Evaluating the impact of electronic Logistics Management Information Systems (eLMIS) and electronic Immunization Registries (eIR) in low- and middle-income countries

TANZANIA

January 2023

NIMR - MMRC
Mbeya Medical Research Center

For questions, please contact: Viviana.Mangiaterra@sdabocconi.it

Presentation outline

Objectives

- Background to research and tool introduction
- Context of use of the tools
- Research study
- Findings
- Next Steps
- Limitations

Background

Background to the research

- The research forms part of a multi-country evaluation.
- **Topic:** The impact of electronic immunization registries (eIR) and electronic logistic management systems (eLMIS) in low and middle-income countries.
- **Project duration:** 2020 – 2022
- **Countries evaluated**: Guinea, Honduras, Rwanda and Tanzania.
- **Evaluation team** (Tanzania): Mbeya Medical Research Center of the National Institute for Medical Research (NIMR-MMRC), the University of Bocconi, MM Global Health Consulting.
- **Data collection** (Tanzania): October/November 2021
- **Sponsors:** Bill & Melinda Gates Foundation (BMGF), co-sponsored by the World Health Organization (WHO) and Gavi, the Vaccine Alliance.

BILL & MELINDA GATES *foundation*

World Health Organization

Gavi The Vaccine Alliance

Why was Tanzania selected as part of this evaluation?

- ✓ **Scale:** Both eIR and eLMIS tools scaled up to sufficiently wide geographical areas to allow for comparisons in implementation
- ✓ **Timeline:** Duration of use of the tools is sufficient to explore possible impact and to build off previous evaluations
- ✓ **Tools:**
  - ✓ Evaluation of both eIR (TImR) and eLMIS (VIMS)
  - ✓ Both tools satisfy basic requirements of an eIR and eLMIS

Tanzanian digitalization context

Despite strong political commitment, the lack of functioning electronic data exchange has impeded the implementation and use of electronic tools in the country to date

Tanzania eHealth Strategy 2013-2018

Prioritized establishing eHealth standards, rules, and protocols for information exchange and protection, as well as comprehensive health facility, provider and client registries

2013-2018

Tanzania Health Information Exchange 2014-2019

MoHCDEG, supported by USAID developed an integrated, interoperable health information system. It was to enable cross-program data exchange, leveraging off the existing Health Information System (HIS) that collects and reports data across multiple health programs.

2014 - 2019

Health Sector Strategic Plan 2015-2020

Focused on achieving interoperability and the rapid deployment of information and communication technology (ICT) for improving administrative processes, patient/client recording and reporting, and communication

2015-2020

National Digital Health Strategy 2019-2024

Aimed to strengthen digital health governance and leadership; improve client experience through efficient provision of high-quality health services; empower health care providers and managers to take evidence-based actions; sustain availability of human resources; and standardize information exchange.

2019 - 2024

Background to the introduction of the electronic tools

eIR: The eIR was a phased development process commencing in 2013 as a partnership between the MoH and the Better Immunization Data (BID) initiative.

eIR: In 2014/2015 the country piloted the Tanzania Immunization Information System (TIIS) in Arusha but experienced numerous challenges. The country then started to develop **Tanzania Immunization Registry (TImR)** which was piloted in Arusha in 2015.

eIR: TImR was officially released in 2017 and was rolled out to Arusha, Tanga, Kilimanjaro and Dodoma by end 2018.

eIR: By end 2020, TImR was rolled out to 15 of the 26 regions (3,736 HFs) and included 1,6 million records.

eLMIS: Vaccine Information Management System (VIMS) was launched in 2015 as a collaboration between MoH, BMGF, JSI, CHAI, PATH and Village Reach. It combined three preexisting supply chain management tools: the district vaccine data management tool (DVD-MT), the stock management tool (SMT), and the cold chain inventory tool. VIMS is an adapted module of OpenLMIS.

VIMS was pre-tested in 2016 in 7 regions, followed by a phased implementation in 15 regions, and then rolled out to all regions and districts in the country.

Integration of TImR+VIMS took place between June 2016 – January 2018, however challenges with the integration remained and have contributed to the tool/s being abandoned in many facilities and districts.

Use of the TImR+VIMS at health facility level

- The tool, referred to as TImR at HF level, includes both the TImR and VIMS i.e., HWs cannot access VIMS without the TImR interface at the HF
- Using TImR+VIMS, HWs can register and track children, and schedule individual immunization events and vaccination sessions
- The tool can automatically deduct a vaccine dose from the stock available every time a dose is administered and recorded in the TImR component; provide notifications on when there is low stock or a stock-out; predict vaccine stock quantities based on targeted population and the immunization schedule; provide visibility of vaccine stock levels to HWs at the HF level, and directly exchange data with the district level.
- While the system was designed to be able to send SMS reminders and serve as a platform for Adverse Events Following Immunization (AEFI) monitoring, these functionalities were not introduced immediately and are not functional today.
- To date, the TImR has not been linked to birth registries or to the Civil Registry or Vital Statistics (CRVS) database. There are discussions to link unique tool identifiers with national identifiers through the Registration, Insolvency and Trusteeship Agency (RITA), but timelines have not yet been established.

Introducing TImR+VIMS at health facility level

- When the TImR+VIMS (known as TIMR at HF level) was introduced, a back-entry process was initiated with all records included in HF paper-based registers to be entered into the TImR.
- HWs were required to register all children seen for vaccinations and to enter all vaccines the child had previously received. Unique identifiers, printed on barcode labels, were provided to caregivers to facilitate ease of access to the child's records for future visits. Details of immunization events were entered either at the time of vaccination or were to be back-entered at the end of the same day.
- Pilot implementation in Arusha showed that the back-entry process was neither reliable nor cost-effective and a decision taken to focus on new registrations only.
- The requirement of completing paper-based forms and reports was maintained; thus, all facilities completed dual data entry from the time of the tool introduction. While the intention was to replace the use of paper-based data collection tools, this has not yet been realized in most places and a combination of different systems currently exist across the country:
  - TImR+VIMS
  - TImR+VIMS+paper immunization registry (IR)
  - VIMS+paper IR

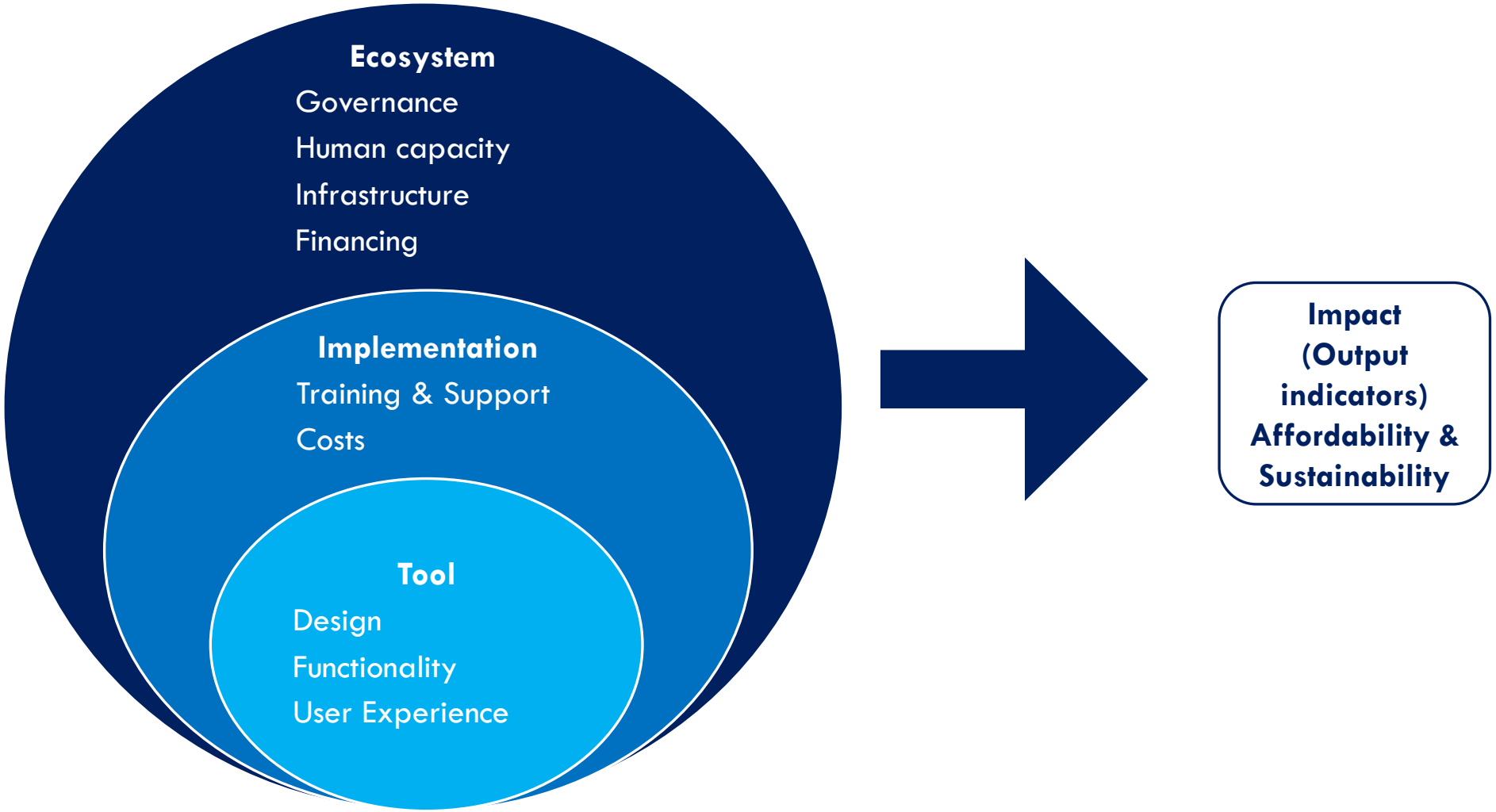
Evaluation Research

THEORY OF CHANGE (SUMMARY)

The Theory of Change (ToC) serves as the foundation for an evaluation framework used to guide the interpretation of the key findings

Vision	**Reduce morbidity and mortality from VPDs by enhancing equitable access to vaccines and strengthening immunization delivery within PHC**	
Mission	Improve immunization program performance by sustained use of the eIR and eLMIS	
Strategic Outcomes	**eIR**	**eLMIS**
	1. Functioning eIR as part of a broader health information system 2. Improved immunization data quality 3. Increased use of immunization data for decision-making 4. More efficient, affordable, and sustainable eIR use 5. Increased stakeholder satisfaction and engagement	1. Improved eLMIS functionality 2. Improved vaccine forecast accuracy 3. Improved inventory and stock levels (data use for decision making) 4. More efficient, affordable, and sustainable eLMIS use 5. Increased stakeholder satisfaction and engagement

Evaluation framework



Research questions

- Has the implementation of the TImR and VIMS improved immunization service delivery? *(Impact)*
  - To what extent do these systems comply with established norms and standards? *(Tool)*
  - What were/are the barriers and opportunities for implementing these systems? *(Tool, Implementation and Ecosystem)*
  - What was the impact of the TImR and VIMS on the national immunization program both in terms of process efficiencies and health outcomes (e.g., cost savings, performance, timeliness, coverage)? *(Impact)*
- What was the short- and medium-term economic and financial impact of implementing and scaling up these systems in the whole country? How affordable and sustainable are the systems? *(Impact, Affordability & Sustainability)*
- How interoperable is the TImR and VIMS with the national health management information and civil registration systems? *(Tool, Ecosystem)*
- How can new evidence on tools and technologies, modalities, and governance of the TImR and VIMS inform further investments from domestic sources, health financing institutions and technical partners for the sustained implementation of these systems? *(Impact, Ecosystem, Affordability & Sustainability)*

Methodology: Programmatic impact evaluation

- A mixed methods approach involving both quantitative and qualitative methods.
- Impact was evaluated in terms of service delivery processes including data quality, data use for decision-making, program and process efficiencies including vaccine stock levels, as well as user experience and perception of the tool by HWs and their clients (in line with the ToC).
- The evaluation aimed to identify and explore factors critical for the successful implementation and further scale-up of the electronic tools.
- Accuracy between different records and competency of users were also assessed.

List of data collection tools

Data collection instrument	Health facility	District	Region
Interview guide	61	30	10
Competency assessment	25		
On-site accuracy check	62		
Health worker survey	60		
Caregiver interview guide	81		

Note: The programmatic data collection instruments were adapted from pre-existing and validated tools including: the Modular Data Quality Assessment Protocol with Electronic Immunization Registry Component (PAHO, 2017); a range of data instruments used in the Evaluation of the Better Immunization Data Initiative (Mott MacDonald, 2019); and the eIR Readiness Assessment.

