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

RWANDA

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Republic of Rwanda
Ministry of Health

"Seek-in"
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Presentation outline

Objectives

- Background to research and tool introduction
- Context of use of the tool
- 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** (Rwanda): The Centre for Impact Innovation and Capacity Building for Health Information and Nutrition (CIIC-HIN), the University of Bocconi, MM Global Health Consulting.
- **Data collection** (Rwanda): Feb/March 2022
- **Sponsors:** Funded by the Bill & Melinda Gates Foundation (BMGF) and 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 Rwanda selected as part of this evaluation?

- ✓ **Scale:** Fully scaled up eIR across the country
- ✓ **Tool:** DHIS2 Tracker meets the criteria of an eIR

Background to the Introduction of the tool

DHIS2 eIR Tracker (e-Tracker) implementation: Customization and training from May 2019, and nationwide roll-out between September 2019 and January 2020. Implementation leveraged off existing digital health infrastructure, including available internet coverage as well as experience with other digital health tools e.g., eLMIS and an Open Medical Record System (OpenMRS)

Rwanda transitions towards a fully-digital management of immunization data and improved interoperability between different health information systems

Rwanda Health Management Information System (R-HMIS) became digital with the introduction of DHIS2: DHIS2 is used nationally across public and private health facilities, and across programs. It is managed by the Rwanda Biomedical Centre (RBC), an implementing Agency of the Ministry of Health.

Implementation was supported by strong political will, a well-established strategic framework and the Rwanda Health Information Exchange System (RHIES) architecture. The stated goal in the country is: "One Citizen, One Record"

- ✓ *Service-Oriented, Modern, Accountable, and Real-Time (SMART) Rwanda Master Plan (SRMP) (2015–2020)* aimed to improve service delivery environment for healthcare providers to increase productivity and experience; reduce costs per patient and per encounter; and to improve patients experience when interacting with the health system.
- ✓ *National Digital Health Strategic Plan (2018 – 2023)* articulates the government's vision for digital health and complements the SRMP
- ✓ *Health Sector Strategic Plan IV (2018 -2024)* lays out a strategic direction for eHealth and research to "ensure the availability of interoperable, responsive and functional information systems providing high-quality data in a timely manner to inform planning and decision-making"

Context to the Use of the e-tracker

- **Tool selection:** Tracker (referred to in Rwanda as the e-Tracker) is the DHIS2 app for individual-level transactional data. The tool was selected to leverage the country's existing HMIS (based on the DHIS2) as well as the substantial local DHIS2 capacity to maintain the tool.

- **Scale:** All 505 health centers that deliver immunization services (including public, non-profit and faith-based organizations)

- **Implementation:** During the nationwide roll-out (September 2019 – January 2020), performance-based funding (PBF) was used to incentivize new registrations at the time of BCG administration. The PBF scheme was later discontinued, and data capturers have focused on the back-entry of data. Since its introduction, the country has used a dual system of paper-based and electronic reporting tools. Transition to a fully paperless system was initiated on 1 October 2022.

- **Integration and interoperability:** The e-Tracker links to the infant's National Identification Number (NIN) as the unique identifier. Interoperability with the Civil Registry and Vital Statistics (CRVS) System has been designed and configuration of the CRVS-eIR interoperability is complete. The system has been tested and validated by EPI supervisors, and end users completed training on how to retrieve data from birth registrations and to use it to enroll children in immunization programs. The CRVS-eIR integration should now be operational.

- **Impact of COVID-19:** Routine immunization coverage rates declined during the COVID-19 pandemic and the entire implementation period of the tool has been impacted by COVID-19. Thus, the assessment of the impact of the tool on routine immunization coverage indicators is limited due to confounding by COVID-19.

Use of e-Tracker at different levels

Health Center

- Health workers complete paper-based records which are entered into the e-Tracker by data managers who also regularly update the tool.
- e-Tracker is used for data entry of vaccine doses administered as well as for analytical tasks (e.g., monthly reporting, generating defaulter lists, generating new immunization records, including for children with lost vaccination cards or those resident in other health center catchment areas, etc.).

District

- EPI Supervisors (at District Hospitals) follow-up on health center reports and identify gaps in the information transmitted.
- Data is used for supervision and decision making

Central

- RBC oversees documentation, notification and registration of immunization-related data at all levels of the health system.
- It collates, analyzes and feeds back data obtained from the lower levels to district levels, provides guidance, and capacity building and disseminates data and summary reports.

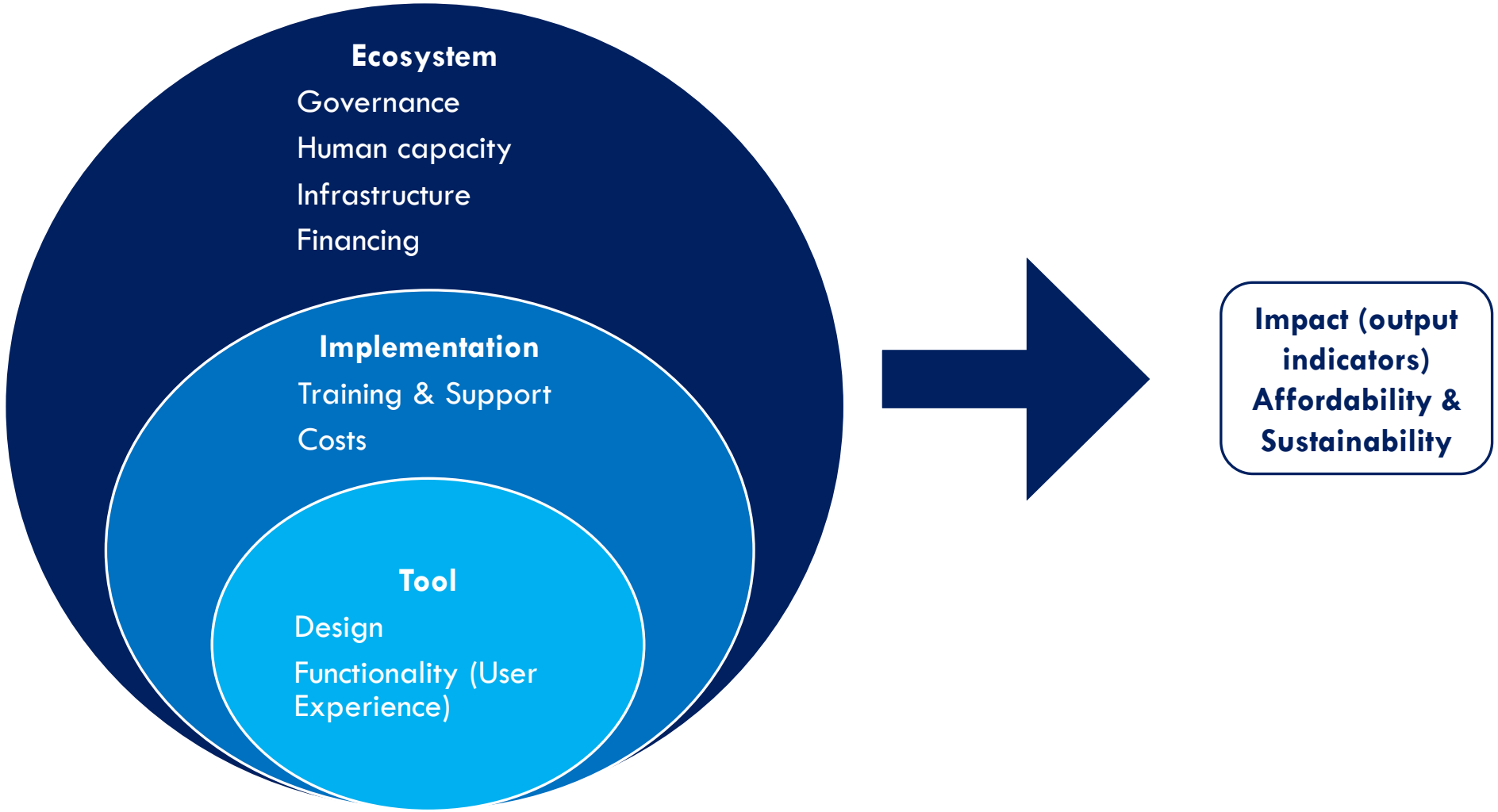
Research study

THEORY OF CHANGE (SUMMARY)

The ToC serves as the foundation for an evaluation framework used to guide the interpretation of the key findings from this evaluation

Vision	Reduce morbidity and mortality from VPDs by enhancing equitable access to vaccines and strengthening immunization delivery within PHC (IA 2030)
Mission	Improve immunization program performance (equitable coverage and system efficiency) by sustained use of the eIR
Strategic outcomes	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

Evaluation framework



Research questions

- Has the implementation of the e-Tracker improved immunization service delivery? *[Impact]*
  - To what extent does the system comply with established norms and standards? *[Tool]*
  - What were/are the barriers and opportunities for implementing it in the country? *[Ecosystem, Implementation, Tool]*
  - What is the impact of the e-Tracker on the national immunization program (e.g., cost saving, efficiencies, timeliness, coverage)? *[Impact]*
- What is the short- and medium-term economic (i.e., costs) and financial (i.e., expenditure) impact of rapidly implementing and scaling-up the systems in the whole country? How affordable and sustainable is it? *[Impact, Affordability and Sustainability]*
- How interoperable is the e-Tracker with other RHMIS modules and the civil registration system? *[Ecosystem, Tool]*
- How can new evidence on tools and technologies, modalities, and governance of the e-Tracker inform further investments in other countries from domestic sources, health financing institutions and technical partners for its sustained operation? *[Ecosystem, Impact, Affordability and Sustainability]*

Methodology: Programmatic impact evaluation

- A mixed methods approach involving both quantitative and qualitative methods.
- Impact was assessed in terms of input, process, and output indicators as well as by appraising the potential effect of e-Tracker on uptake of vaccines
- Evaluation aimed to identify and explore discrete factors critical for the successful implementation and scale-up of the e-Tracker
- Tools were designed to explore the use of the tool including infrastructure and workforce requirements as well as its impact on data quality and data use. Accuracy between different records and competency of users was also assessed.

