4,702	US$5,501	US$4,300
Total costs over project period			**US$4,193,647**

[a] Financial cost only for three months. Hence annual costs would be approximately US$8000.

[b] Not tracked separately in the financial records but included in the rollout costs.

In the context of a comparison with Dodoma, it is the rollout costs which are significant, minus the hardware costs – this leaves the expenditure lines for meetings, training and deployment (it also seems relevant to include the small amount for supportive supervision here).

Region specific costs

This analysis allows us to isolate and compare the rollout/implementation cost for each region (Table 13)

Table 13: Summary of rollout costs by region

	Arusha	**Tanga**	**Kilimanjaro**	**Dodoma**
Meetings	US$8,728	US$9,783	US$7,097	
Training	US$33,232	US$20,686	US$17,148	
Deployment	US$146,701	US$162,353	US$103,617	
Supportive supervision		US$6,178	US$8,786	
Total: Region specific costs	US$188,661	US$199,000	US$136,648	US$89,795

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[84] Deployment = Per diems, lodgings and transport associated with deployment of the EIR to the health facilities and district immunization offices. Transport includes vehicles purchased (one for each country) and expenditures for fuel and maintenance of these vehicles; also includes hiring other vehicles used for the deployment.

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The spending in Dodoma was two-thirds of the rollout spending in Kilimanjaro – both regions have seven districts, but Dodoma has 10% more facilities. "Deployment costs" – i.e. costs for visiting health facilities and district offices – largely account for the higher costs in Kilimanjaro (and even higher costs in Arusha and Tanga).

These cost comparisons are not exactly comparing like with like. However, we do think they are broadly comparable, especially because neither includes core staff (PATH or JSI/InSupply). The BID costing has a separate line item for BID Initiative staff. The Dodoma figures do not include JSI headquarters costs or level-of-effort estimates for local staff.

Commentary on findings from the special study

For this special study on Dodoma Region, the evaluation team was asked to address four sets of questions relating to the design of the IMPACT Team approach, its contribution to results, relative costs and lessons that could inform scale-up and sustainability.

Using a realist analytical framework, the evaluators reviewed the intervention mechanism to investigate the IMPACT Team approach. We noted that distinctive features of the approach included a classroom-based trainer of trainer intervention, along with formation of District-based IMPACT teams for data-driven quality improvement to attain a shared immunization goal. We found that while many aspects of the approach were well received, some potential benefits of the IMPACT Team approach were hampered by unreliable data quality in the EIS (especially in EIR data uploads to the district level) and difficulties in institutionalising structured data review meetings.

In keeping with our scope of work, our review of contributions of the IMPACT Team approach to results focused on intended outcomes from the BID Initiative as defined in the BID results framework. This defined intended outcomes in terms of data quality, data use for decision-making, scale-up and country ownership and resource commitments.

At facility level, we found that data quality in the EIR was highly compromised by lack of completeness of the data. This was mostly because the EIR is not being used for every eligible client. Factors contributing to this were: hardware problems (e.g. faulty tablet computers), software issues (often associated with slow speeds and failure to install successive updates); availability of internet bundles and barcodes; and human resource constraints (e.g. insufficient numbers of staff fully trained in using the EIR). While the EIR continues to be used alongside the IVD legacy system, these factors all mitigate regular and consistent use of the EIR – especially in busy clinics. Moreover, at district level, DIVOs understand that the EIR data is unreliable, so continue to use the paper-based IVD reports to populate VIMS on a monthly basis. Arguably, this perpetuates something of a vicious circle, where lack of dependence on the EIR reduces incentives to actively address usage challenges. It is unlikely that the IMPACT Teams will shift this status quo without strong directive leadership from regional and national levels – this, in turn, will probably depend on some basic operational challenges with the EIR being resolved.[85]

Our investigation of data use for decision-making focused mostly at the facility level. Here, we gave particular attention to assessing staff proficiency in using the EIR to enter, retrieve and interpret data. Our sample was small but, overall, it appeared data use skills were higher in Bahi District. The fact that Bahi District also performed well in IVD reporting suggests it may be benefiting from an existing culture of good reporting practice. In Dodoma Urban, high churn in the DIVO leadership, hardware challenges and delayed procurement of internet bundles may have limited the effectiveness of the IMPACT Team in promoting the EIR for improved data use practices.

Our interviews on country ownership and buy-in for scale-up confirmed that IVD program leaders regard the IMPACT Team approach as a progression from the DDUM approach. It is clear that involvement of

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[85] Recent experience from Tanga Region on how to facilitate this shift is likely to instructive.

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government officers in rollout has been highly advantageous for ownership and has helped to build the capacity needed for a sustainable government-led approach. The formation of IMPACT Teams has the potential to create peer support networks and quality improvement practices that extended beyond the role of mentors (the DDUM approach); however, stakeholder suggest these benefits are unlikely to be realised without ongoing change management support.