Methodology: Economic impact evaluation

	Implementation costs of the TImR+VIMS	Routine operating costs of using the TImR+VIMS	Cost impact of using the TImR+VIMS (as opposed to using VIMS + paper IR)	Financial sustainability
Scope of the analysis	Costs of the VIMS and TImR for: (i) Design & development (ii) Initial roll-out (iii) Scale-up (iv) Continuous improvement	Routine economic costs related to the management of immunization and vaccine stock data using TImR+VIMS	Difference in the operating costs of managing immunization data with TImR+VIMS as compared to the use of VIMS + paper IR; broader impact of using TImR+VIMS on pre-specified costs related to immunization service delivery	Maintaining the continuous operations of TImR+VIMS, using domestic resources
Type of analysis	Descriptive analysis	Activity Based Costing analysis of users	Activity Based Costing analysis of users compared to non-users – subgroup analysis by user groups and rural vs urban facilities	Descriptive and comparative analysis. Analysis of the total cost of the system based on the Activity Based Costing analysis
Source of data	IVD Department MoHCDGEC, PATH, JSI	Questionnaires, HFR data	Questionnaires, HFR data	International Monetary Fund (IMF), WHO, Immunization Costing Action Network (ICAN) estimates

Activity-Based Costing (ABC)

Collection of data through questionnaires on :

Direct costs

- Annual frequency of performing each activity
- Number of staff and their profile (salary) performing the activity
- Time spent to perform each activity
- Additional costs such as for consumable goods (fuel, paper costs for printing), services (transportation fares, per-diems, etc.) and durable goods (cables, spare parts for maintenance)

ACTIVITY-BASED COSTING (ABC)

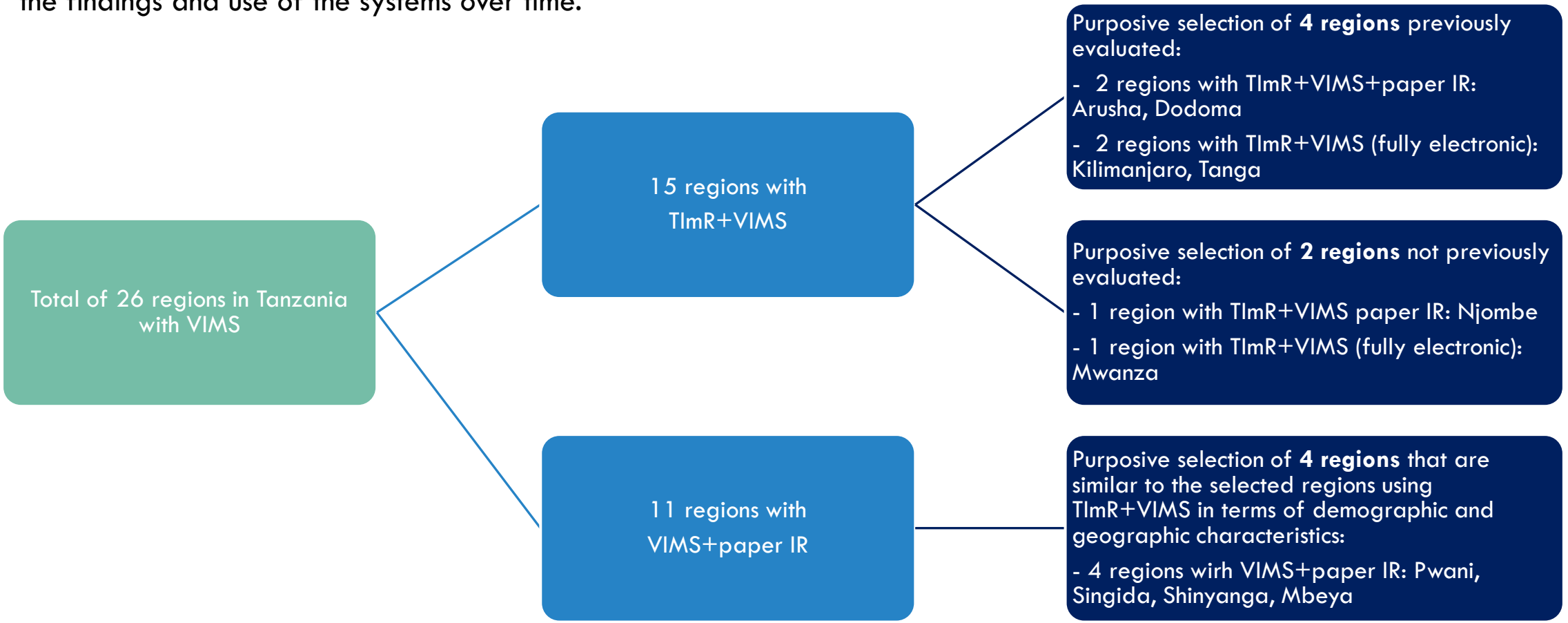
Activities impacted by the implementation of the tools

Activity	Description
Vaccination session execution: Child registration	Time spent entering details and data regarding a new child registration (including service provision and data management, finding client folder and event recording).
Defaulter identification	Reviewing registry to identify children who missed appointments, making list of defaulters
Defaulter contacting	Contacting defaulters to remind caregivers of missed vaccinations
Organizing outreach sessions	Preparation for the delivery of vaccination in outreach settings
Identifying performance gaps	Reviewing data to find performance gaps (such as HFs not being on track for coverage goals)
Report generation	Time taken to search for and record data that will be included in the regular reports on immunization services and stock management.
Report transportation	Physical transport of weekly/monthly reports to higher administrative level for submission
Vaccine quality control/ monitoring	Physical counting, recording, and checking of closed vaccine vials for expiry dates or temperature excursions. Physical counting, recording, and checking of any open vials.
Cold Chain monitoring	Data entry of records of the refrigerator or freezer temperatures
Determining quantities of vaccine to order	Data mining and information extraction from dispensing/vaccine use and storage system and processing it to prepare the next order
Refresher trainings	Recurrent trainings provided to HF staff on recording and reporting of immunization data, whether using paper or electronically
Technical and/or administrative support visits	Recurring visits from higher health system levels for supportive supervision and technical assistance in immunization service delivery

Sampling

A purposive sampling strategy was used to identify a representative sample of regions, districts and health facilities

Selection considered the following: regions with anticipated full electronic use of the TImR+VIMS; regions which used TImR+VIMS together with a parallel paper-based IR; and regions which had not yet introduced TImR and were only using the VIMS. All regions where previous evaluations of the systems had taken place were included to allow for comparison of the findings and use of the systems over time.



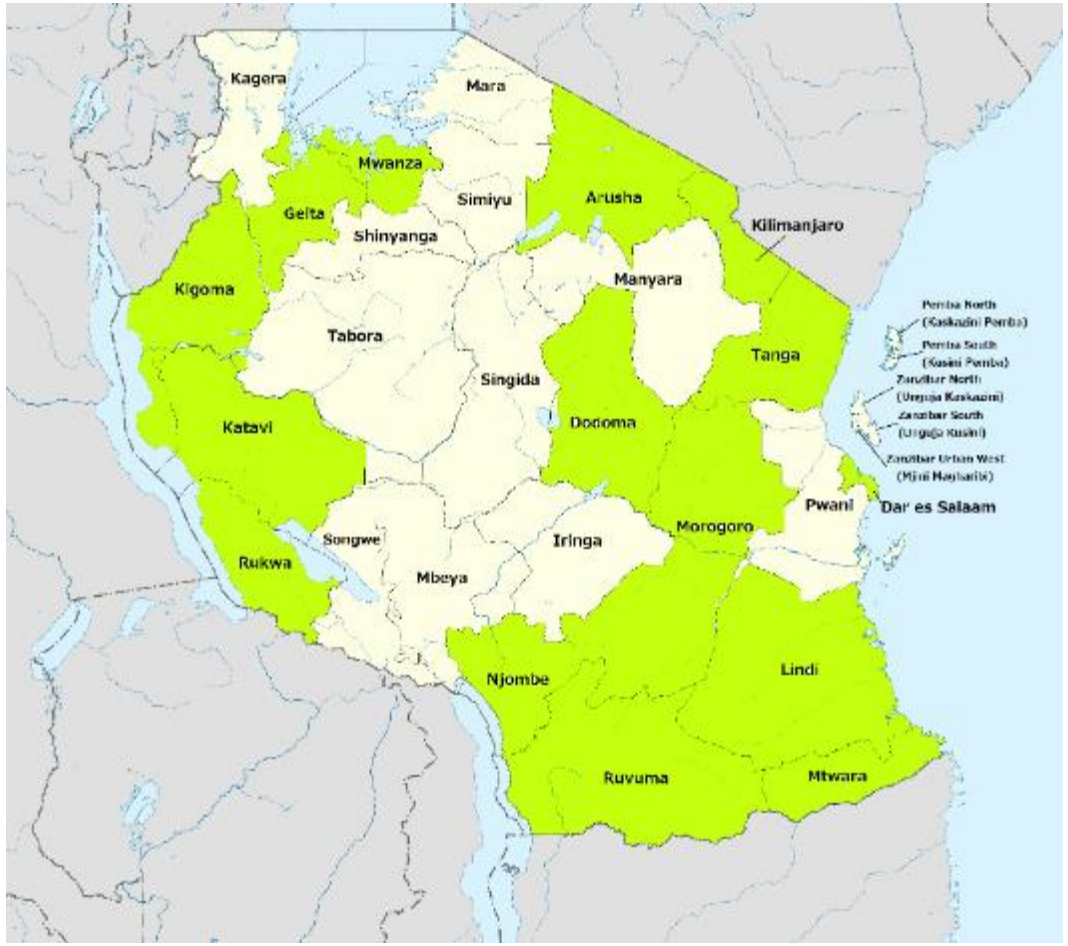
Sampling strategy continued…

Pairing regions: Regions using the TImR+VIMS were paired with regions not using the tools which were as similar as possible in their demographic and other characteristics, all of them neighboring regions. The number of regions in each group was proportional to the number of regions with and without the intervention in the whole country.

Sampling criteria: Within each selected region 3 districts were randomly selected, and within each selected district, 2 HFs were purposively selected. Criteria for the latter selection included: location (urban or rural); level of HF (hospital, health center, dispensary, etc.); and size of HF catchment area.

Sample size: The resulting sample included 10 regions, 30 districts and 61 health facilities. One additional health facility was visited in Dodoma Region, a region which had stopped using the TImR to allow for additional insights into the decision to discontinue use.

Representativeness: The HF sample can be considered representative of the overall sampling frame of HFs in the selected regions. Some minor discrepancies may have been due to the HFs needing to deliver immunization services at the time of the visit. A larger proportion of hospitals was sampled as at least 1 hospital per pair of regions was to be included in the sample. As 80% of the sites delivering vaccination services in the sampled regions were dispensaries, 46 dispensaries (representing 75% of the sample sites), 10 health facilities, and 5 hospitals were included.



Regions in Tanzania with TImR+VIMS (green)

Methods

Ethical approval: The evaluation protocol and data collection instruments were submitted for ethical approval by NIMR-MMRC and ethical clearance was obtained on 2 September 2021 under the procedures set by the Tanzania Commission for Science and Technology (COSTECH).

Field work: Data collection was coordinated by NIMR-MMRC and executed over a period of 3 weeks in October and November 2021, following training of data collectors and piloting of data collection tools. Five teams of 3-4 members each visited two paired regions, one with the electronic tools in use and the neighboring region as 'control'. In each region all selected districts and health facilities were visited, and all interviews and observations conducted.

Teams were composed of an experienced MMRC team lead, a trained and competent data collector and a driver. Each team also included a senior expert from the MoH, familiar with the regional immunization system and with access to sources of relevant immunization data. Data collectors were fully trained on all aspects of the protocol and the administration of the questionnaires and data collection forms and equipped with the necessary technical evaluation tools such as electronic tablets.

Data collection and analysis: Data were entered on-site using the open-source data platform Open Data Kit (ODK). Daily reports of all collected data were sent to the NIMR-MMRC headquarters in Mbeya where a senior data analyst reviewed data for quality and completeness and provided immediate feedback in case of missing or unclear data. Data were cleaned and compiled by senior NIMR-MMRC staff with remote assistance by the Bocconi - MMGH team. Additional data were collected, specifically related to the costs of implementation as well as on immunization-related indicators from government and development partner sources. Data were analyzed by Bocconi - MMGH staff in close collaboration with the NIMR-MMRC team using Microsoft Excel, with the 'Datawrapper' tool used for data visualization.

Users and non-users

To allow for cross-country comparisons, a health worker survey was used in all countries to identify users and non-users. It was based on the Modular DQA tool with eIR component (PAHO, 2017). This survey has six domains: computer literacy, infrastructure, information quality, IT service, use, and user satisfaction. Categorization of users was based on the data derived from the 'Use' domain.

In Tanzania, the health worker survey confirmed the user groups identified a-priori:

- TImR+VIMS (fully electronic)
- TImR+VIMS+paper IR
- those no longer using TImR+VIMS

Questions of the domain 'Use'

*Note at HF level, TImR includes TImR+VIMS

1. I frequently use the TImR for my tasks
2. I am dependent on the TImR for at least one of my assigned tasks
3. Our facility regularly uses TImR to generate our monthly reports
4. Our facility regularly uses the TImR to generate a list of defaulters
5. Our facility regularly uses the TImR to generate recall or reminder messages for parents
6. Our facility regularly uses the TImR to generate new records of immunization for children that have lost their child health card
7. Our facility regularly uses the TImR to record stock transactions (receipts, issues, wastage)
8. Our facility regularly uses TImR to identify near-to-expiry vaccines
9. Our facility regularly uses TImR to order new supplies
10. Our facility regularly and correctly monitors cold chain equipment (refrigerator) temperature using remote temperature monitors that send data to VIMS

Findings

Implementation Status
User Characteristics

Implementation Status

Only 1/3 of HF's expected to be using the TImR+VIMS were still using the tool

The evaluation revealed that contrary to available information, the VIMS+TImR was in use in only three (i.e., Kilimanjaro, Mwanza and Tanga) of the six regions (the above plus Arusha, Dodma, Njombe) anticipated to be exclusively transitioning to fully electronic use of VIMS+TImR.

Only two of the six sampled HFs in Kilimanjaro and three of the six sampled HFs in Mwanza were found to be in fully electronic mode.

System implementation was variable in the remaining districts and HFs of the three regions, with some using VIMS+TImR+paper IR and others using only the VIMS+paper IR. In Arusha region, the VIMS+TImR was used in parallel with a paper IR. The regions of Dodoma and Njombe which had introduced TImR in 2019 had since abandoned the use of VIMS+TImR and reverted back to only using the VIMS together with a paper IR.

	Users		Non-users	
Level	TImR+VIMS	TImR+VIMS + parallel paper IR	VIMS + paper IR (no longer using TImR+VIMS)	VIMS + paper IR (never used TImR+VIMS)
RIVO (n= 10)	3	1	4	2
DIVO (n= 30)	7	1	10	12
HF (n=61)	5	10	21	25

User characteristics

The TImR+VIMS was designed for use by clinical HF staff and by DIVOs and RIVOs at district and regional offices.

Respondents were almost equally split between rural and urban locations.

HF respondents were primarily clinicians.

When comparing HF users and those no longer using the tool, users were more likely to:

- consider themselves adequately trained
- have access to support from the district (or elsewhere)
- receive more frequent supportive supervision

DIVOs and RIVOs also reported having a clear understanding of roles and responsibilities related to the use of electronic tools.

User characteristics		Users		Non-users	
		VIMS+TImR-only	VIMS+TImR + paper IR	No longer VIMS+TImR	Never VIMS+TImR
Location of HF	Rural (n = 34)	40%	50%	57%	60%
	Urban (n = 27)	60%	50%	43%	40%
Role within immunization services (at HF)	Data manager (n=1)			5%	
	Clinical staff (n=60)	100%	100%	95%	100%
Access to support from the district or elsewhere	HF (n=61)	100%	90%	20%	
Frequency of immunization supervision activities	Once a month	40%	10%	19%	4%
	Once a quarter	40%	80%	33%	76%
	At least once a year	20%		33%	16%
	None		10%	14%	4%
Use of VIMS/VIMS+TImR to inform supervision	HF (n=61)	100%	70%	76%	64%
	District (n=30)	71%	100%	70%	67%
	Region (n=10)	67%	100%	50%	100%
Adequately trained on VIMS+TImR/VIMS	HF (n=61)	60%	40%	20%	NA
	District (n=30)	100%	100%	50%	50%
	Region (n=10)	67%	0%	50%	75%

User characteristics continued…

Results of the HF survey indicate that:

- Computer literacy was not a barrier to implementation
- Access to infrastructure facilitated more frequent use
- Those using both the TIMR+VIMS with or without a parallel paper IR had a higher perception of information quality than those no longer using the tool.
- No longer users perceived the quality of IT services received as very low, while frequent use, particularly exclusively electronic, was associated with better access to quality IT services
- User satisfaction is greatest amongst users of the exclusively electronic tool.