List of data collection tools

Data collection instrument	Health center	District hospital
Interview guide	24	12
Competency assessment	49	16
On-site accuracy check	24	-
Health worker survey	44	13
Caregiver interview guide	95	-

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

	1. Financial expenditures of implementing the e-Tracker	2. Routine operating costs of using e-Tracker	3. Cost impact of using e-Tracker	4. Financial sustainability of e-Tracker	5. Scenario analysis of a fully electronic registry
Scope of the analysis	Design & development and roll-out expenditure of e-Tracker	Routine operating costs related to the management of immunization data using e-Tracker	Difference in the operating costs of managing immunization data with e-Tracker as compared to the paper-based system	Financial sustainability of maintaining the continuous operations of the systems, using domestic resources	Simulating the impact on costs of a complete paperless registry
Type of analysis	Descriptive analysis	Activity Based Costing analysis – subgroup analysis by frequent vs non-frequent users and rural vs urban users	Activity Based Costing analysis using a before and after comparison of avoided cost from e-Tracker	Descriptive and comparative analysis. Analysis of the total cost of the system based on the Activity Based Costing analysis	Simulation
Source of data	HISP data, RBC, e-Tracker data extract	Questionnaires, RHMIS data	Questionnaires, RHMIS data	International Monetary Fund (IMF), WHO and country report indicators, e-Tracker data extract	Questionnaires, RHMIS data

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)

Indirect costs

- Electricity, internet, communications, maintenance of non-medical equipment, etc.

Activities impacted by the implementation and use of the e-Tracker in Rwanda :

Activity	Description
Vaccination session execution: Child registration	Entering details and data regarding a new child registration (including services provided and data management, finding client folder and event recording).
Defaulter identification	Reviewing registry to identify children who missed appointments, establishing list of defaulters
Organizing outreach sessions	Preparation for the delivery of immunizations in outreach settings
Identifying performance gaps	Reviewing data to find performance gaps (such as not being on track for reaching coverage goals)
Report generation	Searching for and recording the data that will be included in the regular reports for immunization and stock management.

Identifying a comparator:
Frequent and non-frequent users

- Because the tool was introduced nationwide, at the same time, it was not possible to perform a comparison between users and non-users. Findings from a health worker survey were used to determine this comparator.
- The survey was based on the Modular DQA with eIR component (PAHO, 2017), with six domains: computer literacy, infrastructure, information quality, IT service, use, and user satisfaction
- If a HC scored <25% on the domain 'Use', it was classified as a "non-frequent user" (n = 9). HCs scoring >25% were classified as "frequent users" (n = 15)
- The classification was validated using inputs from other primary data sources and confirmed against the a-priori classification of the extent of eTracker use for reporting immunization data to the national level

Questions of the domain 'Use':

1. I frequently use the eTracker for my tasks
2. I am dependent on the eTracker for at least one of my assigned tasks
3. (if applicable) Our health center regularly uses the eTracker to generate our monthly reports
4. (if applicable) Our health center regularly uses the eTracker to generate a list of defaulters
5. (if applicable) Our health center regularly uses the eTracker to generate recall or reminder messages for parents
6. (if applicable) Our health center regularly uses the eTracker to generate new records of immunization for children that have lost the Child Vaccination card

Findings

Use of the tool varied across the country

Despite the national roll-out, use of the tool varied across HCs and DHs. Frequent users were more likely than non-frequent users to:

- be adequately trained
- understand their roles and responsibilities
- report good access to infrastructure and IT support
- perceive improvements in the quality of data
- report increased user satisfaction
- be located in rural areas, in HCs with larger catchment populations and with lower Pentavalent vaccine drop-out rates
- report slightly less frequent supervision activities
- be data managers than clinical staff

District-level staff supervising frequent users were more likely to use the e-Tracker to inform their supervision activities.

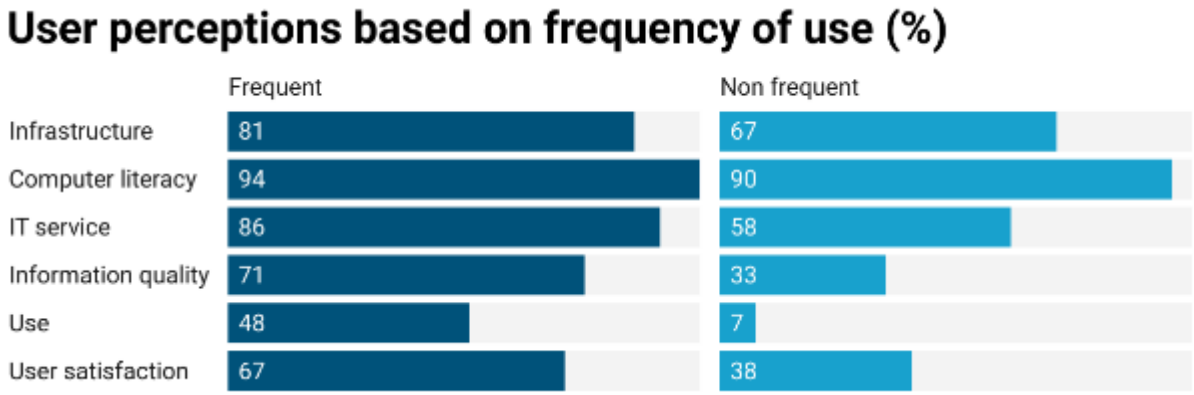
USER CHARACTERISTICS		Frequent	Non-frequent
Location	Rural	60%	44%
	Urban	40%	56%
Type of HC	NGO/FBO	13%	11%
	Public	87%	89%
<1yr population catchment area	Large	73%	89%
	Small	27%	11%
Penta3 drop-out rates	High	27%	11%
	Low	67%	67%
Role within immunization services	Data manager	73%	56%
	Clinical services	27%	44%
Frequency of immunization supervision activities	At least once a year	13%	11%
	Once a month	33%	56%
	Once a quarter	53%	33%
Use of the e-Tracker by DH to inform supervision		79%	56%
Access to support from the DH or elsewhere		80%	89%
Adequately trained		27%	22%
Clear understanding of roles & responsibilities in use of e-Tracker		93%	67%

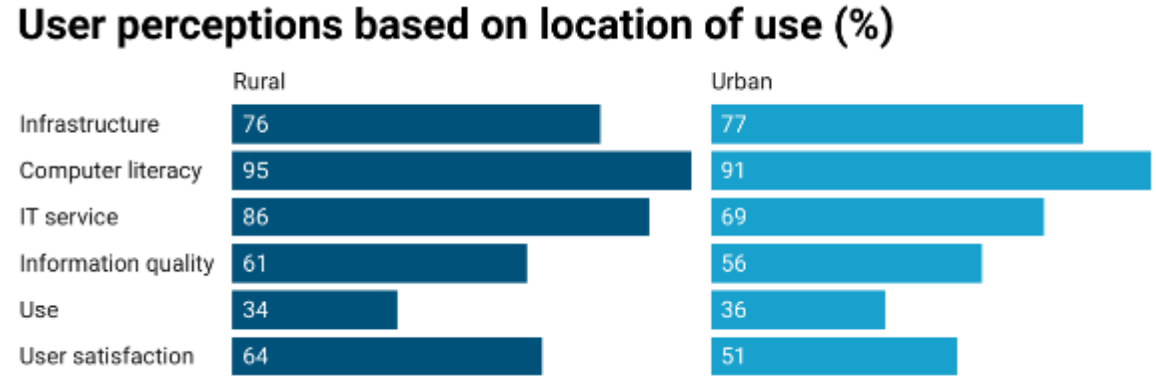
Frequent & rural users reported better experience with use of the tool than non-frequent and urban users

Frequent, and rural users had a more positive perception of:

- their own computer literacy
- the quality of the information in the e-Tracker
- the availability of IT service support
- overall user satisfaction

Note: Better infrastructure did enable more frequent use of the e-Tracker





Findings

ECOSYSTEM

Ecosystem

- **Governance and policy:** The country demonstrated strong political will, and has a well-established strategic framework, and a coordinating body for digital health. There is ample experience with implementing IT solutions in the health sector.
- **Human capacity:** Specialized knowledge to support and maintain the e-Tracker exists through RBC, MoH, HISP, the DHIS2 Community of Practice and others
- **Standards & interoperability:** The e-Tracker forms part of the digital health architecture and the integration with the CRVS is underway. The decision to use the National Identification Number (NIN) as the unique identifier is likely to facilitate integration.
- **Infrastructure:** Internet access remains a concern (one third of HCs did not have sufficient internet access); whilst most respondents said they could access hardware when they needed it, three quarters of HC staff stated that hardware was insufficient. Access to electricity was a concern for ~10% of HCs and DHs.

"Easy to use and ensures consistence of data; network problems and insufficient staff" – Health center

Findings

TOOL: TRAINING, SUPPORT & USER EXPERIENCE

Tool implementation

Training & support

- **Training:** One quarter of HC and DH staff felt they had been adequately trained; the majority of staff requested additional training.
- **Roles & responsibilities** for using the eTracker were largely well understood by HC staff, but some respondents felt not well equipped to undertake these responsibilities. Urban users were more likely than rural users to understand their roles & responsibilities.
- **Technical support** was considered timely and useful, particularly by frequent HC and DH users. Frequent and rural users were more satisfied with the timeliness of IT support than non-frequent users.
- **Functionality** of the tool was considered limited, particularly by non-frequent users.