The analysis of costs associated with the IMPACT Team approach suggests it offers an economical alternative to the DDUM approach for scale-up. Cost savings appear to derive from a smaller [InSupply] team that provided highly structured inputs at defined intervals over a shorter timeframe. However, it remains difficult to draw definitive conclusions on the cost-effectiveness of the IMPACT Team approach because, like for the DDUM approach, it has not been possible to align inputs to convincing improvements in intended results. Moreover, while the IMPACT Team approach has been delivered relatively cheaply, several key informants suggested it needs to be accompanied by more follow-up training and support to be fully effective.

We understand that, for scale up to other regions, government is now trying a variation on the IMPACT Team approach, in which representatives from each health facility are trained to champion and support the rollout of the BID Initiative in their respective facilities. Unfortunately, it is beyond the scope of work of the evaluation team to review this variation on the implementation strategy.

A number of lessons from implementation of the IMPACT Team approach were documented earlier in this report. Some additional *tentative* lessons emerging from our results analysis are summarized in the Box below.

Box 9: Additional (tentative) lessons emerging from the results analysis

- An existing institutional culture of strong data reporting may be a factor in success when implementing the IMPACT Team strategy. Experience from Bahi District suggests that the relatively successful uptake of the BID Initiative in this district could be linked to an existing culture of diligent and accurate immunization reporting and this, in turn, could be linked to the presence of supportive and stable leadership.

- The IMPACT Team approach is associated with economy and efficiency, but additional inputs might be needed to increase its effectiveness. The evaluators' costing analysis pointed to considerable cost savings associated with the IMPACT Team approach – probably due to a highly rationalised delivery approach and a focus on intensive but time-limited inputs to establish and train the IMPACT Team. Stakeholder feedback suggested that, while this approach delivered well on the core elements of the BID Initiative, it could be strengthened by more follow-up support and stronger linkages to other change management initiatives.

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Annex 4: Reflections on the BID theory of change

The BID theory of change provides an additional conceptual framework for identifying lessons from the Tanzania experience. The BID theory of change is based on an overarching primary hypothesis. This posits that the BID package of interventions (which includes an EIR, data use and stock management initiatives) will lead to improved immunization data quality and use at scale in two demonstration countries; this, in turn, will lead to commitments and resources for further scale-up in new countries. Based on the evaluation work to date, the evaluators have concluded that the evidence for the primary hypothesis is inconclusive. The BID theory of change also includes a number of secondary hypotheses. Table 14 summarizes the evaluators' reflections on these secondary hypotheses based on the evidence from the milestone evaluations.

Table 14: Evaluators' review of secondary hypotheses in the BID theory of change

BID Hypothesis	Evaluators' reflections
1. There are packages of interventions that can be assembled and adapted locally to address major [immunization data] challenges.	• Adaptation of packages to local contexts needs considerable time and investment as all components of the package (e.g. EIR software, stock management solutions) need to be customized to the local health systems context and user needs at each system level.
2. Improved data use will influence data quality, and vice versa.	• Experience from Zambia and Tanzania suggests data quality and data use are likely to be linked; however, sustainable change in data use activities will ultimately depend on the availability of good quality data and on health workers having the training and time institutional support to look at data and understand what it means.
3. Better information will lead to better decisions, which will lead to better health outcomes.	• In Zambia and Tanzania, the interventions were not sufficiently advanced to generate evidence to test this hypothesis. Tanzania's 2017 HSS proposal to Gavi describes the multiplicity of factors constraining the effectiveness of the IVD program. The BID Initiative has also illustrated that the political economy of health sector decision-making in Zambia and Tanzania is complex, and not determined by data quality alone.
4. Early and sustained government and user engagement at all levels of the health system will result in contextually appropriate, acceptable, sustainable, and feasible solutions that can be scaled within and across countries.	• Evidence from the milestone evaluations is consistent with this hypothesis but highlights the considerable time and flexibility required to identify all key stakeholders/data users at each structural level, and to sustain the level of involvement necessary. Stakeholder engagement also needs to translate into country ownership, buy-in and active participation. Experience from the BID Initiative also suggests that, in LMICs such as Zambia and Tanzania, stakeholder engagement might also need to be accompanied by major investments in capacity development (IT and end user).
5. Creating strong linkages between the different levels of the health system along the continuum of health care from health facility to	• Evidence from the milestone evaluations is consistent with this hypothesis but highlights the need situate the EIR solution within the wider information systems

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	national level will provide the cohesiveness and coordination essential for the effective scale up of a BID solution.	architecture. Strong leadership and coordination is required to create linkages to other relevant initiatives, and needs to operate horizontally, as well as vertically. The patient-centric approach underpinning the BID interventions may also need values clarification and significant institutional change.
6.	Countries share common problems and approaches to immunizations; therefore, the design of common solutions should be possible and will increase impact and save money over time.	• Evidence from Zambia and Tanzania suggests that, while countries may face common data quality and use challenges, it will take more time and investment to identify common or generic solutions. Open IZ software appears to have good potential for providing a standard EIR platform, but it will still need to be customized to local user needs. There may be inherent tensions between a generic data driven approach and meeting local user needs through co-design processes.
7.	Providing a credible proof of concept, demonstrating impact, and including a total cost of ownership (TCO) model for the BID solution will affect buy-in from national governments and external funders to the extent that they will commit resources to scaling up the BID solution.	• These are important principles, but stakeholders need to agree from the outset what constitutes proof of concept, and the transition steps from the legacy system. Furthermore, extended costing studies (that include costs to government and compare costs by outcome level results) are needed to provide credible data on total cost of ownership for different versions of the BID package across a range of implementation settings.