Whilst there was no consistent difference between rural and urban users in computer literacy and IT services, urban users had better access to infrastructure, used the tool more regularly. Overall satisfaction with the fully electronic tool was slightly higher in rural areas.

HW perception based on location of use (%)

	Computer literacy	Infrastructure	Information quality	IT service	Use	User satisfaction
VIMS+TImR	100	82	86	92	85	94
Rural	100	67	92	94	73	100
Urban	100	88	84	92	89	92
VIMS+TImR+paper IR	93	86	93	82	79	92
Rural	96	83	91	81	74	86
Urban	91	88	95	82	84	97
No longer TimR+VIMS	93	52	58	18	7	64
Rural	93	56	67	28	13	69
Urban	93	49	50	8	2	58

Findings

ECOSYSTEM

Ecosystem

- **Governance and policy:** The country has had strong political will, a well-established strategic framework, and experience in implementing other IT solutions in the health sector. It also had strong partner involvement which facilitated the introduction of these tools, but which also have impacted the ability of the country to self-sustain these interventions.
- **Human capacity:** The specialized knowledge to support and maintain the tools does not exist within the Ministry of Health. The heavy reliance on external software developers has hindered the ability of local staff to respond to the technical challenges experienced by HWs. The MoH staff trained by the developers are no longer in their previous roles and were not able to respond to the maintenance and implementation requirements of the tools.
- **Standards & interoperability:** The integration between the eIR and eLMIS has experienced significant challenges. The tool is no longer sending SMS reminders and is not yet integrated with a CRVS.

"I didn't know I was supposed to continue with the tool. I thought it was a [partner] project and that it was over" – Health Facility

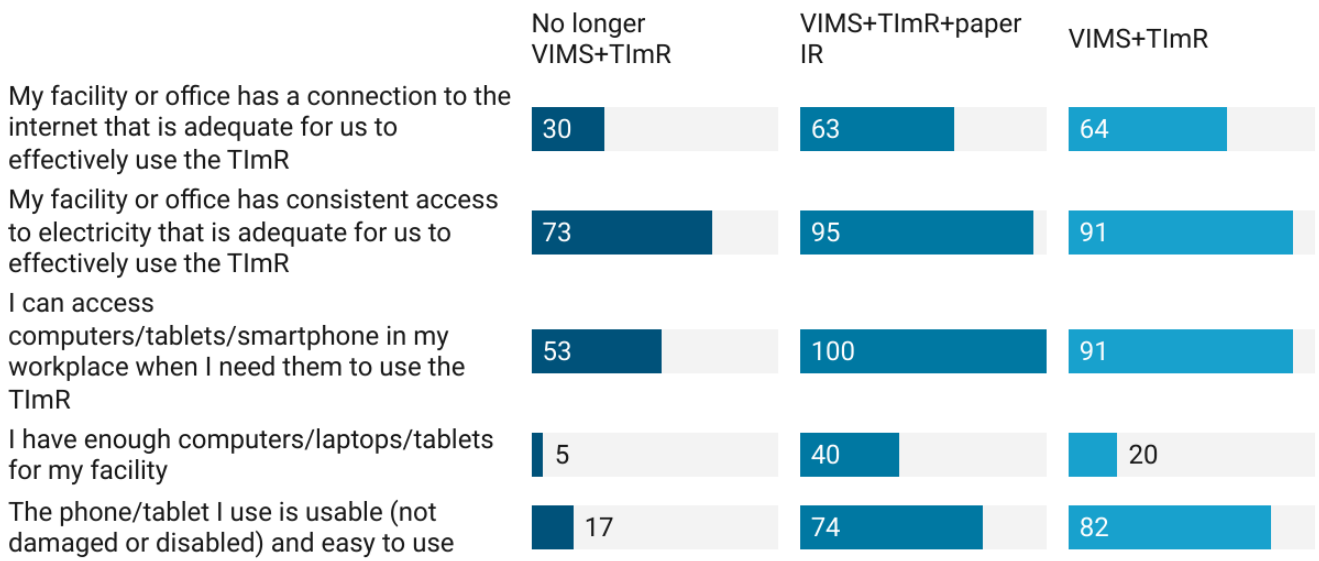
Ecosystem continued
Infrastructure

HF

- The biggest infrastructure challenge was access to the internet and data bundles (the majority of users had access to hardware when required, however, this was still considered insufficient).
- Users reported much better access to electricity, internet connectivity, and functioning hardware than those no longer using the tool.

DIVOs and RIVOs

- The greatest challenge was similarly access to the internet. The vast majority did not think they had sufficient hardware (data not shown).



"When the internet connection is good, using the tablet is quicker than paper" – Health Facility

Findings

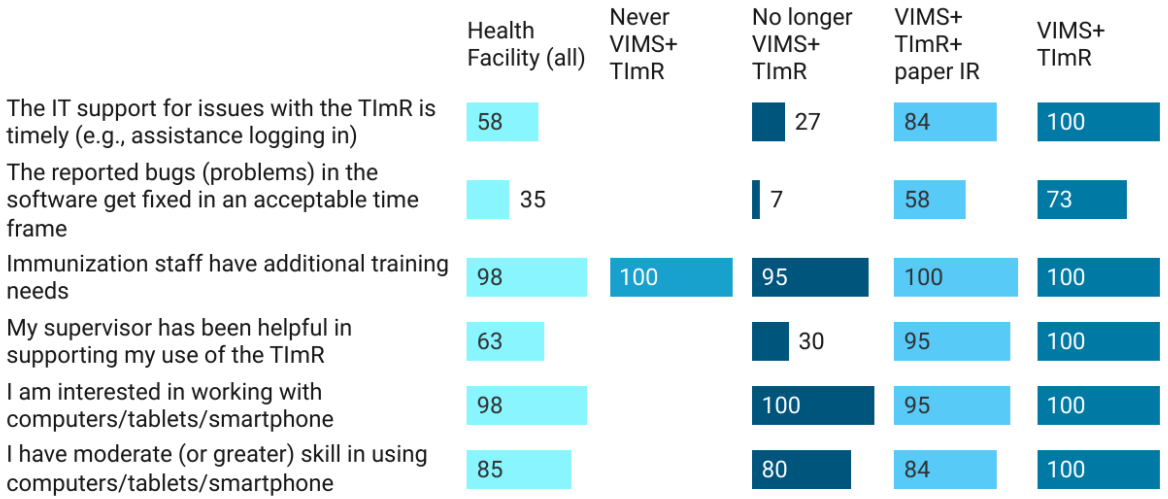
TOOL: TRAINING, SUPPORT & USER EXPERIENCE

Tool implementation

Training & support

- Users (both exclusively TIMR+VIMS and those using it in parallel with a paper IR) were more likely to consider the IT support as timely than those no longer using the tool. Those no longer using the tool also stated that that any software challenges were not fixed in an appropriate timeframe.
- Two-thirds of HF respondents - the majority of whom were users - thought their supervisors had been helpful in supporting the use of the tool. Those no longer using the tool were much less likely to think so.
- The majority of HF respondents were interested in working with computers; 85% thought they had moderate or greater IT skills and all respondents thought that IT hardware would support them to be more efficient at work.

HW perception of training and support (HF %)

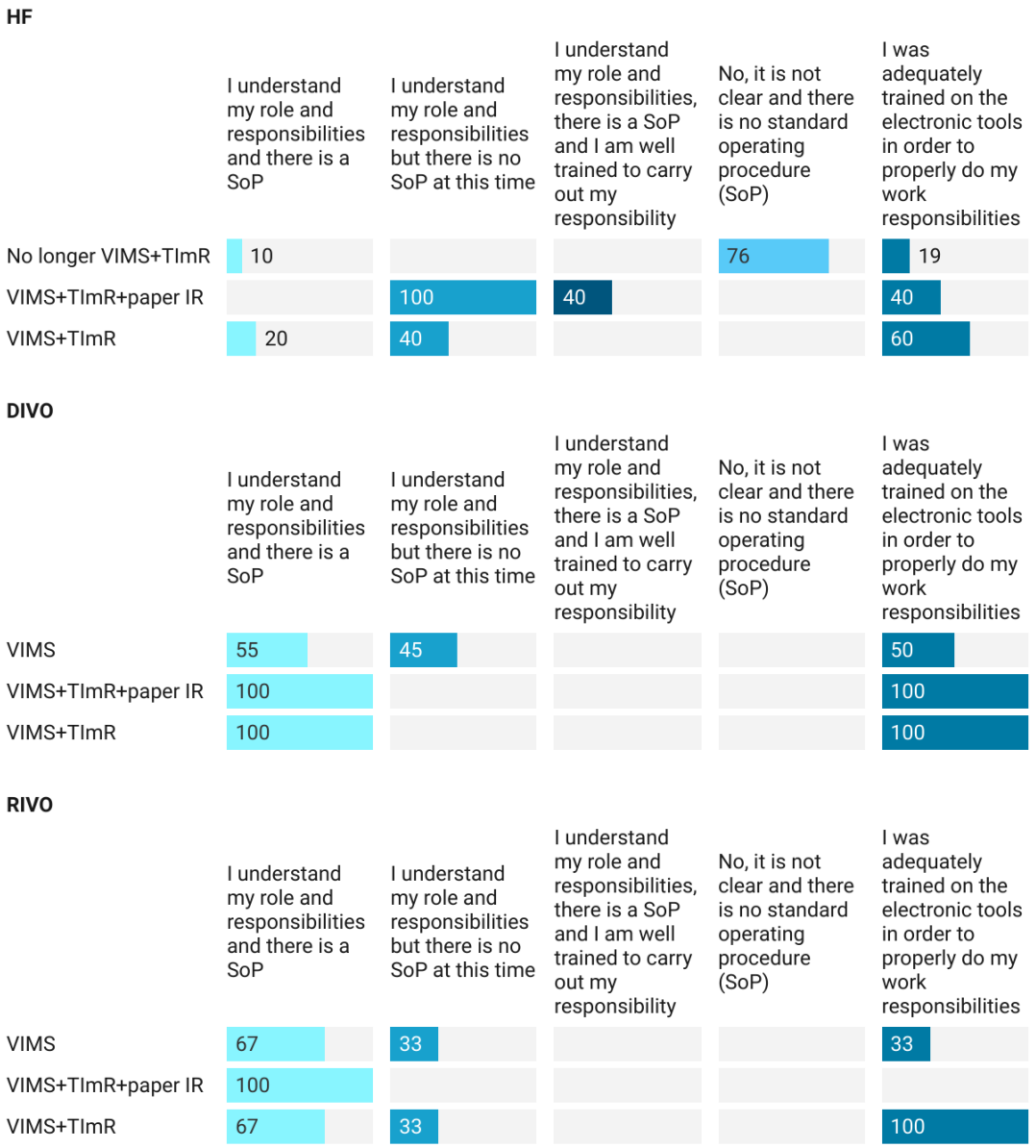


Tool implementation

Training & support

- More than half of HF users, and all district and regional respondents understood well their roles and responsibilities. However, standard operating procedures (SOPs) were not routinely available. Available training materials at HFs included job aids and instruction manuals. DIVOs and RIVOS largely had access to instruction manuals which, according to the DIVOs, needed to be updated.
- Almost all HF respondents had additional training needs, most commonly in data analysis, data recording, data reporting, and data collection. By contrast, all district-level TImR+VIMS users thought they had been adequately trained on the electronic tools while only half of the district-level VIMS-only users reported having received adequate training. At the regional level, TImR+VIMS users were more adequately trained than VIMS-only users.

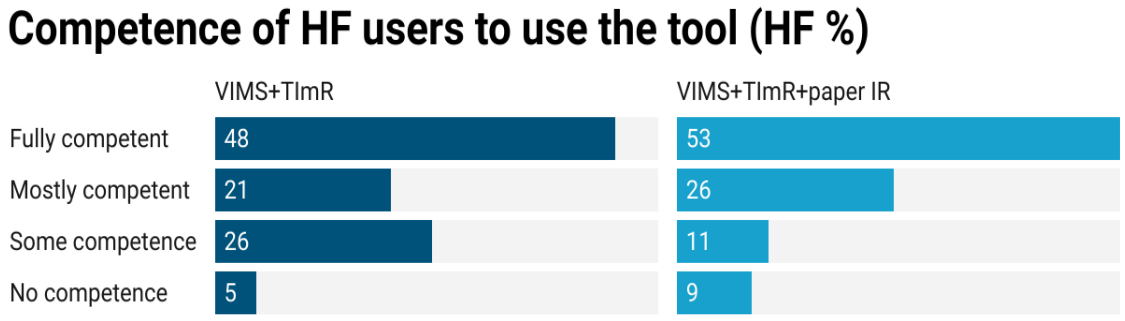
Roles, responsibilities, SoPs and training at health facility, district and regional levels (%)