User perception of available training and support

	HC	HC: Rural	HC: Urban	HC: Non-frequent user	HC: Frequent user	DH	DH: Rural	DH: Urban
I am adequately trained on the electronic tools in order to properly do my work responsibilities	25	23	27	22	27	25	25	25
I understand my role and responsibilities but I am not properly equipped	54	77	27	44	60	83	75	88
I understand my role and responsibilities and I am well equipped to carry out my responsibilities	29	8	55	22	33	8		13
The IT support for issues with the eTracker is timely (e.g., assistance logging in)	75	95	55	50	87	92	100	88
(if applicable) The user guides or help functions in the eTracker are useful	89	91	86	79	93	92	31	62
Overall, I think that the eTracker is functioning when I need to use it	50	46	55	22	67	75	100	63

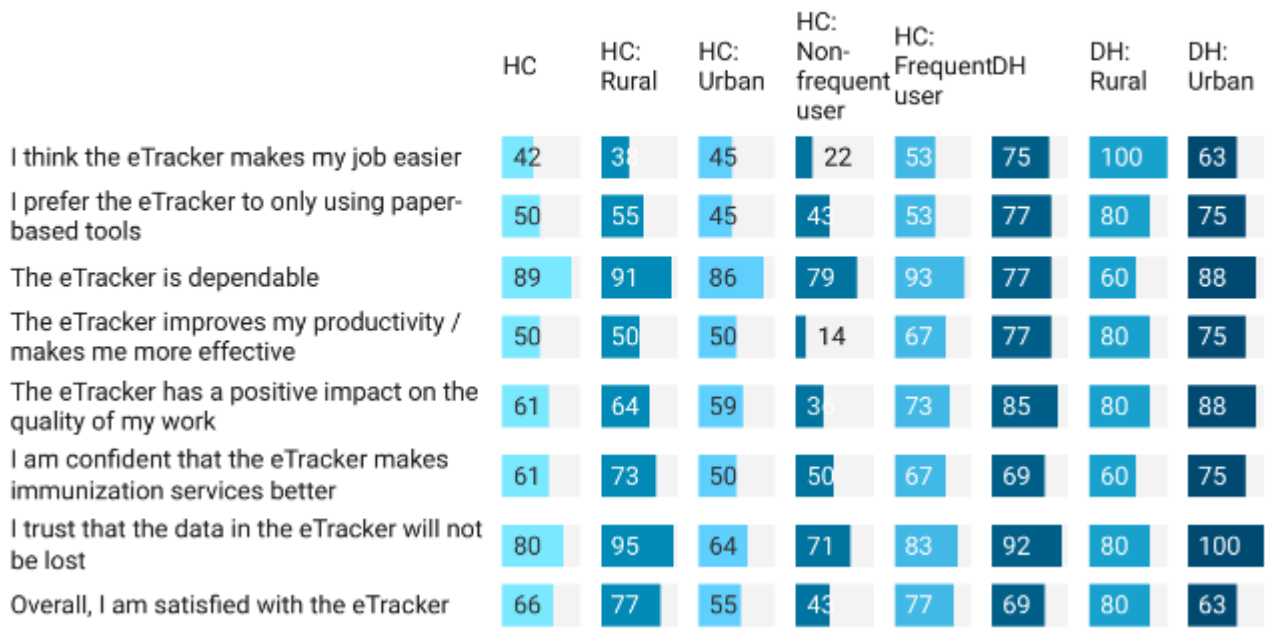
> *"e-Tracker seems to be a powerful tool for vaccine data management, though there are still challenges with its use, and it is overburdening staff due to the duplication of efforts, limited training and high staff turnover." – Enumerator*

Tool functionality

User experience

- **Use:** At the HC level, the e-Tracker was most often used for forecasting vaccine requirements, determining needs for immunization and outreach sessions, and planning for staff needs. At the district level, EPI supervisors used the e-Tracker mainly for program monitoring and evaluation, monthly reporting, and for adjusting supervisory visits to target HCs with low performance.
- **User-friendly & trusted:** The tool was considered user-friendly and HWs trusted that data would not be lost; this was particularly true for frequent and rural users.
- **Efficiency:** While ~half of HC and DH staff thought they could finish tasks faster by using the e-Tracker, use of the tool was overall not perceived to be efficient, due to the duplicate paper / electronic system in place. Frequent users were, however, more likely to state that tasks could be completed faster by using the e-Tracker.

User satisfaction with the tool



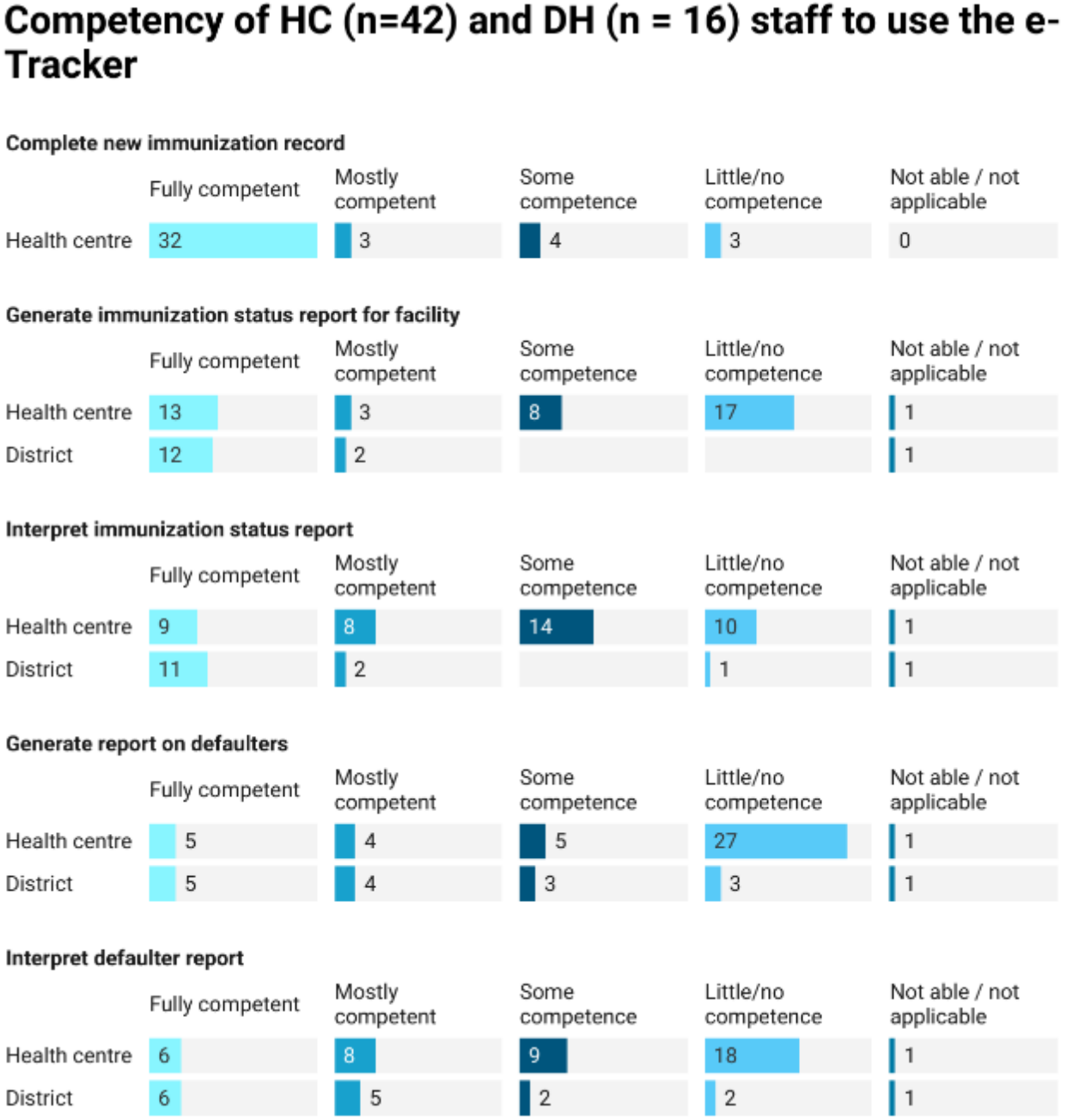
"e-Tracker speeds up our work and gives us the information we need easily." – Health center

Tool functionality

User experience (continued)

- **Impact on time and & management:** Additional staff were required, and staff had to be reorganized to cope with additional workload due to the dual system. Only one third of HC respondents thought the tool had had no impact on staff management; this was shared between frequent and non-frequent users.
- **Computer literacy:** Most users expressed interest in working with computers (89%), had at least moderate skills in using the hardware (93%), and felt that the equipment supported them in being more efficient at work (98%)
- **Competency:** A standard e-Tracker competency assessment was conducted showing limited competence in generating and interpreting immunization status and defaulter reports

> *"Easier retrieving data and stores data for long time…but it requires much time." – Health center*