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Annex 5: Panel sample of health facilities

Panel sample of health facilities in Southern Province, Zambia

Livingstone District

Facility name	Type	Ownership	Catchment population	Distance from district HQ (km)
Libuyu	Urban Health Centre	Government	18,616	6
Linda	Urban Health Centre	Government	11,847	3
Boma	Hospital Affiliated Centre	Government	10,154	3
Nakatindi	Rural Health Centre	Government	5,077	12
Mahululu	Rural Health Centre	Government	1,692	35
Dambwa North	Urban Health Centre	Government	8,462	5

Kazungula District

Facility name	Type	Ownership	Catchment population	Distance from district HQ (km)
Makunka	Health centre	Mission	10,570	56
Mukuni	Health centre	Government	8,456	17
Nyawa	Health centre	Government	11,627	124
Siakasipa	Health post	Government	3,171	48
Sinde	Health post	Government	3,171	38
Sons of Thunder	Health post	Private	N/A	23

Sinanzongwe District

Facility name	Type	Ownership	Catchment population	Distance from district HQ (km)
Buleyamalima	Health centre	Government	11,405	28
Maamba Hospital*	Hospital Affiliated Centre	Government	107,695*	35
Siatwinda	Health centre	Government	9,682	69
Sinazeze	Health centre	Government	11,845	17
Sinazongwe	Health centre	Government	12,094	1
Sulwegonde	Health centre	Government	3,845	89

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Panel sample of health facilities in northern Tanzania

Arusha City (Arusha Region)

Facility name	Type	Urban/rural	Volume	Ownership
Ngarenaro Health Center	Health center	Urban	High	Public
St. Elizabeth Hospital	Hospital	Urban	High	FBO
Daraja mbili Health Center	Health center	Urban	High	Public
Arusha Center for Women	Hospital	Urban	High	Private
Cannosa Dispensary	Dispensary	Urban	Low	FBO
Terrat Dispensary	Dispensary	Urban	Low	Public

Karatu District (Arusha Region)

Facility name	Type	Urban/rural	Volume	Ownership
Karatu Lutheran Hospital	Hospital	Rural	High	FBO
Karatu Health Center	Health center	Rural	High	FBO
Matala Dispensary	Dispensary	Rural	High	Public
Slahhamo Dispensary	Dispensary	Rural	Low	FBO
Mang'ola Juu Dispensary	Dispensary	Rural	Low	Public
Mang'ola Health Center	Health center	Rural	Low	Public

Longido District (Arusha Region)

Facility name	Type	Urban/rural	Volume	Ownership
Engarenaibor	Health center	Rural	High	Public
Gelaibomba	Dispensary	Rural	Low	Public
Namanga	Dispensary	Rural	High	Public
Enduimet	Health center	Rural	Low	FBO
Gelailumbwa	Dispensary	Rural	Low	FBO
Sinya	Dispensary	Rural	Low	Public

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Moshi Municipal (Kilimanjaro Region)

Facility name	Type	Urban/rural	Volume	Ownership
Maryland	Health center	Urban	TBC	Private
CCP	Health center	Urban	TBC	Min.of Defence
Pasua	Health center	Urban	TBC	Public
Bondeni	Dispensary	Urban	TBC	Public
Shirimatunda	Dispensary	Urban	TBC	Public
St. Joseph	Hospital	Urban	TBC	Public

Mwanga District (Kilimanjaro Region)

Facility name	Type	Urban/rural	Volume	Ownership
Mwanga HC	Health center	Rural	High	Public
Usangi District Hospital	Hospital	Rural	Low	Public
Langata Bora	Dispensary	Rural	High	Public
Mriti	Dispensary	Rural	Low	Public
Ngulu RC	Dispensary	Rural	Low	FBO
Kifula HC	Health center	Rural	High	Public

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Panel sample of health facilities in Dodoma Region, Tanzania

Dodoma Urban

Facility name	Type	Urban/rural	Volume	Ownership
Agakhan	Health center	Urban	High	Private
Amani HC	Hospital	Urban	High	NGO
Chololo	Dispensary	Urban	High	Public
Dodoma RRH	Hospital	Urban	High	Public
Mijuni Immaculate	Dispensary	Urban	High	FBO
UHC Makole HC	Health center	Urban	High	Public

Bahi District

Facility name	Type	Urban/rural	Volume	Ownership
Bahi HC	Health center	Rural	High	Public
Chiguluka	Dispensary	Rural	Low	Public
Ibugule	Dispensary	Rural	High	Public
Lamaiti	Dispensary	Rural	High	Public
Mnkola	Dispensary	Rural	High	Public
Mtitaa	Health center	Rural	High	Public

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