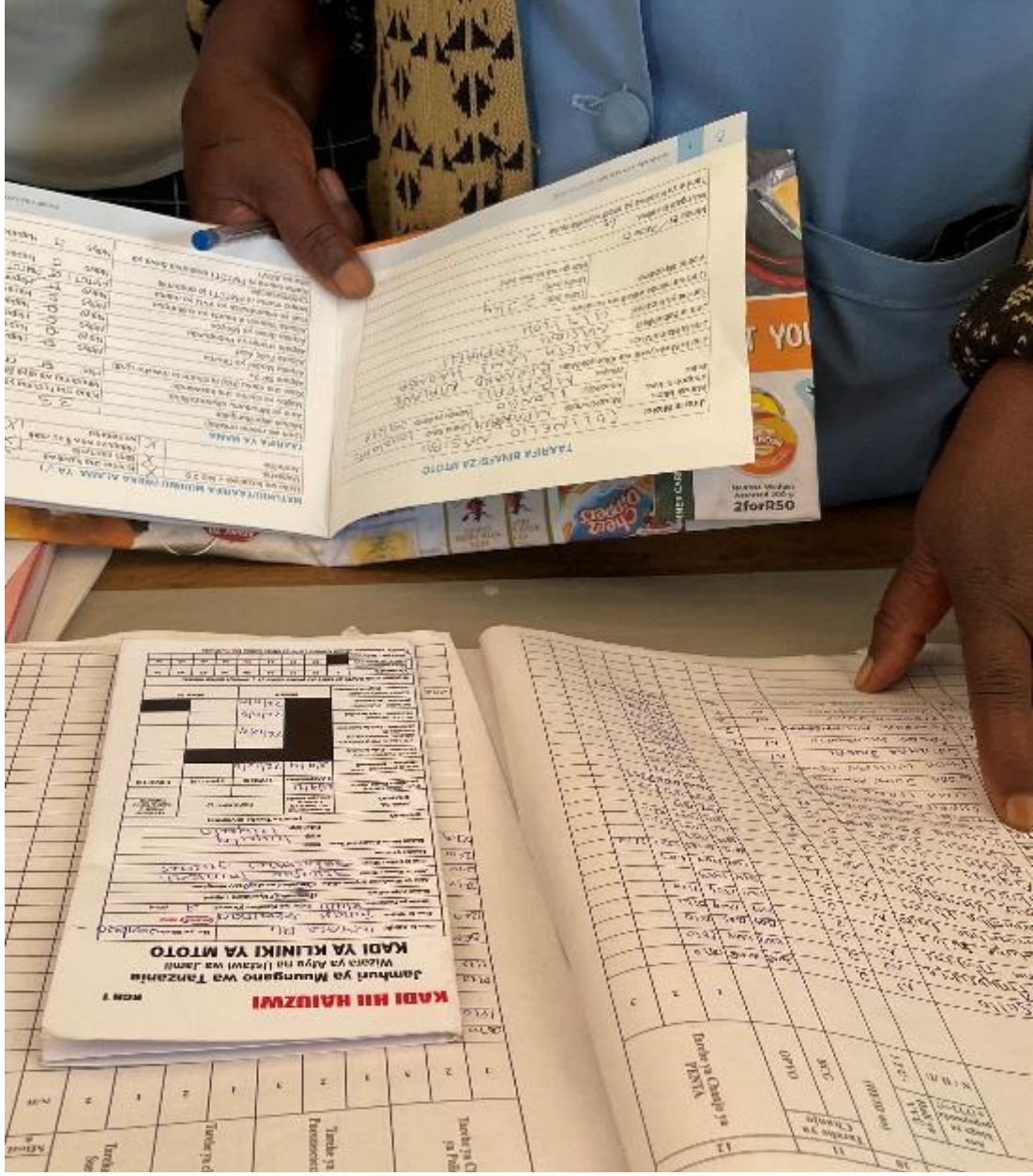


Competency assessment

The competency assessment was intended to be used at all facilities where the TImR+VIMS had been introduced (HF n = 36), however non-existence of the tool, or of electricity hindered completion of the assessment in some places. A total of 25 responses were assessed i.e., 9 responses from 5 HF exclusively using the VIMS+TImR, and 16 responses from the 10 HF using a parallel system, VIMS+TImR+paper IR.

TImR+VIMS+paper IR users appeared to be similarly competent compared to users with an exclusively electronic TImR+VIMS.





"…users are competent in using the system, however they were unable to generate the defaulter report, so we asked the DIVO to retrain them"– Health Facility

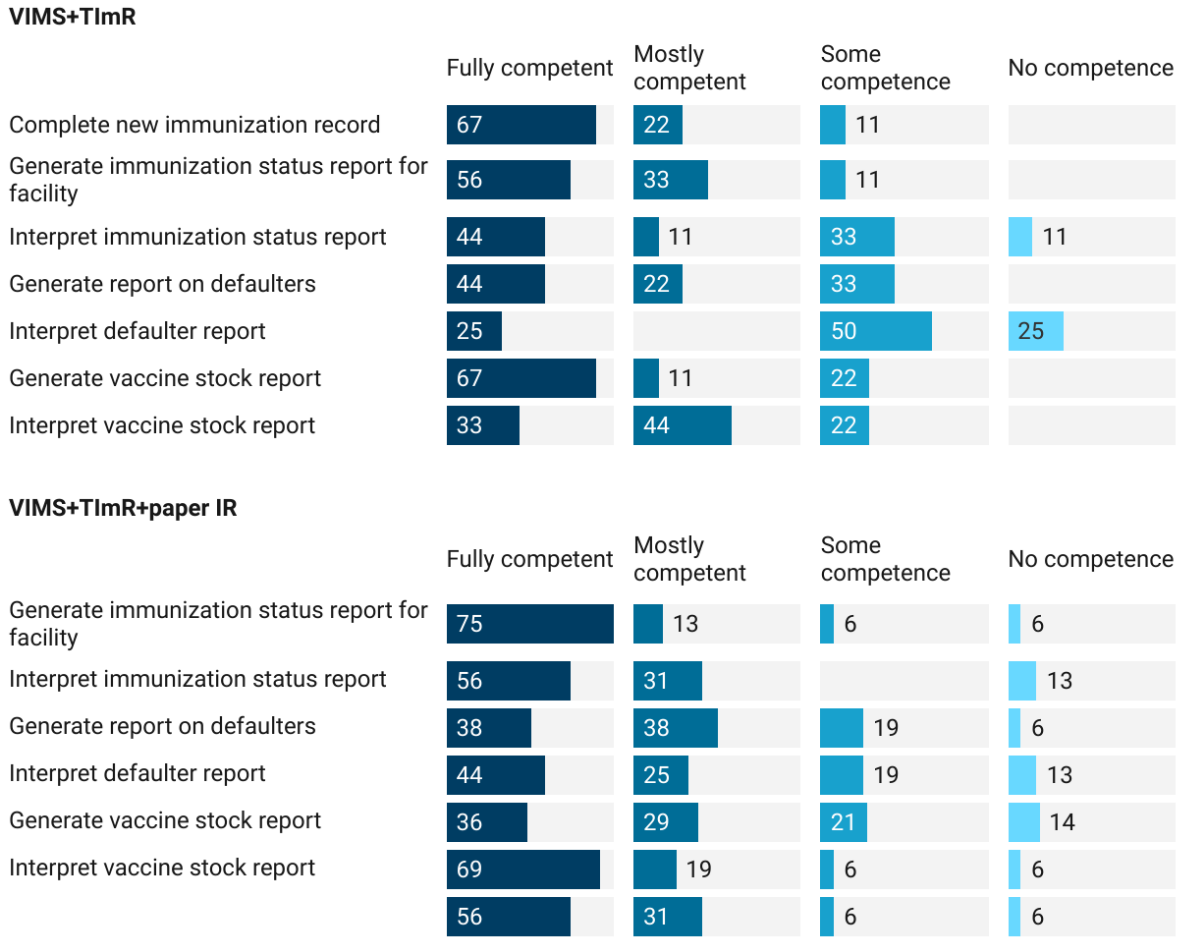
Competency assessment continued…

Users were more comfortable in generating reports, than in interpreting them.

HWs noted concerns regarding no orientation being received after new updates were done to the tool, and not being able to enter data instantly due to poor internet connection. Some HWs acknowledged that they were capable of using the tool, but that software challenges prevented them from using it (tool being very slow, poor synchronization and system “bugs”).

The DIVOs were acknowledged as supporting tool implementation.

Competency of different users groups (%)



Findings

TOOL: Functionality

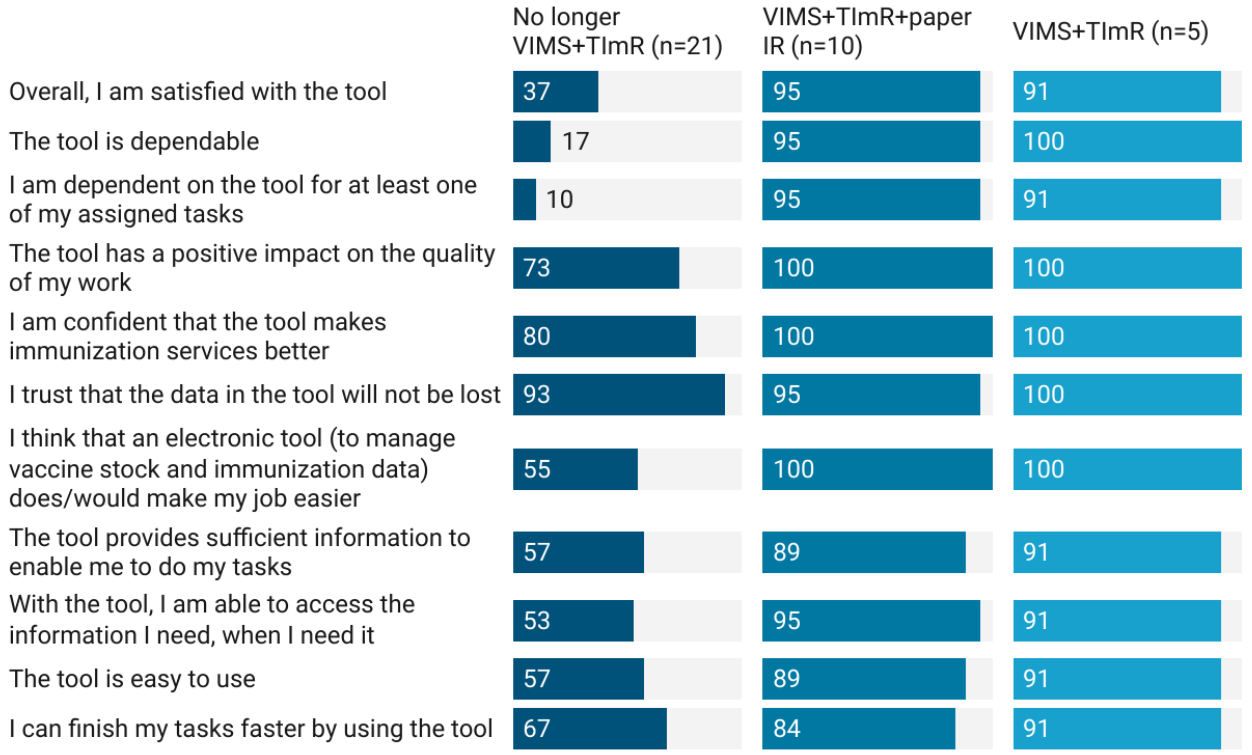
Tool functionality

User experience

Users (both using exclusively electronic tools and those using parallel paper IR) were more likely than those no longer using the tool to:

- be satisfied with the tool and to consider the tool to be dependable.
- think that the tool had a positive impact on the quality of their work whilst improving immunization services.
- trust that the data in the tool would not be lost and to feel that an electronic tool did make their job easier.
- think that the tool provided sufficient information to enable them to perform their tasks and access the information required.
- think that the tool was easy to use and that they could finish their tasks faster by using the tool.

HW user satisfaction (%)

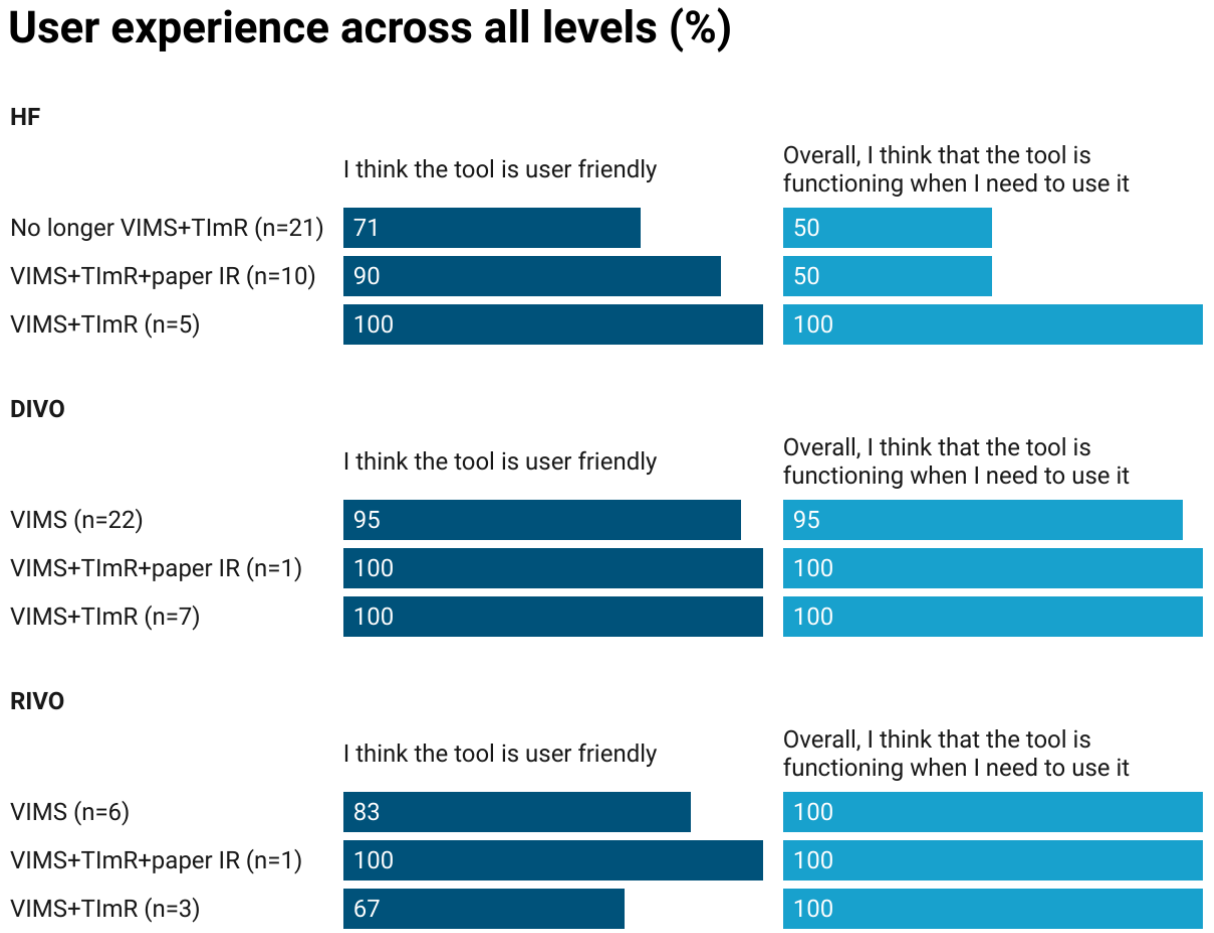


"Because it is easy to use and simple it takes only a short time for lots of tasks." – Health Facility

Tool functionality

User experience

- Users at HF and district level (both using exclusively electronic tools and those using parallel paper IR) were more likely than those no longer using the tool to think that the tool was user-friendly; RIVOs using both the TImR and VIMS were less likely to think so than those using VIMS alone.
- HF respondents were less likely than district and regional respondents to state that the tool was functioning when required.
- Users of the tools at all levels reported consistent IT challenges, notably tablets "sticking" (i.e., not progressing in the software program) and poor interoperability between the TImR and the VIMS. Respondents noted that IT challenges were significant and impacting the sustainable adoption of the tools.