Findings

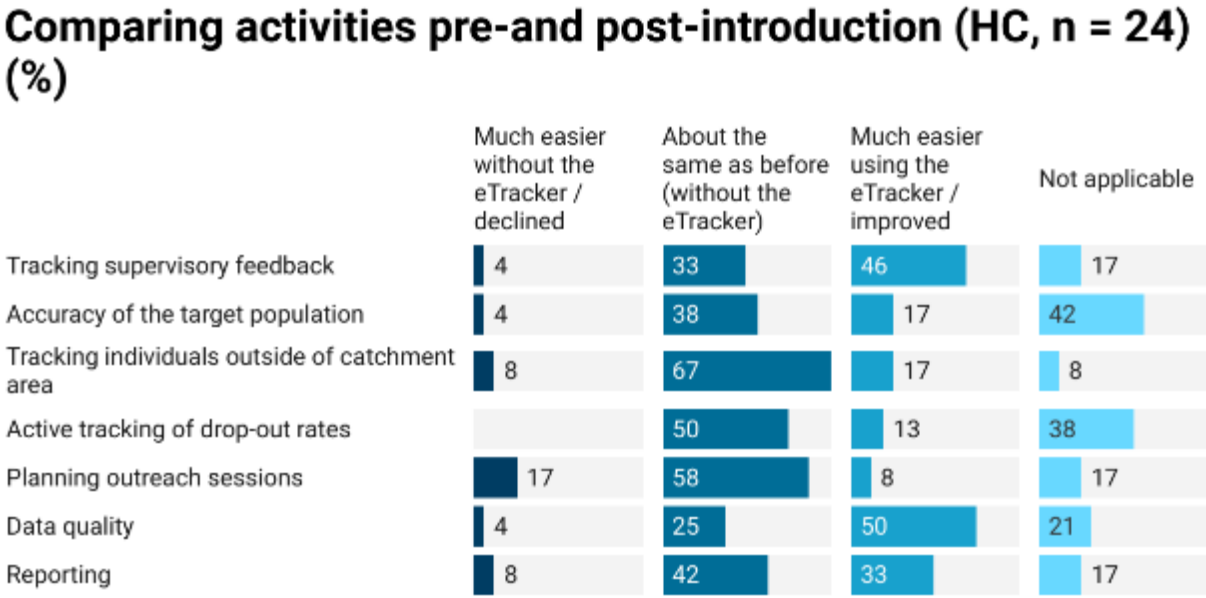
IMPACT

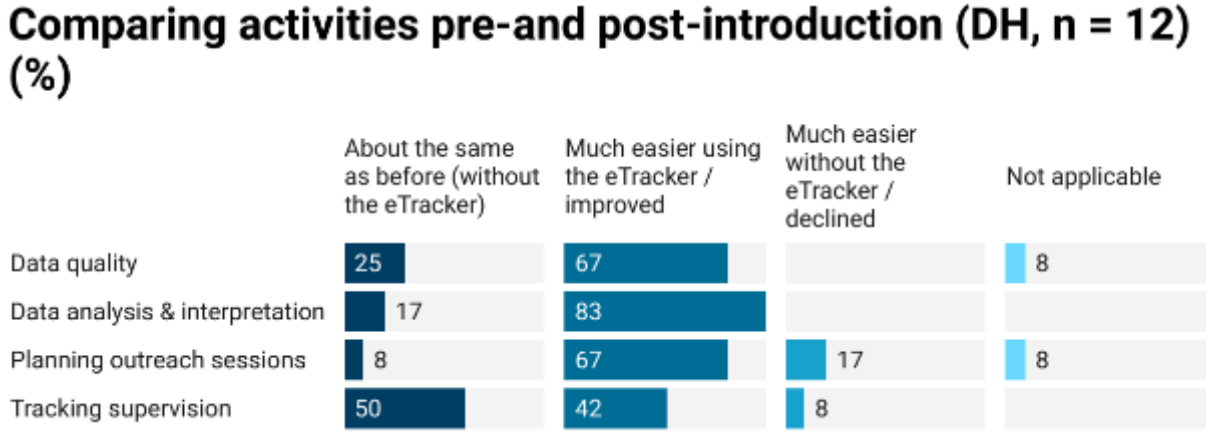
Perceived benefits of the tool

- **Availability of information:** More than half of HC and DH staff felt that the e-Tracker provided sufficient information to enable them to do their tasks. Frequent users were more likely to say so and to state they were able to access information when needed.

- **Caregiver satisfaction:** Less than one third of HCs regularly used the e-Tracker to generate new immunization records for children that had lost their child vaccination card or came from outside their catchment area; caregivers in HCs frequently using the tool acknowledged this as a perceived benefit.

- **Pre-post assessment** showed that about half of HC respondents thought their activities had improved with using the tool. Respondents who reported improvements perceived greatest benefits in the areas of data quality, tracking supervisory feedback and reporting. More than half of district-level respondents thought their activities had improved since the introduction of the tool, most notably in the area of data analysis and interpretation.



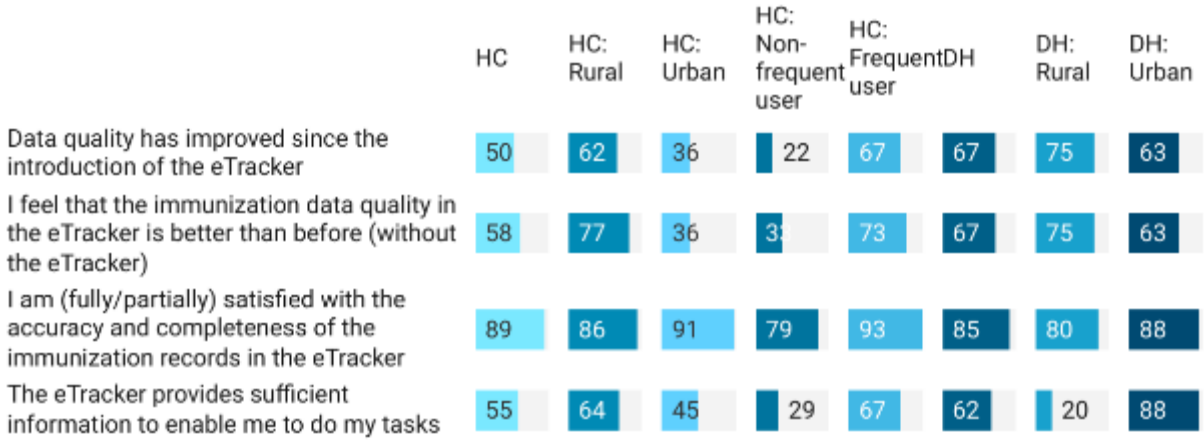


Impact

Data quality

- **Most accurate source of data:** More than three quarters of HC still perceive the paper registry as the most accurate source of a child's immunization history
- **Improved data quality:** About half of HC and two thirds of DH respondents thought that data quality had improved since the introduction of the tool
- **Accuracy & completeness:** About one quarter of HC and DH staff were satisfied with accuracy and completeness of immunization records; frequent users were more likely to be satisfied.
- **Comparison to paper registry:** Rural HC users were more likely than urban HC users to consider the e-Tracker data quality to be superior to that of the paper registry

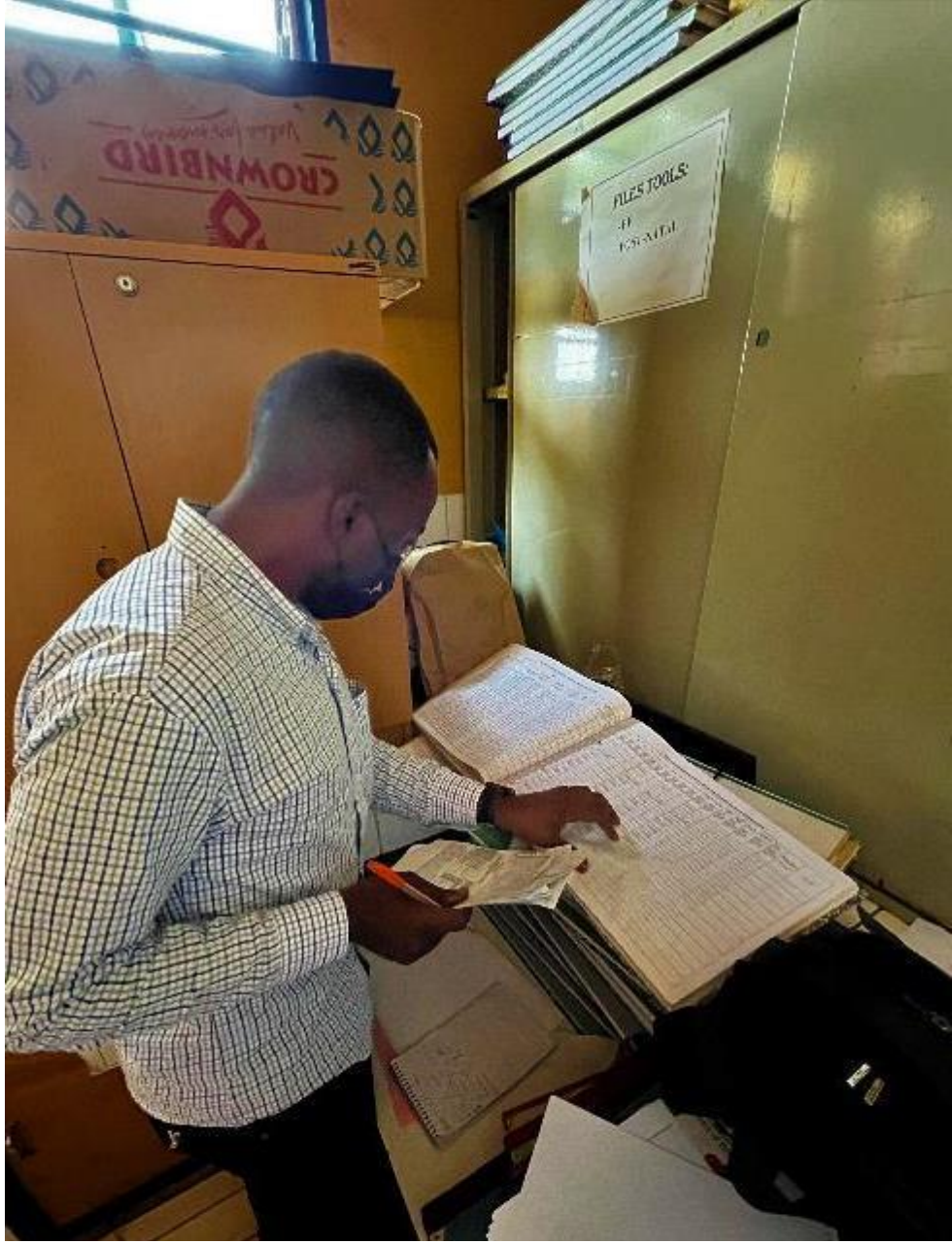
Perceptions of data quality by different users (%)



"Makes the job easier by helping children to be vaccinated and reducing dropouts and paperwork; reduces budget and increases the quality performance of immunization activities."
–District Hospital

On-site accuracy check

- An on-site accuracy data check was conducted comparing data on several variables from three different data sources (e-Tracker; the child paper registry; and the child vaccination card)
- Across all HCs, only 21% of entries matched exactly
- Frequent users were more likely to have entries match exactly, or only with some differences (80%). Only 11% of entries from non-frequent users matched exactly or with some differences.
- There was no relationship between HWs` perception of data accuracy and the accuracy confirmed during the on-site accuracy check

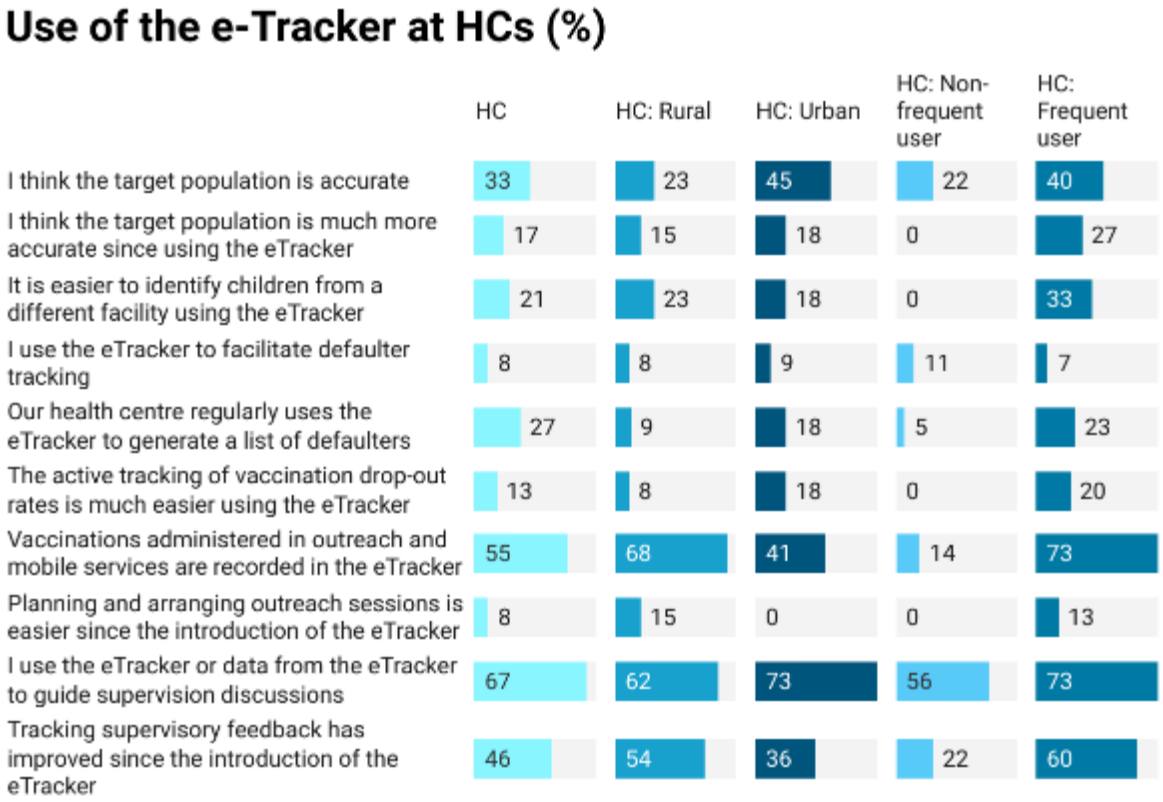


"e-Tracker speeds up our work and gives us the information we need easily." – Health center, Rwanda

Impact

Data use

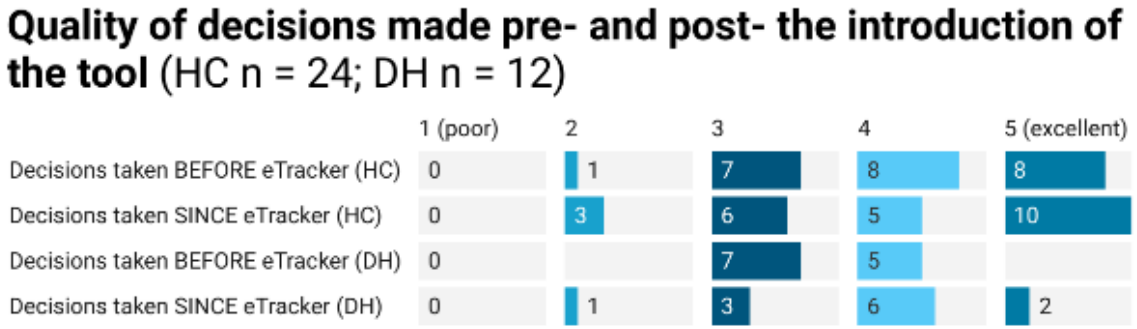
- **Target population estimates** are not yet being impacted due to lack of interoperability with the CRVS so far and the varied use of the tool across the country. Frequent, and urban, users were more likely to think that their target population was accurate, and that this had improved since the introduction of the tool. Frequent users were more likely to state that the tool made it easier to identify children from a different facility.
- **Defaulter tracking, estimation of drop-out rates and supporting outreach services** are activities which are not yet benefitting widely from using the tool; nevertheless, frequent users are more often stating that they are using the tool for these activities.
- **Supervision** activities at HC level are being impacted positively by using the tool. About half of HC and DH level respondents reported that tracking supervisory feedback had improved since e-Tracker introduction.

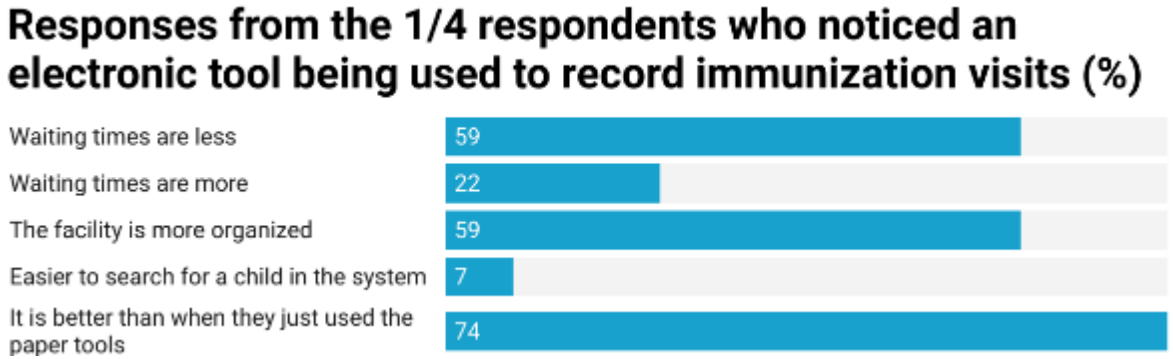


Impact

Data use

- **Performance data:** Three quarters of DHs prioritized needs of HCs based on performance data. The primary source of this data was the paper-based data system (50%), followed by the e-Tracker (33%).
- **Quality of decisions:** District level respondents perceived an overall improvement in the quality of decisions made since implementation of the e-Tracker. Their overall perception was that the tool had positively impacted their work by improving the quality of supervision and feedback.
- **Caregiver satisfaction:** Some caregivers interviewed had noticed HC staff using an electronic tool to record their visits. About a quarter of them had also noticed a difference to their immunization visits since use of the tool, with HCs being more organized and with less waiting times. It was also reportedly easier to search for a child if the caregiver did not bring the child vaccination card.





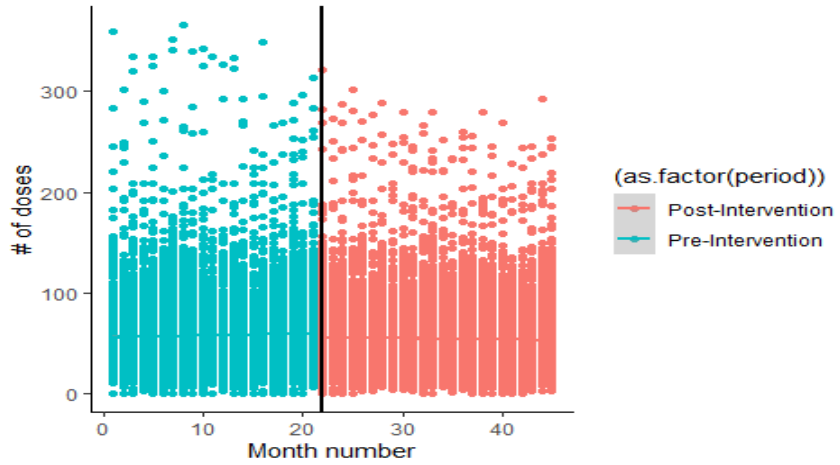
Vaccine uptake trends following the e-Tracker introduction

Interrupted time series (ITS) analysis of EPI data showing impact of COVID-19

The introduction of the e-Tracker coincided with the COVID-19 pandemic and subsequent containment measures.