"The district is using the TImR+VIMS in immunizations services but the system is not stable, so they have introduced data sets in excel format to avoid losing data".- District

Findings

IMPACT: Data quality

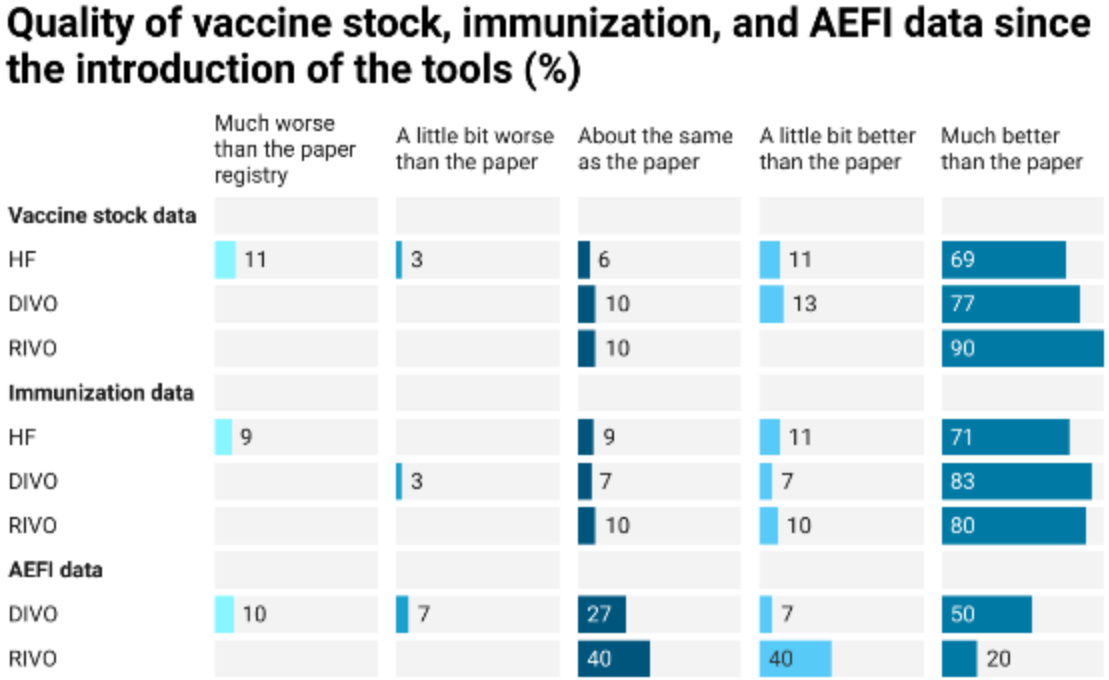
IMPACT
Data quality

- The majority of respondents agreed that both vaccine stock data and immunization data quality had improved since the introduction of the TImR/VIMS. The potential change in quality of AEFI data could not be fully assessed as the TImR+VIMS was only rarely used for reporting AEFI (particularly at HF level).

- HF users were more satisfied with the accuracy and completeness of vaccine stock and immunization records in the TImR+VIMS than those no longer using the tool. There was no difference between rural and urban users here.

Reported challenges in data quality included:

- HF:, poor data collection and data recording due to the tool failing to work properly, insufficient training on the tool, and inaccurate denominators.
- District/Region: limited or no interoperability between the VIMS and TImR; challenges with the VIMS in retrieving and displaying data; and the need for continued use of paper tools.

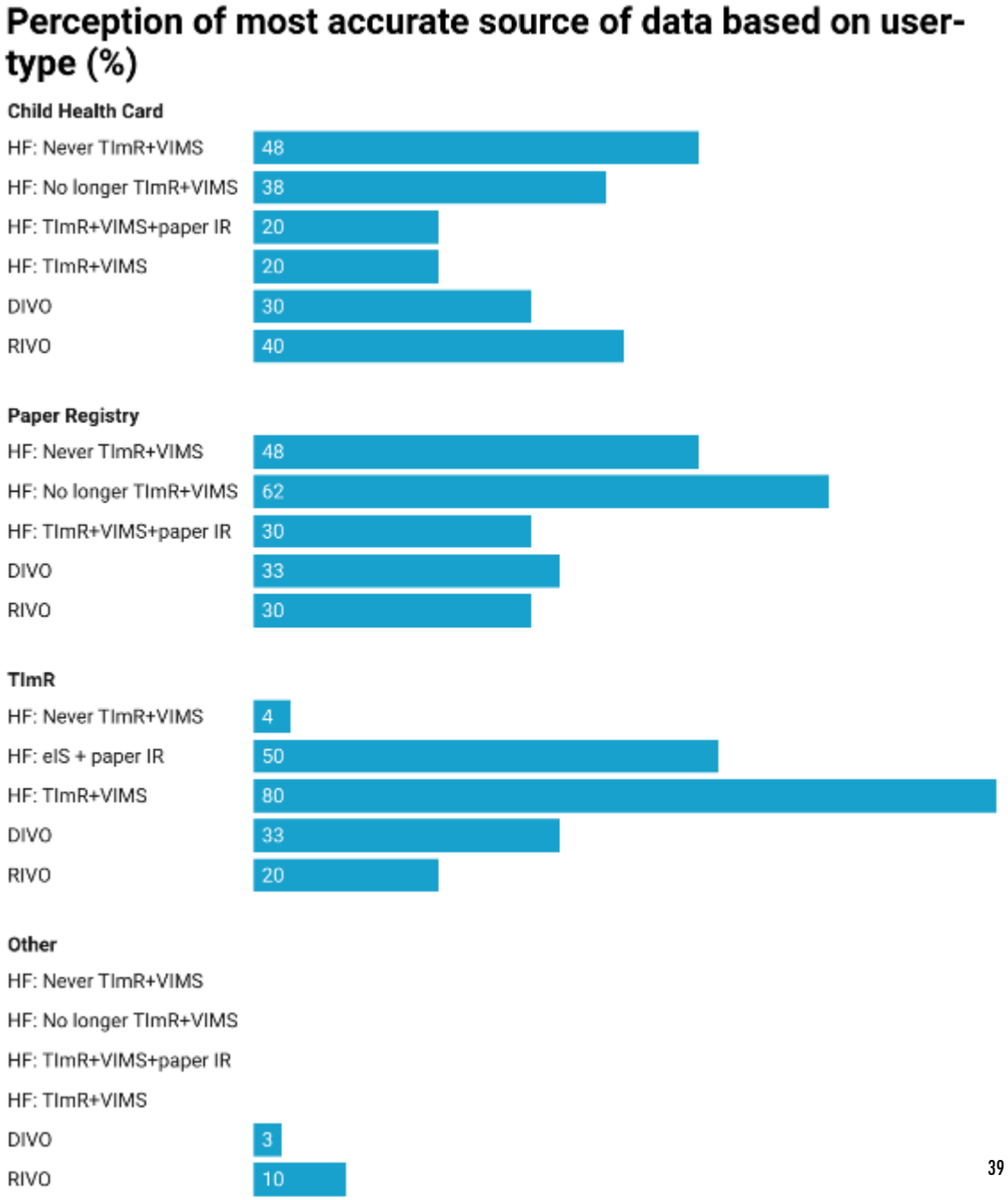


IMPACT

On-site accuracy assessment

- The majority of HF respondents considered the paper registry and Child Health Card to be the most accurate source of data. District and regional respondents were largely split between the perception of accuracy across the three different data sources, including the electronic registry.

- The documented data discrepancies were explained by HF staff by a number of factors including: children vaccinated at other HFs and thus, whilst documented on the Child Health Card, data not entered into the registry; child registration often done by community health workers (CHWs) who were not skilled in capturing data properly; delayed data entry due to staff shortages or poor internet connectivity resulting in staff forgetting to enter all or some details; and failure of the electronic system in accepting historical data.

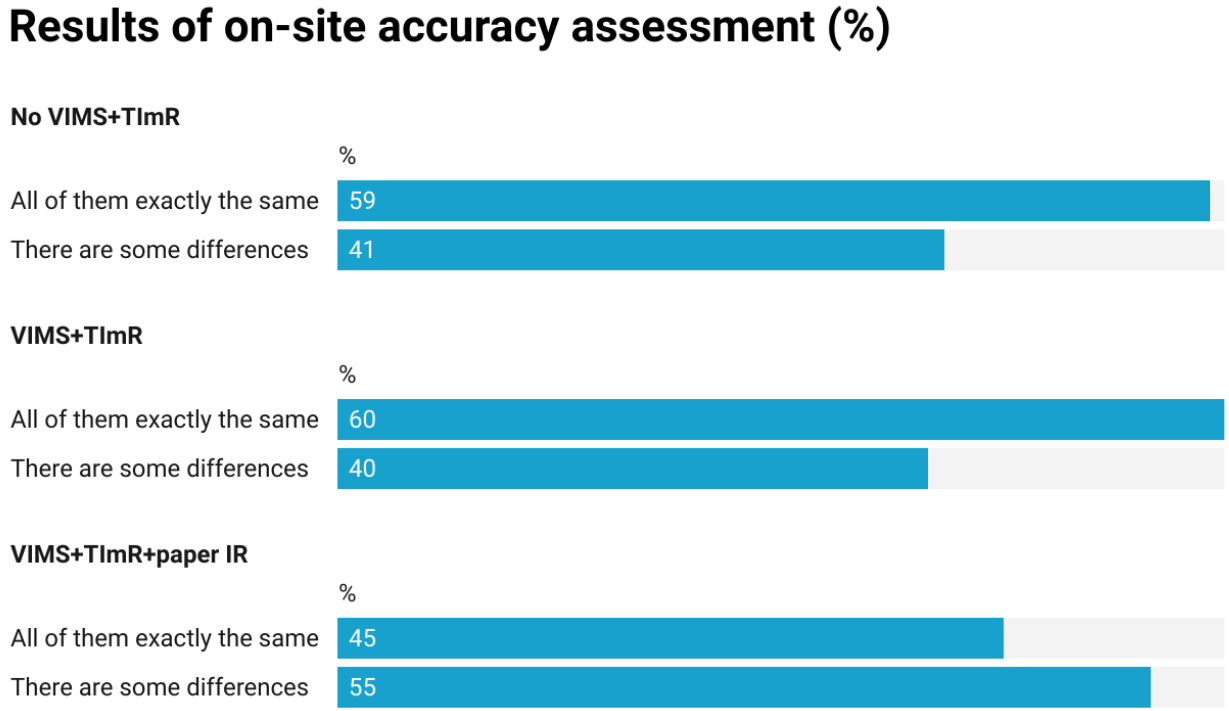


IMPACT

On-site accuracy assessment

The on-site data accuracy check, comparing data entries for selected children in the paper registry, the child health card and the electronic database, showed that just about half of the entries matched overall. The highest accuracy between records was seen in either TImR+VIMS-only or exclusively paper IR settings where around 60% of entries fully matched. In contrast, in settings with a dual system (TImR+VIMS+paper IR), only 45% of entries matched exactly.

There was an association between perceptions of accuracy stated by HF respondents and accuracy confirmed during the on-site accuracy check: 60% of respondents who were satisfied with the accuracy and completeness of the TImR+VIMS data actually had data entries from different sources matching exactly; while only 33% of respondents who were not satisfied with their data quality had such matching entries.



Findings

IMPACT: Data use | Program management

IMPACT

Program management (health facility)

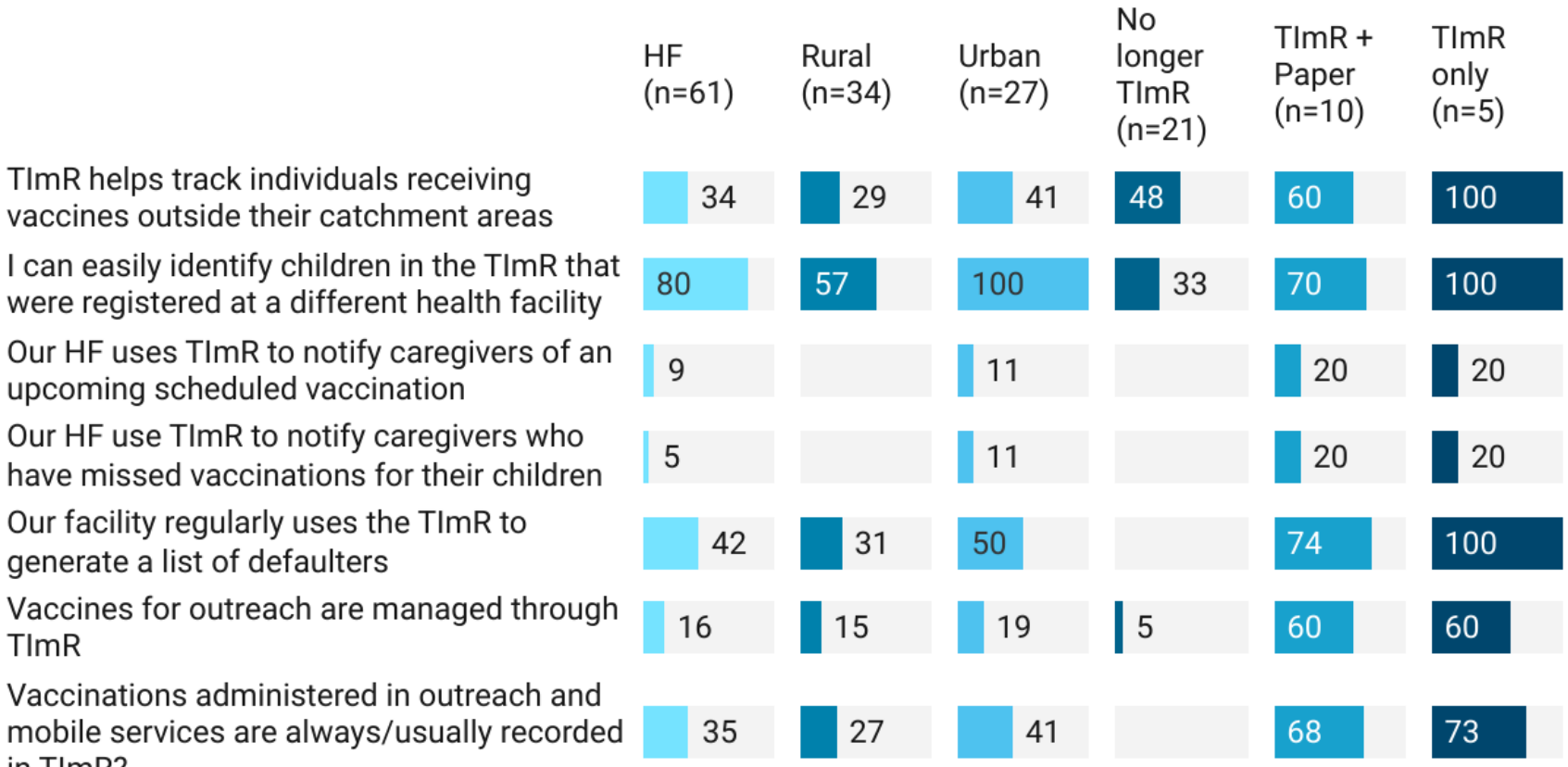
- Most users stated that the system helped to track individuals outside their catchment area and that they were easily able to identify children that were registered at a different facility. Urban users were more likely to be able to identify children registered at a different health facility than rural users.
- Less than one quarter of HF users (n=15) used the TImR+VIMS to notify caregivers of upcoming or missed vaccinations; these respondents also thought that such reminders were effective. However, the possibility to send SMS's via TImR was no longer functional (in 2022).
- Most HFs had a defaulter tracking mechanism in place. The majority of HF users regularly used the TImR+VIMS to generate a list of defaulters. Urban users were slightly more likely than rural users to use the TImR+VIMS to generate such a list. The majority of users thought their defaulter tracking process was effective, but there was no difference in effectiveness perceived between users and non-users of TimR.
- Whilst most HFs conducted outreach sessions for vaccination, most (70%) managed outreach immunization data by using paper-based registries; only 7% of HFs used the TImR+VIMS+paper IR and another 7% used the TImR+VIMS for this. However, the majority (60%) of users managed vaccine stock data for outreach services through the TImR+VIMS.