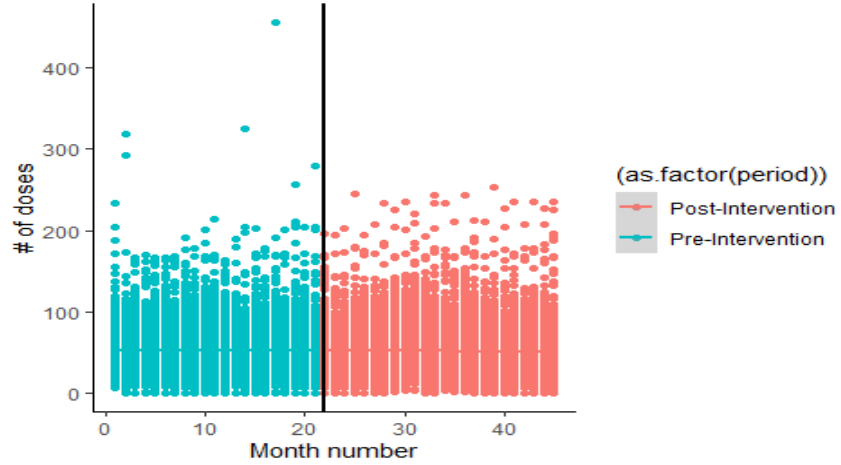
Penta3 vaccine uptake

- Trend analysis shows that for the months following the introduction of the e-Tracker there was a **decrease of administered doses** by 0.3 per month per facility compared to before. The baseline mean number of doses at time=0 (Jan 2018) was 52,6 doses per facility.
- In the months before the introduction of e-Tracker, an increase of 0.09625 doses per month was noted. Post introduction, there was a decrease in doses by 3.5665.



MR2 vaccine uptake

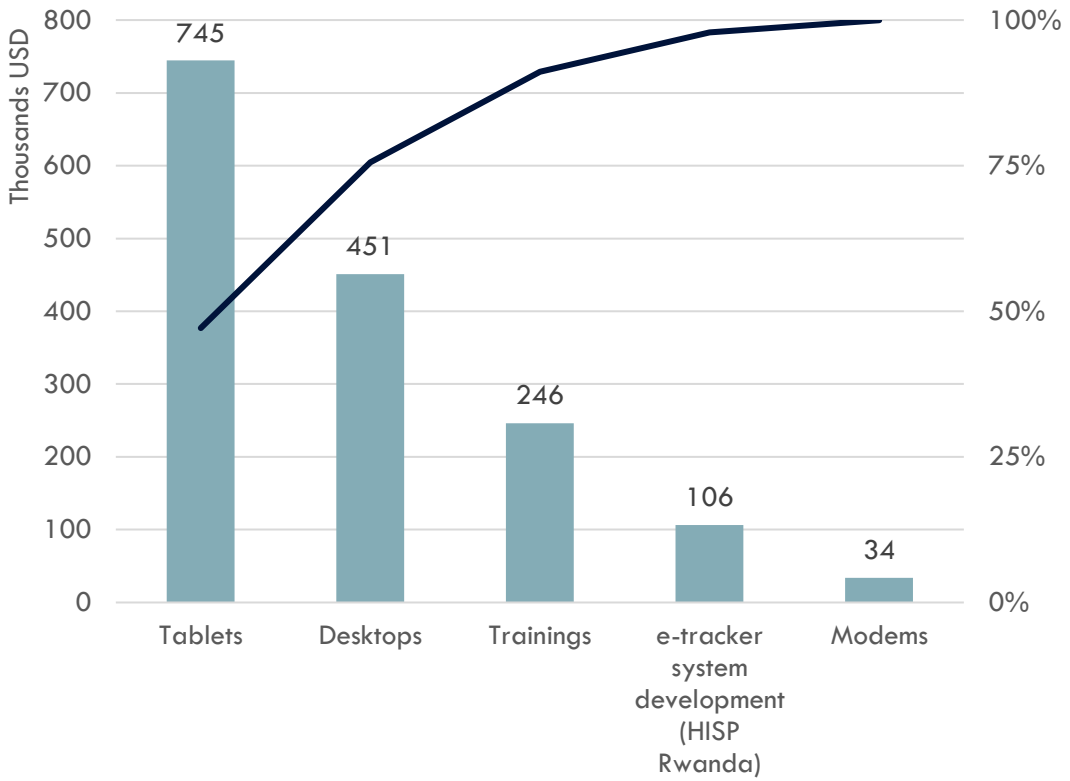
- For the months following the introduction of the e-Tracker there was an **increase of visits** by 0.007 compared to before (n.s.)
- The mean number of doses at time=0 (Jan 2018) was 52.5 doses per facility. For the months before e-Tracker use, there was a **decrease of 0.036 doses per month** (n.s.). Post introduction there was an increase in doses by 0.18 (n.s.)



Findings

COSTS

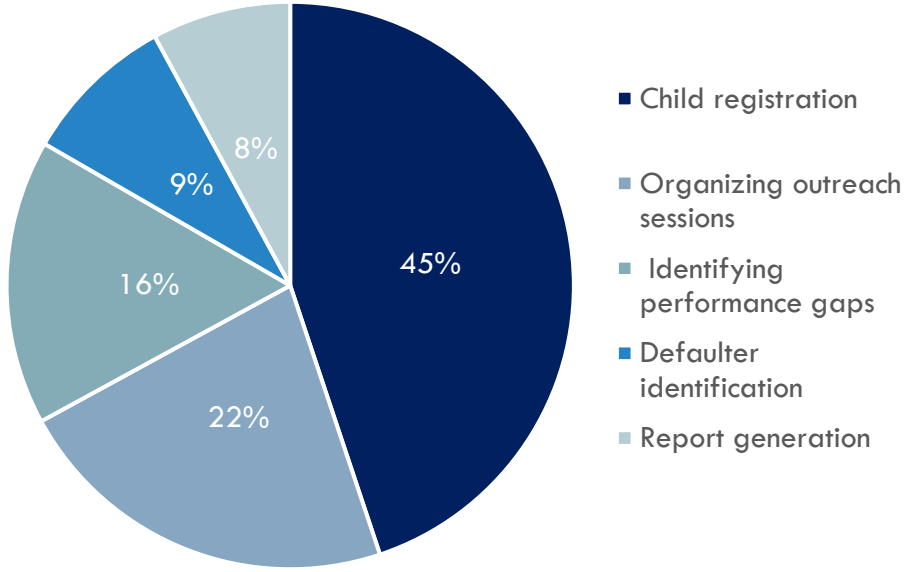
- The majority (77%) of the overall financial expenditure was for the purchase of hardware by RBC which was mainly funded by Gavi
- Trainings accounted for 15% of the total expenditure for implementation
  - Training was delivered to a total of 1,738 HWs through training of trainers and cascade trainings at all administrative levels during a 3-day period
- System development costs contributed 7% to the overall costs



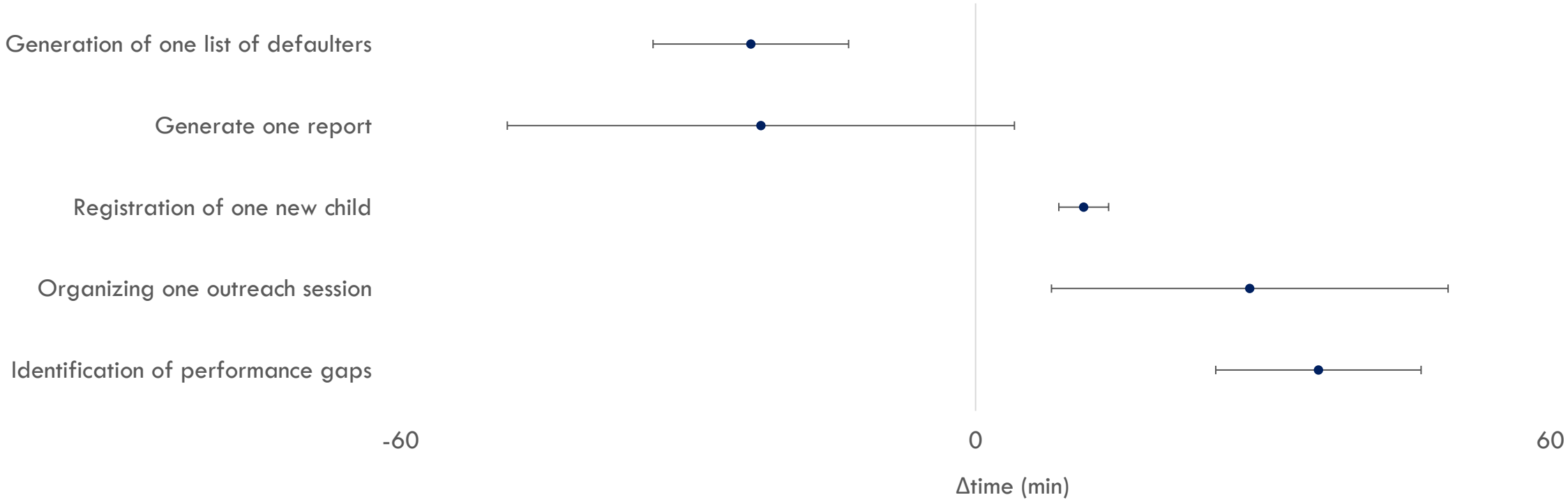
The total financial expenditure of the e-Tracker in Rwanda, as incurred by the RBC with support from Gavi and WHO in 2019, amounted to USD 1,581,229.