"In the past the outreach session was done only once, but by using the electronic data system the sessions were now increased to three" – Health Facility

IMPACT

Program management (health facility)

Impact of tools on HF program management (%)

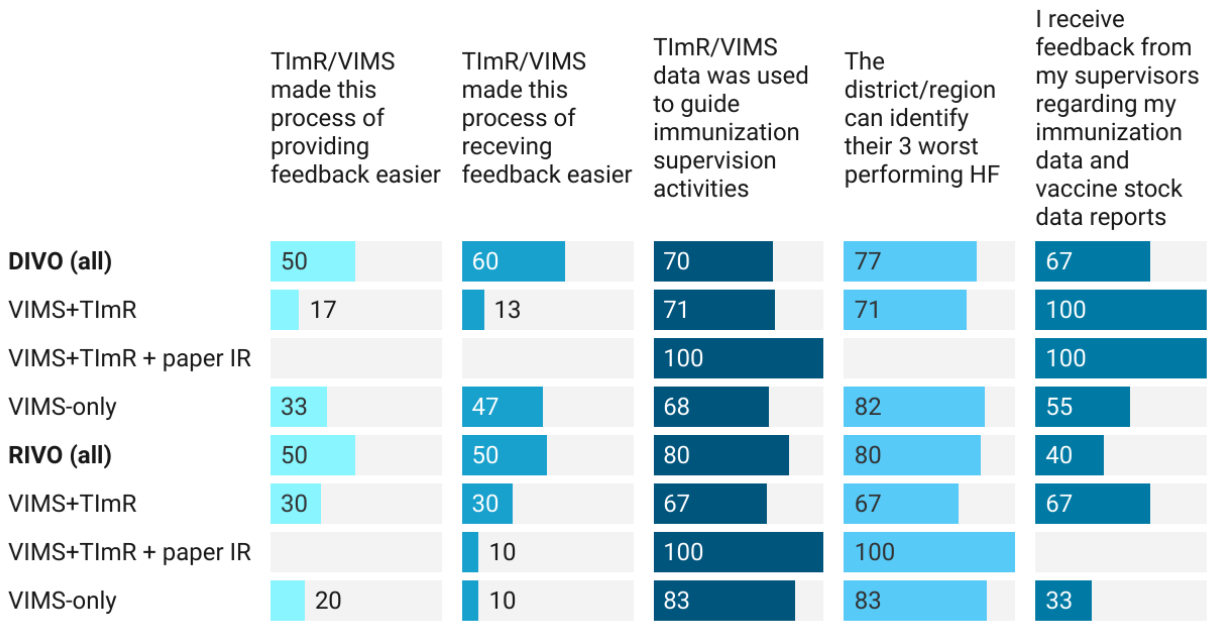


IMPACT

Program management (District & Region)

- The majority (90%) of HFs received feedback from the district on their immunization and vaccine stock data. Half of DIVOs thought that the tools had made the process of providing feedback easier and more than half of district users thought that the electronic tools had made the process of *receiving* feedback easier. Similarly, half of RIVOs thought that these tools had made these processes easier.

Impact of tools on DIVO/RIVO program management (%)



"The electronic tool simplifies work, as there is currently no need to prepare reports because the data can be accessed through the system"– Region

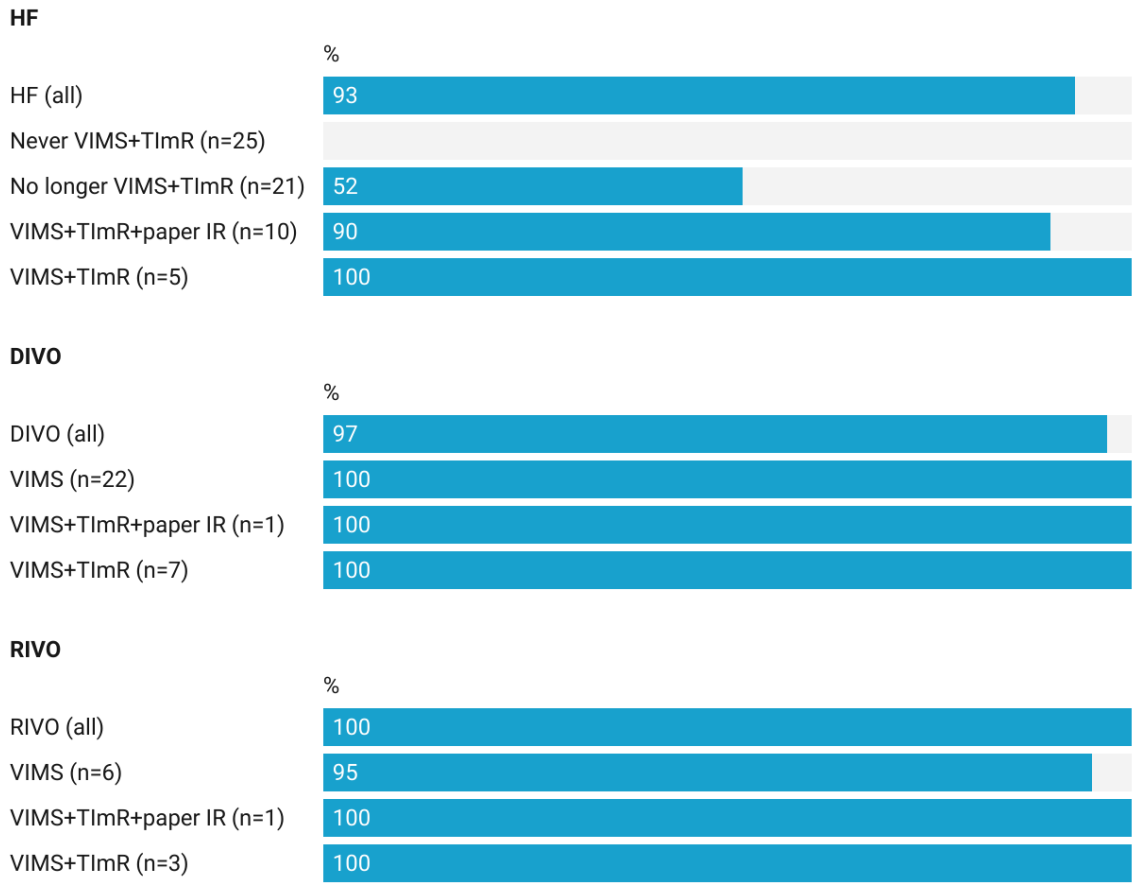
Findings

IMPACT: Data use | Stock management

IMPACT
Stock management

- Almost all users at all levels thought that the tools assisted them in better managing stock; although only half of HF users no longer using the tool agreed with this.
- Urban HF users were slightly more likely than rural HF users to think that the tool improved their management of vaccine stock. HF staff stated that the TImR+VIMS assisted them in direct communications with the DIVOs by automatically calculating stock balances. The majority of HF users regularly used the TImR+VIMS to generate monthly reports and to order new supplies.
- The majority of respondents (including those no longer using the tool) thought that the receiving and putting-away of vaccine supplies was 'faster using the TImR+VIMS'.
- However, there were concerns about the unsatisfactory speed and reliability of the tool, and the need for additional training.

% of users at different levels who think that the tools allow for more effective stock management

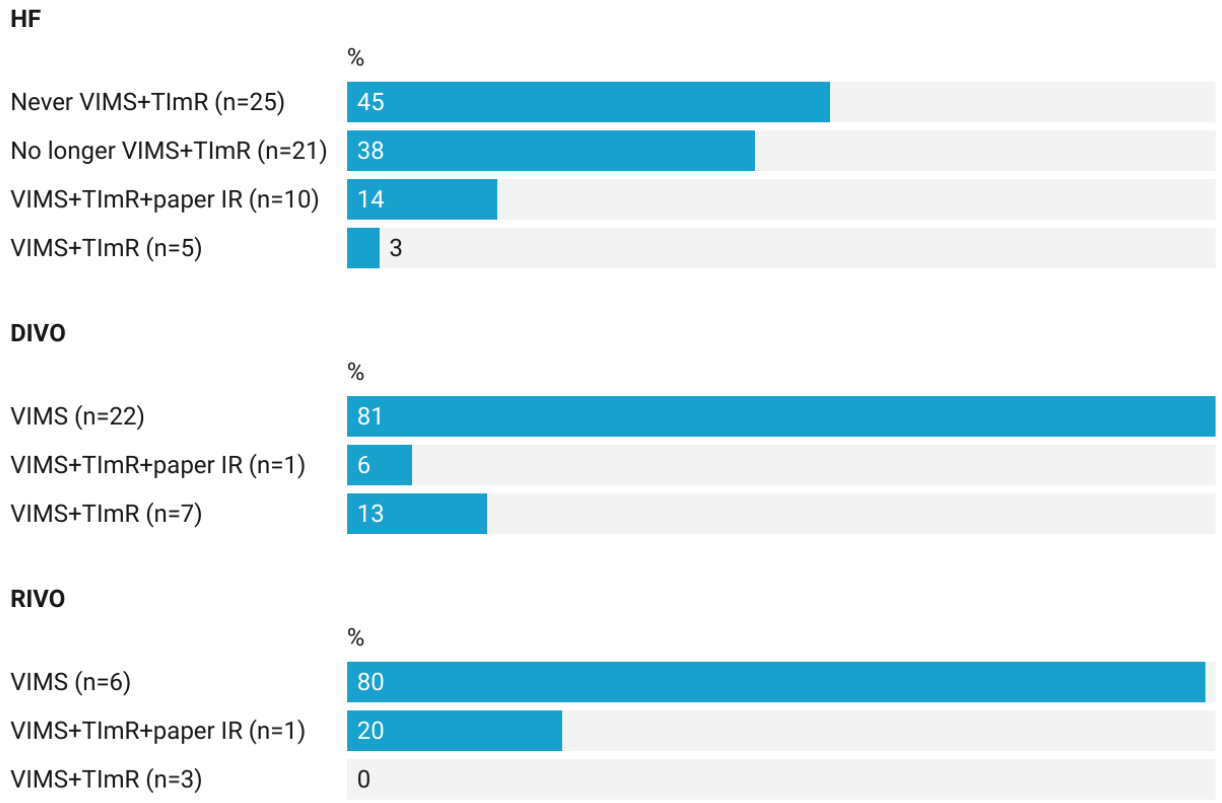


"Everything is simple in the VIMS and all the required reports are generated automatically." - District

IMPACT
Stock management

- Approximately half of HFs, district, and regional offices had experienced a vaccine stock-out in the three months prior to the evaluation.
- At HF level, 83% of these stock-outs occurred in HFs not using the TImR+VIMS, while only 17% occurred in those using the TImR+VIMS.
- Overall, users of the fully electronic system were less likely to have experienced stock-outs than users of the TImR+VIMS+paper IR and non-users.

Experience of stock-outs in the prior 3 months



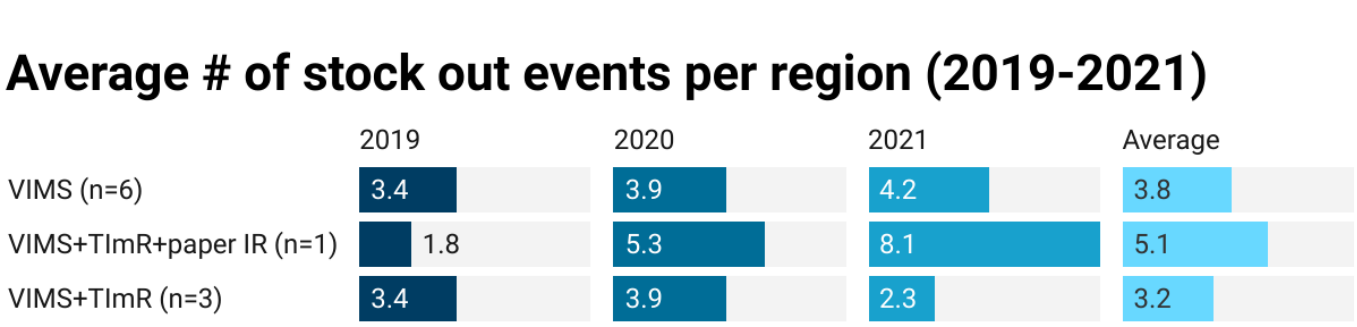
"When TImR was working, stock management was easier, and it took less time to accomplish everything." – Health Facility

Impact

Stock Management

The primary data collected during the evaluation in the 10 regions was compared to data extracted from the VIMS for the years 2019 – 2021 and the total number of stock-out days per region reviewed.

Over the three-year period, regions using the TImR+VIMS experienced the least number of stock outs with an average of 3.2 events, compared to 5.1 events in those regions with (TImR+VIMS+paper IR) and 3.8 events (in those with VIMS only).