- Child registration was the costliest activity, with the average time per child registered estimated at 18 minutes, accounting for 45% of the total cost
  - This result reflects the fact that real-time registration at the point of vaccination is not performed, use of paper registries has been maintained
- The largest cost input was personnel, accounting for 85% (USD 343.6) of the total cost per health center

The resulting total yearly cost of operating the e-Tracker was USD 291,657 or USD 0.09 per dose.



The average cost of performing immunization data management activities using the e-Tracker was estimated as USD 405.2 (95% CI: 350.1, 460.3) per health center, per year.



e-Tracker use has resulted in additional time needed for new child registration, outreach organization and identification of performance gaps, and in less time for defaulter identification and report generation

The implementation of the e-Tracker increased the costs of managing immunization data by 30% by an average of USD 92.5 (95% CI: 24.5, 160.5) per health center

Analytical costs and difference in costs (USD) for immunization data management and activities related to the immunization program with and without the e-tracker (paper only).

Activity	With e-Tracker (USD)	Without e-Tracker (USD)	Mean difference in costs (USD)	P-value
Activities related to immunization data management				
Vaccination session execution: new child registration	184.4 (144.1, 224.6)	106.3 (82.7, 129.8)	78.1 (31.5, 124.7)	0.01
Defaulter identification	36.7 (22.1, 51.2)	36.4 (23.9, 48.9)	0.3 (-18.9, 19.4)	0.85
Organizing outreach sessions	86.6 (57.8, 115.3)	63.3 (39.7, 86.9)	23.3 (-13.9, 60.5)	0.15
Identifying performance gaps	64.7 (47.4, 82)	47.9 (36.9, 58.9)	16.8 (-3.7, 37.3)	0.47
Report generation	32.9 (24.2, 41.5)	58.8 (44.8, 72.9)	-26 (-42.5, -9.5)	0.01
Total	**405.2 (350.1, 460.3)**	**312.7 (272.9, 352.5)**	**92.5 (24.5, 160.5)**	**0.09**
Additional activities related to the immunization program				
Delivering outreach	1,021 (749.5, 0)	1,006.2 (736.3, 1276.1)	14.8 (-368, 397.6)	0.90
Emergency vaccine replenishments	0 (0, 0)	0 (0, 0)	0 (0, 0)	1.00
Total	**1,426.2 (1,149.2, 1,703.1)**	**1,318.9 (1,046.1, 1,591.7)**	**107.3 (-281.5, 496)**	**0.48**

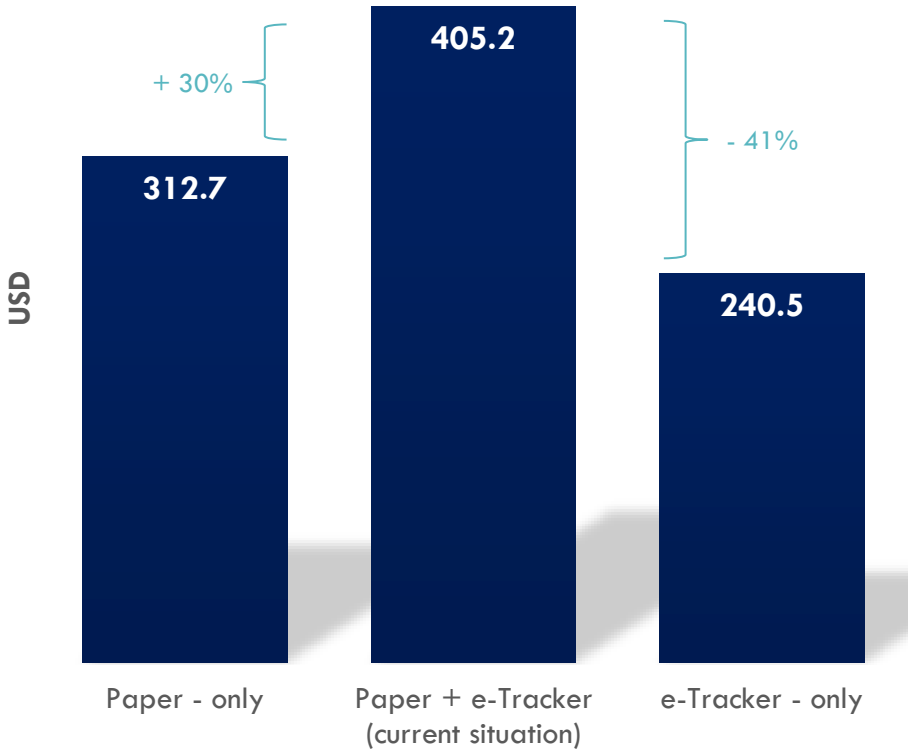
- **Child registration costs increased by 74%** (p=0.01), with all HCs commenting that new child registration was performed first using paper registries and then transferred to the e-Tracker.

Affordability & sustainability

The net cost of operating the e-Tracker of USD 128,735 represents about 1.1% of the average budget allocated to routine immunization activities in 2017-2019 (both external and domestic sources), or 9% of the domestic expenditure for running the VPDP

ITEM	PAPER-ONLY COSTS (USD)	CURRENT COSTS (USD)
Total yearly recurrent cost of using the e-Tracker in all HCs	157,914	204,626
Cost of printing registries at national level for all HCs	5,009	5,009
Cost of refresher trainings for e-Tracker per year*	0	82,022
Total annual costs for immunization data management	**162,923**	**291,657**
Cost per dose	**0.05**	**0.09**

Based on a simulation, the transition to a fully-electronic system from the current situation with both paper and e-Tracker in use will result in a substantial 41% reduction in costs for immunization data management activities per health center



The simulation considered **assumptions** based on the time of only one person needed to perform each activity with a fully electronic system, in contrast to the multiple personnel and duplication of time taken to perform the activities currently first on paper and then electronically.

	Current dual process with paper-registries + e-Tracker	Fully electronic scenario with only e-Tracker used
Staff time		
Child registration	Usually one nurse registering a child on paper. The electronic data input is done at a second time on a computer desktop by the data manager. (estimated time: 18 minutes)	One nurse responsible for entering data on the e-Tracker per child. The time for data entry assumed to be the average time a data manager currently uses to perform the registration. (estimated time: 5 minutes)
Defaulter Identification	Usually one or more staff (nurse, data manager) generating a defaulter list on paper registries and, in a few cases, also on the e-Tracker (estimated time: 94 minutes)	Only one person (nurse or data manager) to execute the activity employing the average amount of time that data managers spend on pulling a list of defaulters from the e-Tracker currently. (estimated time: 8 minutes)
Performance Gaps Identification	Usually one or more staff (nurse, data manager) performing the activity on both paper registries and, in a few cases, also on the e-Tracker (estimated time: 149 minutes)	Only one person (nurse or data manager) to execute the activity employing the average amount of time that data managers spend on pulling a list of defaulters from the e-Tracker currently (estimated time: 98 minutes)
Report Generation	Either one nurse or one data manager performing the activity using both paper registries and, in a few cases, also the e-Tracker. (estimated time: 184 minutes)	Only one person (nurse or data manager) to execute the activity employing the average amount of time that data managers spend on generating monthly reports with e-Tracker currently (estimated time: 52 minutes)
Other costs		
Printing	Currently, reports and child vaccination cards are printed for immunization.	Printing of reports was eliminated from the fully electronic scenario, but printing of child vaccination cards is maintained.
Refresher trainings	Currently, no refresher trainings have been conducted and were added to the total cost of managing immunization data based on the initial investments in trainings during implementation (USD 82,022).	In the long-term, the capacity building component as well as monitoring of the use of the e-Tracker are theorized to be incorporated under the EPI routine supervision activities, without the need to provide annual trainings specifically on the use of the e-Tracker.

High-Level Summary of Findings

Research Questions and Answers

Summary of evaluation findings

	Strengths	Challenges
Ecosystem	• Strong political commitment • Favourable macroeconomic context	• Limited internet access • Insufficient hardware at peripheral level • Overreliance on external funders
Tool	• eTracker fulfils requirements of an "ideal" eIR • Trustworthy and user-friendly tool • Possibility of integrating with CRVS, eLMIS	• Continued use of paper registries • Use of e-Tracker primarily by data managers (not by vaccinators) • Limited interoperability at time of evaluation
Implementation	• Adequate computer literacy and access to IT support • Sufficient access to hardware (computers) • Nationwide coverage of e-Tracker in a short time, enabling holistic support planning • Low customization costs (7% of total implementation costs)	• Limited IT training • Roll-out coincided with Covid-19 (tablets redirected to pandemic response) • Reliance on external funders to cover the investment for implementation (13.8% of annual immunization expenditure)
Impact	• Improved perception of data quality • Improved quality in decision-making at district level • Use of e-Tracker data to guide supervision activities	• Paper registry considered most trust-worthy data source • Estimated increase of total annual cost for immunization data management in Rwanda by 79%
Affordability & Sustainability	• Transition to fully electronic is simulated to be cost-saving, provided infrastructure and capacity building elements are in place	• Parallel use of the e-Tracker with paper registries unlikely to be cost-effective

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

- Due to the limited period of implementation and the effect of the COVID-19 pandemic on both immunization delivery and the roll-out of the e-Tracker, use of the e-Tracker was not expected to have yet had a measurable impact on immunization outcome indicators (e.g., coverage, timeliness, or drop-out rates). In fact, the ITS analysis for DPT3 coverage data showed that for the two years following e-Tracker introduction there was actually a slight decrease of administered doses compared to before e-Tracker use.
- Impact in this evaluation, therefore, focused on process and output indicators, specifically on data quality and data use for decision-making, which are expected to result in improvements of the outcome measures.
- Improvements in these proxy measures were largely experienced by the more frequent users of the tool at HC level and by supervisors at the DHs. This included better access to information needed, improved data analysis and interpretation, better accuracy and completeness of data and easier reporting of immunization data, including from static clinics and outreach services.
- At the same time, the e-Tracker was deemed beneficial for the conduct of supervisory activities and was ultimately considered by its users to have improved the quality of their decisions related to immunization delivery.