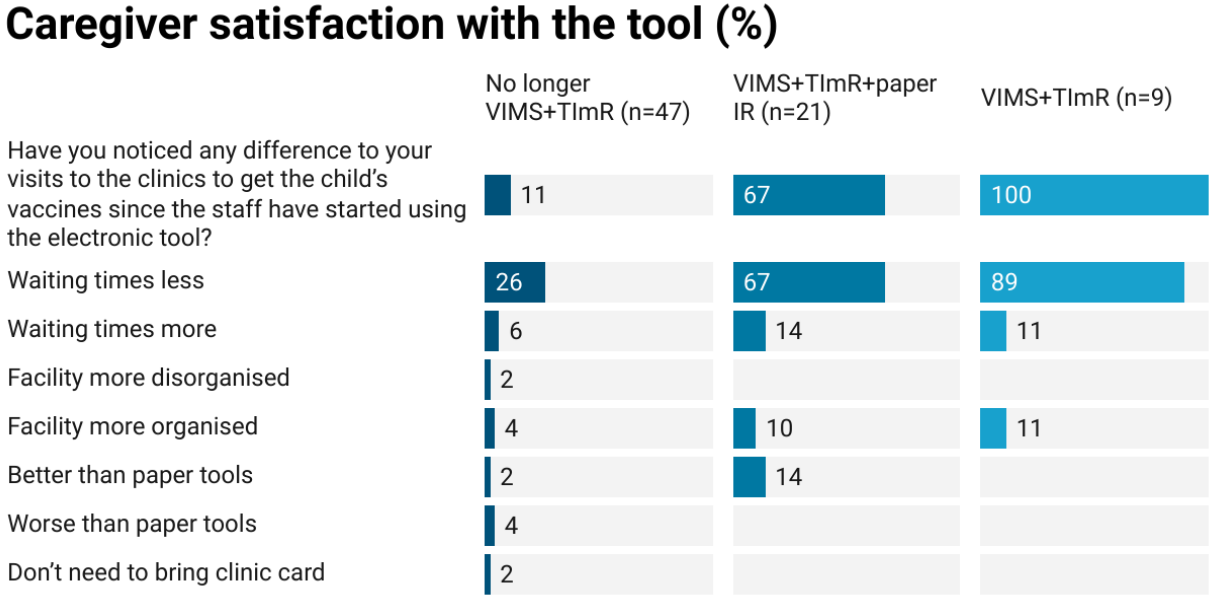
Findings

IMPACT: Caregiver satisfaction

IMPACT

Caregiver satisfaction

- TImR+VIMS-only users were more likely than TImR+VIMS+paper IR and non-users to state that caregiver satisfaction had improved since the introduction of the tools.
- Caregivers felt that they had experienced shorter waiting times in HFs with the tool than in those without the tool; however qualitative insights from HWs also reported increased waiting times for caregivers.
- Caregivers did not think that tool had contributed to the HFs being better organized.
- TImR+VIMS-only users were more likely than TImR+VIMS+paper IR users and non-users to regularly use the tool to generate new records of immunization for children that had lost their child health cards.

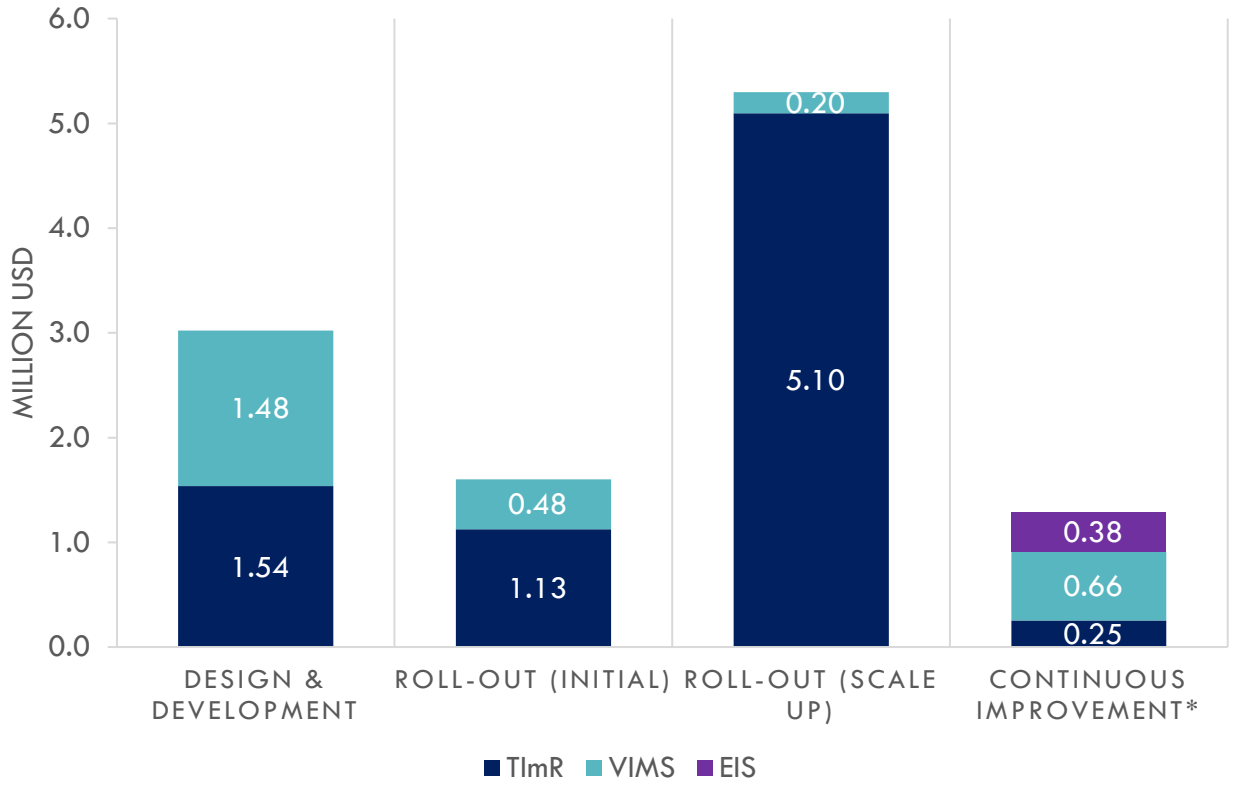


"… the system is good but sometimes it takes us longer to complete our work and that makes parents unhappy with the service, as they wait so long…" – Health Facility

Findings

COSTS

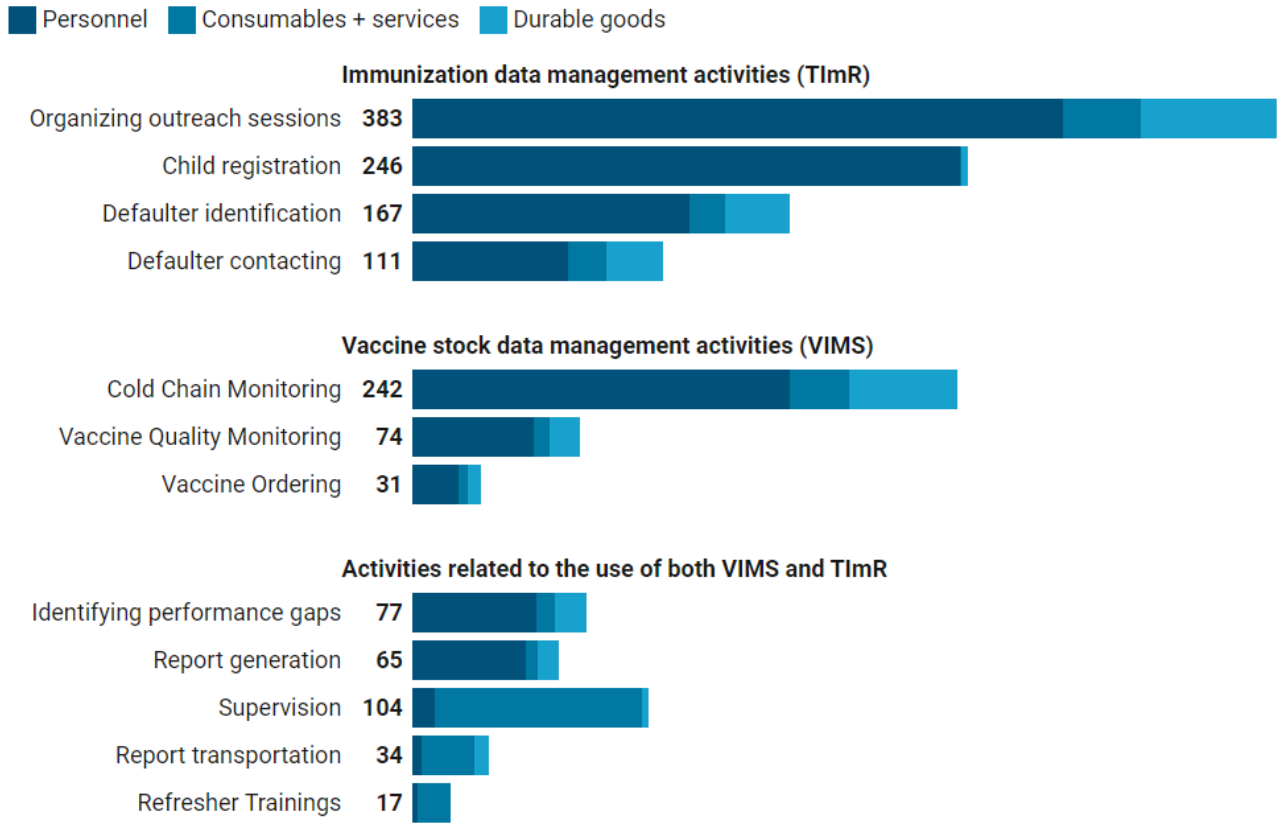
Between 2015 and 2021, a combined total expenditure of USD 12.8M was estimated for the implementation of both systems, TImR and VIMS, majorly financed by external donors such as the BMGF, USAID and Gavi.



- **Design and development** costs included activities such as software development, including project management costs incurred by PATH and JSI, security licenses and system hosting costs
- **Roll-out** costs (initial and scale-up) were predominantly accounted for by trainings and supervision activities.
  - Approximately USD 0.5M were included from the learning costs sustained from developing and piloting Tanzania's first TImR, TIIS, since shelved and substituted.
  - The overall roll-out expenditures for TImR are higher than those for VIMS as the former is implemented down to health facility level, whereas the latter only to district level. The TImR user base is therefore larger, as was the number of trainings required and the amount of hardware and internet bundles needed.
- **Continuous improvement** investments amounted to USD 1.3M and included expenditures for new additions to and refinements of the systems, either in terms of technology or human capacity, as these evolved from their original design.
  - Driven by investments in durable goods at 53%

The average annual cost of performing immunization and vaccine stock data management activities using the VIMS+TImR was estimated at USD 1,551 (95% CI: 1,227; 1,874) per health facility.

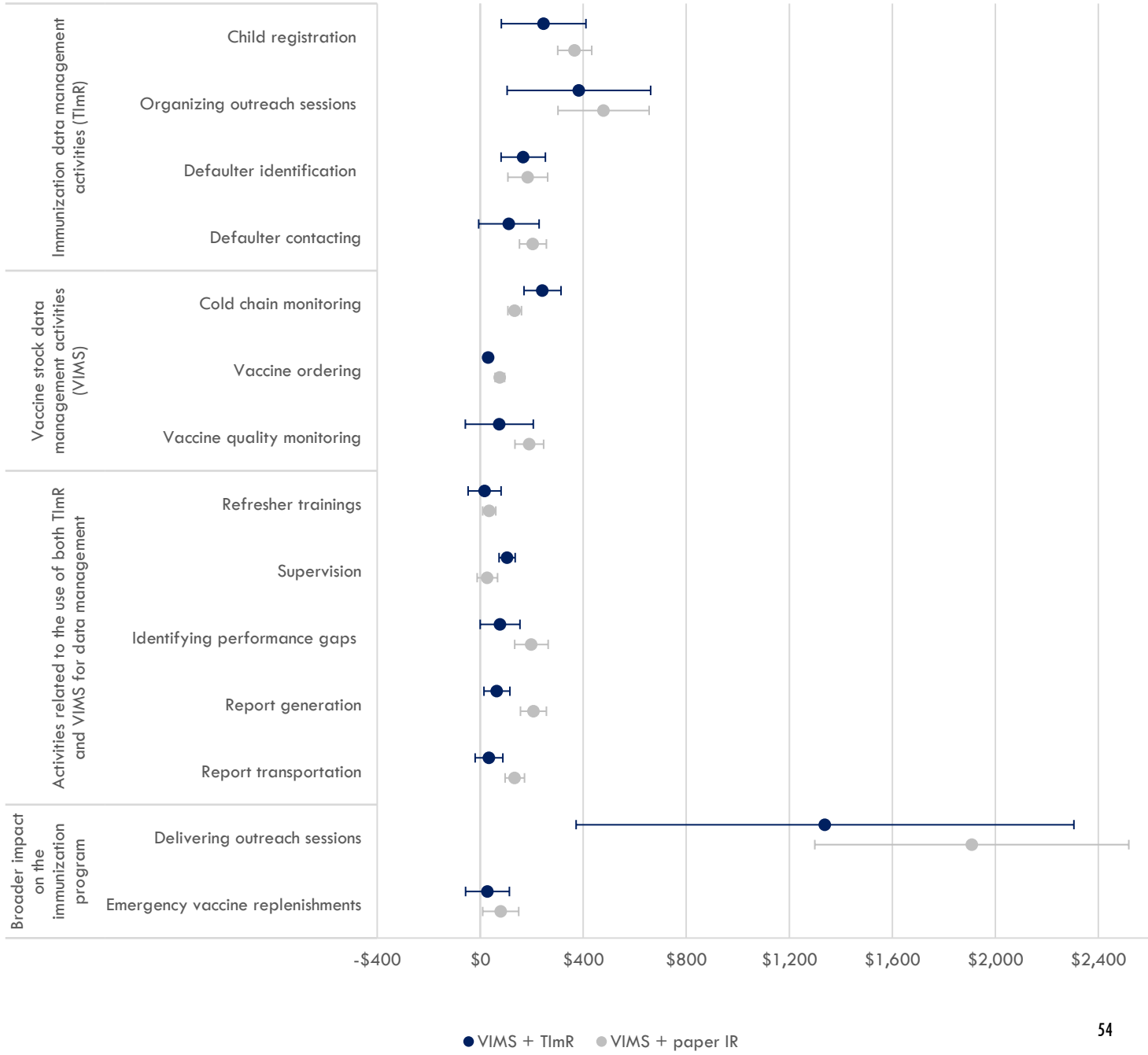
- The cost of **organizing outreach sessions accounted for 24%** of the total cost per HF (USD 383, 95% CI: 190; 577), with sessions organized on average 17 times a year by users of the system, who spent an average of 5 hours for preparing them.
- The **largest cost input was personnel, accounting for 59%** (USD 1,086) of the total cost per health facility.
- **Among VIMS+TImR users at the HF level, most (75%) still operated parallel paper registries,** which were contributing to some printing costs reported.
  - HFs reported the printing of an average of 1,491 pages per year per HF at an average annual cost of USD 26, which reflected the cost of printing reports and registries.



Analysis of costs for VIMS+TImR users (n=15) at HF level, with district and regional costs distributed based on the number of facilities under their administration.

Compared to VIMS+paper IR users, VIMS+TImR users observed cost reductions for all activities except for cold chain monitoring and supervision.

Overall, VIMS+TImR users incurred USD 686 less per year for data management activities.