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

- The full initial investment of adapting and deploying the e-Tracker at national scale was approximately USD 1.6 million. Most implementation-related expenditures were attributed to hardware. Training was the second highest cost item accounting for 16% of the total cost.
- The use of the e-Tracker has led to an increase of costs for immunization data management activities by 30% compared to only using paper registries. The average cost per HC for performing these activities after the implementation of the e-Tracker is USD 405.2 or USD 0.09 per dose. The majority (85%) of this cost was accounted for by personnel costs and was related mainly to the activity of data entry for each child registered.
- The additional financial burden to the country for the e-Tracker was estimated at approximately USD 128,735 per year, representing approximately 1.1% of the average budget allocated to routine immunization activities in 2017-2019 (or 9% of the domestic expenditure for running the VPDP).
- Given the higher costs of the e-Tracker and the limited impact on immunization outcomes to date, it is highly unlikely that the system in its mode of use before October 2022 (i.e., in combination with the paper registries) would be cost-effective.
- Findings from a simulation exercise suggest that transitioning to a fully electronic system, based on eliminating the duplication of HW time, may result in process efficiencies and substantial cost reductions. This transition is more likely to generate a substantial cost saving as compared to a fully paper-based registry if proper equipment and infrastructure are available at the HCs, as well as provided that adequate training and supervision is performed.
- The macroeconomic context in Rwanda appears to be favorable. However, as the country relies heavily upon external funding, especially for the immunization budget, with only 16% of the budget covered by domestic sources, this may imply that the continuous operation of the e-Tracker could be difficult to maintain should external resources decrease in the future.

How interoperable is the e-Tracker with other RHMIS modules and the civil registration system? [Ecosystem, Tool]

- Despite displaying ideal features of an eIR, the limited interoperability of the e-Tracker at the time of the evaluation was perceived as a significant bottleneck to its effective use. This has subsequently changed with the implementation of new technical features, which now include interoperability with both the CRVS and RapidSMS.
- The additional interoperability with the vaccine logistics management module would further enhance the utility of e-Tracker.
- Sufficient stress-testing for full scale-up of additional features will need to be factored into any future implementation plans given the experience from other countries with similar systems 'collapsing' once fully scaled.

How can new evidence on tools and technologies, modalities, and governance of the e-Tracker inform further investments in other countries from domestic sources, health financing institutions and technical partners for its sustained operation? [Ecosystem, Impact, Affordability and Sustainability]

- A decision to further invest in the e-Tracker should be aimed at ensuring that it is effectively used as a data management and decision-making tool at all levels of the health system. Investments in strengthening digital infrastructure, enabling greater interoperability and improving data quality may create a favorable environment for sharable, high-quality immunization data which, in turn, may constitute a first step towards real-time, data-driven decision-making processes.
- Given the identification of specific barriers and enabling factors, it is recommended that an evaluation framework be developed to monitor the uptake and use of the e-Tracker, as well as to document the process changes as Rwanda transitions to a fully digital system. This evaluation should serve as a baseline assessment with a re-assessment of the situation within 1-2 years of the transition.
- The experience of Rwanda in this transition will be an important learning opportunity for other countries presently exploring implementing similar changes.

Next Steps

Recommend re-assessment following transition to fully electronic system

As of 1 October 2022, paper registries are being phased out as per directive by the Minister of Health. Decision was taken to no longer supply paper registers, effectively ceasing their printing.

eTracker now operates with enhanced functionalities

- Interoperability with CRVS
- Addition of Vaccine Logistics Management (VLM) module
- Activation of Rapid SMS reminders

Tablets have been directed back use for Covid-19 to routine immunization; trainings of HWs on use of the e-Tracker have been conducted anew with aim of achieving **real-time data entry by nurses/vaccinators at time of vaccine delivery using tablets**

This evaluation should serve as a baseline assessment. A re-assessment of the impact on immunization output and outcome indicators of the shift of the eIR to a fully electronic system is encouraged 1-2 years from now.

Limitations

Limitations

1. The short period between the e-Tracker roll-out (2019-20) and the data collection (Q1 2022) did not allow the tool to be fully used, nor initial implementation problems to be resolved.

2. The sample of 24 HCs and 12 DHs coupled with the purposive sampling strategy may have impacted the external validity of the findings. While the sample was shown to be representative of all country HCs offering vaccination for several characteristics, including type and size of health facilities, their immunization performance and the use of the e-Tracker for reporting immunization data, a slight oversampling of HCs with higher dropout rates and larger catchment areas as well as those in urban areas could all have potentially biased findings towards lower use of the tool.

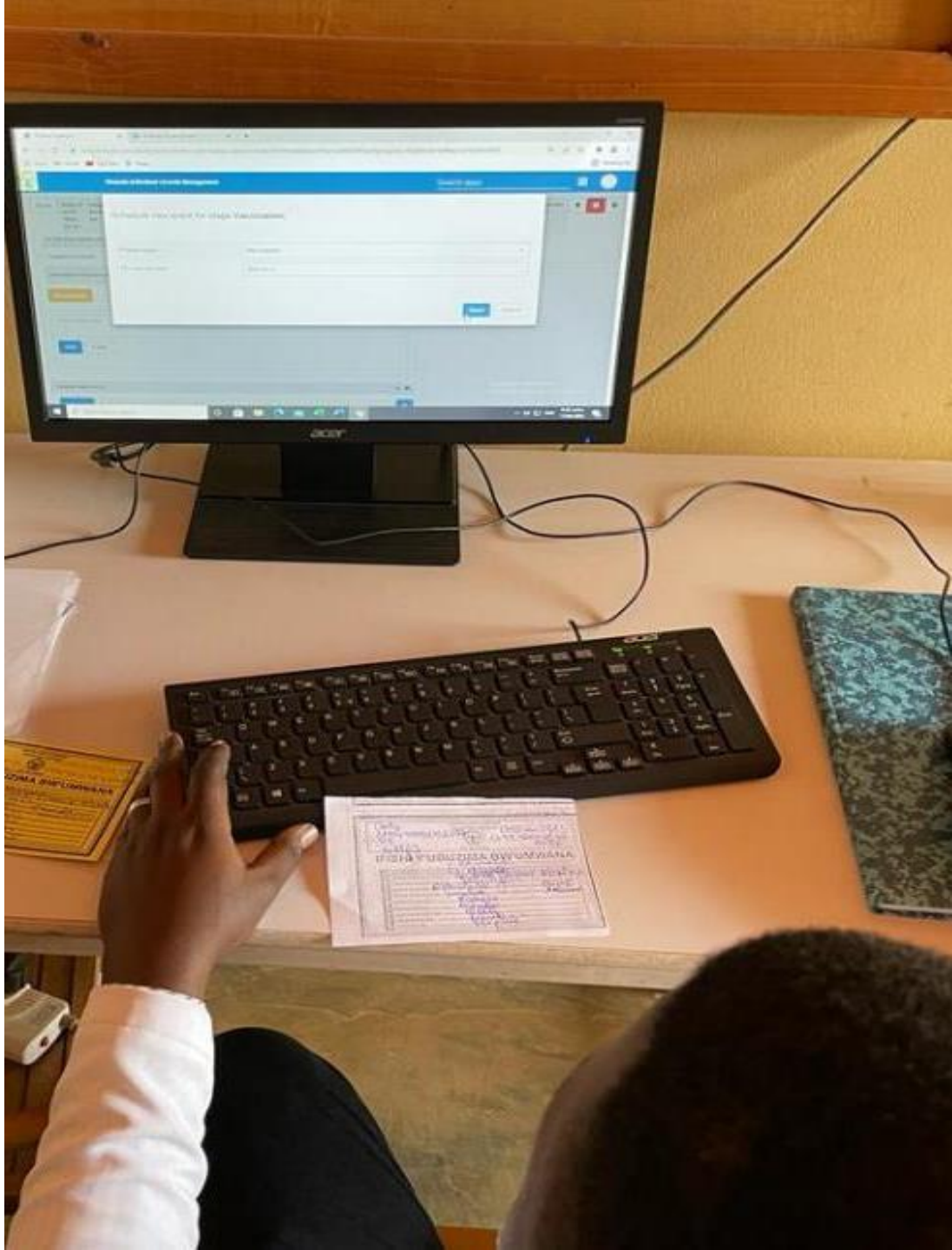
3. The data collected both for the programmatic and economic components consist primarily of perceptions reported by HWs are therefore subject to recall bias.

"Easy to use and ensures consistence of data; but with network problems." – Health center, Rwanda

Limitations (cont.)

4. Recall bias was especially relevant in the cost impact analysis comparing the e-Tracker and the previous paper-based registry system. As the system was swiftly implemented in the whole country, a before and after design was the only option available to quantify impact of the tool use on data management and its costs. However, results of the before and after analysis are consistent with trends observed comparing frequent and non-frequent users. In addition, secondary data sources were explored to validate data obtained from primary data collection.

5. Statistical outliers were excluded during the analysis of data used for estimating the cost of the e-Tracker due to their considerable impact on mean estimates. This resulted in a further reduction of the sample size for some of the activities considered in the cost analysis. This reduction was, however, relatively small, with a maximum of 2 outliers per variable removed from the analysis.



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