Cost impact on data management

Activities with the largest observed cost decreases

Report generation (USD -142 per HF)

- 87% of users reported using the VIMS+TImR for the generation of reports or stated that with the VIMS+TImR there was no need to prepare reports as the data was directly accessible by higher administrative levels through the system
- Non-users stated that they could sometimes spend a whole working day to prepare one report using the paper IR

Report transportation (USD -100 per HF)

- Users reported that submitting reports to higher administrative levels through the VIMS+TImR took only 10 minutes
- Users physically transported reports once every two months, while non users once per month

Child registration (USD -120 per HF)

- Child registration was the largest cost driver for non-users, whereas it was the 3rd most costly activity for VIMS+TImR users
- Users spent on average 11 minutes to register one new child, compared to 14 minutes spent by non-users
- Registration was done in user HFs by vaccinators and enrolled nurses with a lower pay grade compared to clinical officers and registered nurses doing this work in the non-user group. Both groups mentioned limited number of staff and difficult division of tasks as challenges.
- Variability in mixed comments from users: Some users alluded to the ease of use of the system contributing to less time spent per child (5 minutes), while others quoted challenges such as internet stability and system bugs which added time to performing the activity with the tool.

Total costs

Estimated costs for immunization and vaccine stock data management per region included in the sample

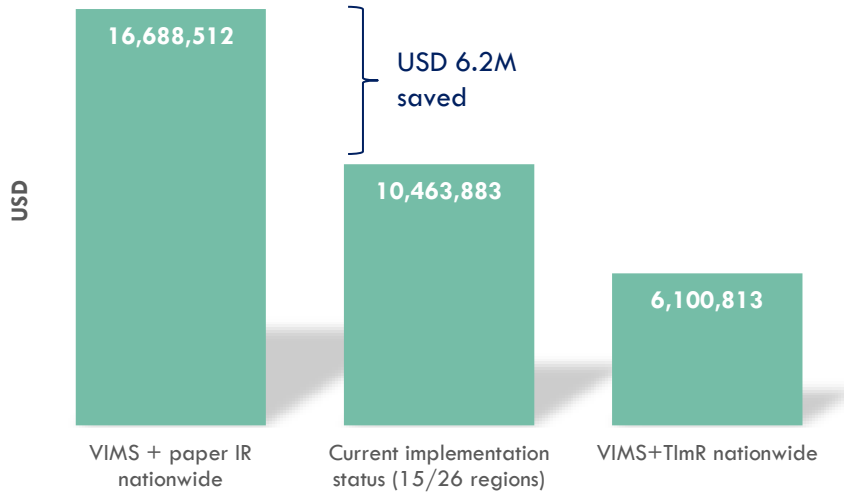
System	Region	Mean cost per HF in USD (95% CI)
VIMS+TImR	Arusha	1,744 (1,162; 2,325)
	Dodoma	1,250 (514; 1,986)
	Kilimanjaro	494 (21; 968)
	Tanga	1,484 (730; 2,237)
	Mwanza	2,457 (1,962; 2,953)
	Njombe	1,432 (286; 2,578)
	Mean	**1,477 (-321; 3,274)**
VIMS+paper IR	Mbeya	1,329 (780; 1,877)
	Pwani	2,574 (2,021; 3,127)
	Shinyanga	6,065 (5,759; 6,372)
	Singida	1,990 (1,446; 2,535)
	Mean	**2,989 (1,991; 3,988)**

The actual cost for immunization data management activities in Tanzania was estimated at **USD 11.7M per year,** with the total cost of the VIMS+TImR in all 15 regions totaling USD 4.62M.

The net cost of immunization and vaccine stock data management using the VIMS+TImR was estimated at USD 10.46M, including the avoided costs from the tools' broader impact on the immunization program (delivering outreach sessions and emergency vaccine replenishments) and maintenance costs at central level.

Affordability & Sustainability

Compared to the average immunization resource needs estimated in the cMYP (2016-2020) and the ICAN estimates of the total cost of the immunization program in Tanzania between 2019-2021, the net operating cost of VIMS+TImR of USD 10.46M currently represents approximately 6.5% of the immunization budget.



	VIMS + paper IR nationwide	Current situation^	VIMS+TImR nationwide
Annual costs for system maintenance at the central level	250,000	700,000	1,400,000
Annual operational costs for immunization and vaccine stock data management (USD)	16,688,512	11,708,284	8,120,148
Avoided costs to immunization service delivery (USD)	NA	-1,944,401	-3,419,336
Net cost (USD)	16,688,512	10,463,883	6,100,813
Net cost per dose (USD)	1.05	0.66	0.38
% of total IVD expenditures*	9.9-10.8%	6.2-6.8%	3.6-4%
% of domestic IVD expenditures**	18.8-20.5%	11.8-12.8%	6.9-7.5%

*^11 regions with VIMS + paper IR and 15 regions with VIMS+TImR ; *based on a range for the IVD budget between USD 154 and 168 million ; **assuming domestic expenditures of 53% of the total*

Considering the initial investment of 12.8M for implementing the system in 15 regions and assuming constant net savings, it is estimated that the return on investment would turn positive after approximately 8 years of implementation.

High-Level Summary of Findings

Research Questions and Answers

Summary of evaluation findings

	Strengths	Challenges
Ecosystem	• Strong political will and solid policy context • Competent national-level MoH staff available for knowledge and skills transfer	• Overreliance on external technical and financial support • Limited internal capacity to implement and maintain electronic tools at national level • Limited access to internet and electricity • Insufficient hardware • Irregular software updates
Tool	• TImR fulfils requirements of an "ideal" eIR • VIMS fulfils requirement of an eLMIS for vaccines • Trusted and user-friendly tool	• Significant challenges resulting in the systems being no longer accessible e.g., to export data at national level, and input data at HF level • Problematic interoperability between eIR and eLMIS and the national HMIS • Server at capacity (procurement of new server in progress)
Implementation	• Adequate computer literacy and access to IT support and supervision	• Continued use of (parallel) paper registries • Variation in modality of use (full electronic, with paper, discontinuation) • Higher implementation costs for TImR as it is rolled-out to HF level • Need for additional training
Impact	• Perceived improvement in **data quality** since tool introduction • Assisted in **tracking individuals** outside of catchment areas, and in **identifying children** registered at a different facility • Regularly used to generate **lists of defaulters** and, where possible, used in outreach and mobile services. • Impacted on the process of **providing and receiving feedback from supervisors** and positively impacted on **the quality of decisions** made in critical areas such as the preparation and conduct of immunization sessions including outreach, supportive supervision, defaulter tracing, identification of performance gaps, and in resource planning. • Improvements in **vaccine stock management** including **reducing the number of stock-outs.** • Overall, HWs were satisfied with use of the tools and thought that they **improved their productivity and made them more effective in their daily work.** • **Caregiver and client satisfaction** was perceived to have improved to some extent, partly as a result of shorter waiting times. • VIMS+TImR use was cost-saving to the country by USD 6.2M annually compared to VIMS+paper IR	• Paper registry considered most trust-worthy data source • Variable use of the tools, in combination with parallel paper registries, impacting on HW workload and data quality • No evidence of impact on immunization coverage (partly due to interfering COVID-19 situation)
Affordability & Sustainability	• VIMS+TImR at current scale considered affordable (annual operating cost: 6.5% of the total IVD budget) • ROI expected at 8 years, conditional on use of system	• Affordability and sustainability inhibited by ecosystem-related challenges

Has the implementation of the e-Tracker improved immunization service delivery? [Impact]

- Due to the COVID-19 pandemic and its repercussions on routine immunization services, it was not expected that the evaluation would be able to assess an impact of the use of the electronic tools on immunization outcome indicators such as coverage, timeliness and drop-out rates.
- The evaluation could, however, show an impact related to more proximal indicators:
  - There was a perceived improvement in **data quality** since the introduction of the tools.
  - The tools assisted in tracking individuals **outside of their catchment areas** and in identifying children that were registered at a different facility.
  - The tools were regularly used to **generate a list of defaulters** and used in **outreach and mobile services**.
  - The tools impacted the process of providing and receiving feedback from supervisors, as well as **the quality of decisions** made in critical areas such as supportive supervision, defaulter tracing, the preparation and conduct of immunization sessions, the identification of performance gaps, and resource planning.
  - The use of the tools was associated with improvements **in vaccine stock management,** including reducing the number of **stock-outs.**

  Of note, at HF level, it was not feasible to separate out any impact of the VIMS from that of the TImR since the latter was used as the data entry interface to both tools.
- Overall, HWs were satisfied with the use of the tools and thought that they improved their productivity and made them more effective in their daily work. Caregiver and client satisfaction also improved to some extent, partly as a result of shorter waiting times.

How interoperable is the TImR and VIMS with the national health management information and civil registration systems? [Ecosystem, Tool]

- The VIMS and TImR were designed to be interoperable. At the HF level, HWs require TImR as the data entry interface for accessing VIMS. Current challenges with the TImR prevent synchronization of data between the tools and have resulted in limited data access. This has partly contributed to the abandonment of the tools in many locations.
- The MoH digital health policy prioritizes interoperability and standardized information exchange between tools within its Health Management Information System.
- There is no immediate plan to integrate the TImR with a CRVS or birth registry system, although it is technically feasible. This is limiting the ability of the tool to assist in reaching zero dose children.

What is the short- and medium-term economic and financial impact of implementing and scaling up these systems in the whole country? How affordable and sustainable are the systems? [Impact, Affordability and Sustainability]

- The full initial investment of developing and deploying the TImR down to the service delivery level in 15 regions was approximately USD 9.3 million, while the VIMS the investment amounted to USD 2.16 million. Most implementation-related expenditures were attributed to hardware for TImR (USD 4.8 million). Training was the second highest cost item accounting for 24% of the combined cost of deployment for both tools (USD 1.5 million for TImR and USD 0.7 million for VIMS).
- The use of the VIMS+TImR was associated with a **decrease in the costs for immunization and vaccine stock data management** activities by 31% compared to using only VIMS+paper IR. The average annual cost for performing these activities with the VIMS+TImR was USD 1.551 per HF, or USD 0.54 per dose. The majority (59%) of this cost was accounted for by costs for personnel. The costliest activity was that of organizing outreach sessions (24% of the total cost).
- When extrapolating the estimated savings at the HF level to the whole county, the total **costs for immunization and vaccine stock data management** activities in the current scenario (i.e., with VIMS+TImR implemented in 15 Regions) was estimated at approximately USD 10.5 million per year. This cost included additional investments for the further development of the tools and represents approximately 6.5% of the estimated budget of the IVD program in 2019-2020. Compared to a scenario with only VIMS + Paper IR, approximately USD 6.2 million savings may be generated every year.
- The reported annual savings may be even higher should the system be implemented in all regions, potentially resulting in further savings of USD 4.2 million per year compared to the current situation.
- Given its current scale and annual savings, the VIMS+TImR, if fully used in all HFs in which it is presently rolled out, is expected to provide returns on the initial investment after 8 years, After this period, use of the tools would free resources from the IVD budget, thus contributing to ensuring its sustainability.
- Resolution of technical issues and reinforced capacity building, coupled with further investments in the digital infrastructure of the health sector in Tanzania would, however, be pre-requisites for such cost benefits to be realized.

How can new evidence on tools and technologies, modalities, and governance of the TImR and VIMS inform further investments from domestic sources, health financing institutions and technical partners for the sustained implementation of these systems? [Ecosystem, Impact, Affordability and Sustainability]

- Many HFs are discontinuing the use of electronic tools in the face of multiple challenges. Large financial investments in specific tools, such as an eIR, without investments in the entire digital health ecosystem, including technical infrastructure, internet connectivity, human capacity and strengthened IT support, are insufficient to allow the tools to realize their programmatic benefits. Further investments in **strengthening the digital health ecosystem** are necessary and encouraged.
- An over-reliance on external partners, including software developers, is concerning. The absence of local capacity to provide timely support has reportedly impeded the sustained use of the tools. Investments in **local capacity building and technology transfer** should be prioritized to enable independent development, local adaptation, and the sustained use of electronic tools.
- Further domestic investments in the TImR and VIMS appear to be warranted, in parallel with fostering an enabling environment. This should include:
  - Strengthened in-house capacity at the national and regional level to manage and monitor use of the tools;
  - Improved server capacity and resolution of software issues; and
  - Improved technical integration and interoperability of the two tools with the health information exchange platform.
- Lessons learned from earlier attempts to remove the parallel paper registries should be reviewed and comprehensive plans made for the removal of paper registries. The implementation of a fully electronic systems should allow for the full benefits of the tools to be realized.

Next Steps

Conditions for continued investment

1. **Development of local capacity** to implement and maintain the eIR and eLMIS at national level. This includes full knowledge transfer from partners and external companies, rectifying current challenges with each tool, and the synchronization challenges between the eIR and eLMIS.

2. **Infrastructure requirements** to be met at all levels of the health system including servers at national level, and computers / tablets at regional, district and HF levels. Access to the internet and electricity should also be expediated.

3. **Training and capacity building** at all health system levels, particularly at the HF level, for proper data entry, analysis and use for decision-making.

4. Once # 1 – 3 complete, implement policy decision to **remove parallel paper processes.**

5. Implement **a monitoring framework** to assess the tools' adoption and impact on the health worker efficiencies, and improvements in data quality and data use; including in the use of the tools for defaulter tracking and outreach activities.

6. **Re-activate SMS reminders** for caregiver notifications.

7. Conduct feasibility assessment of facilitating interoperability between **CRVS / birth registry and the eIR**

Limitations

Limitations

Potential biases may have influenced the findings.

1. Misclassification: A classification was used to distinguish types of users. But there may have been variations in actual use per activity. For example, while a HF was classified as using TImR+VIMS only, there might have been instances where paper was also used for specific activities, and vice-versa.

2. Information: The data collected and reported consist primarily of perceptions reported by HWs during interviews. To reduce the resulting information bias triangulation of primary data sources was done across the levels of the health system. In addition, alternative secondary sources were explored to validate the primary data collected.

3. The cost analysis was performed based on a classification of users at the HF level, with RIVO and DIVO costs attributed to each HF respectively, irrespective of the use of the tool at higher levels. This approach meant that no-longer users of the system were found in intervention areas currently using the system (i.e., TImR+VIMS regions). This influenced the reported cost per facility in each region, as the relative composition of users vs. non-users in the TImR+VIMS regions varied. The total costs were therefore calculated taking into account this variability in the use of the system in the regions where it has been implemented.

4. The sample size with 61 health facilities in 10 regions is necessarily limited. Findings should, however, be comparable to those of earlier recent costing studies on immunization in Tanzania, such as the ICAN study which was based on data from 51 facilities.

5. While a purposive sampling approach was used, care was taken to select HFs to be representative of the entire sampling frame of HFs offering immunization in the respective regions with regards to their type and level (hospital, health center, dispensary), the size of their catchment area and their urban or rural location.

END

For queries, please contact:
Viviana.Mangiaterra@sdabocconi.it