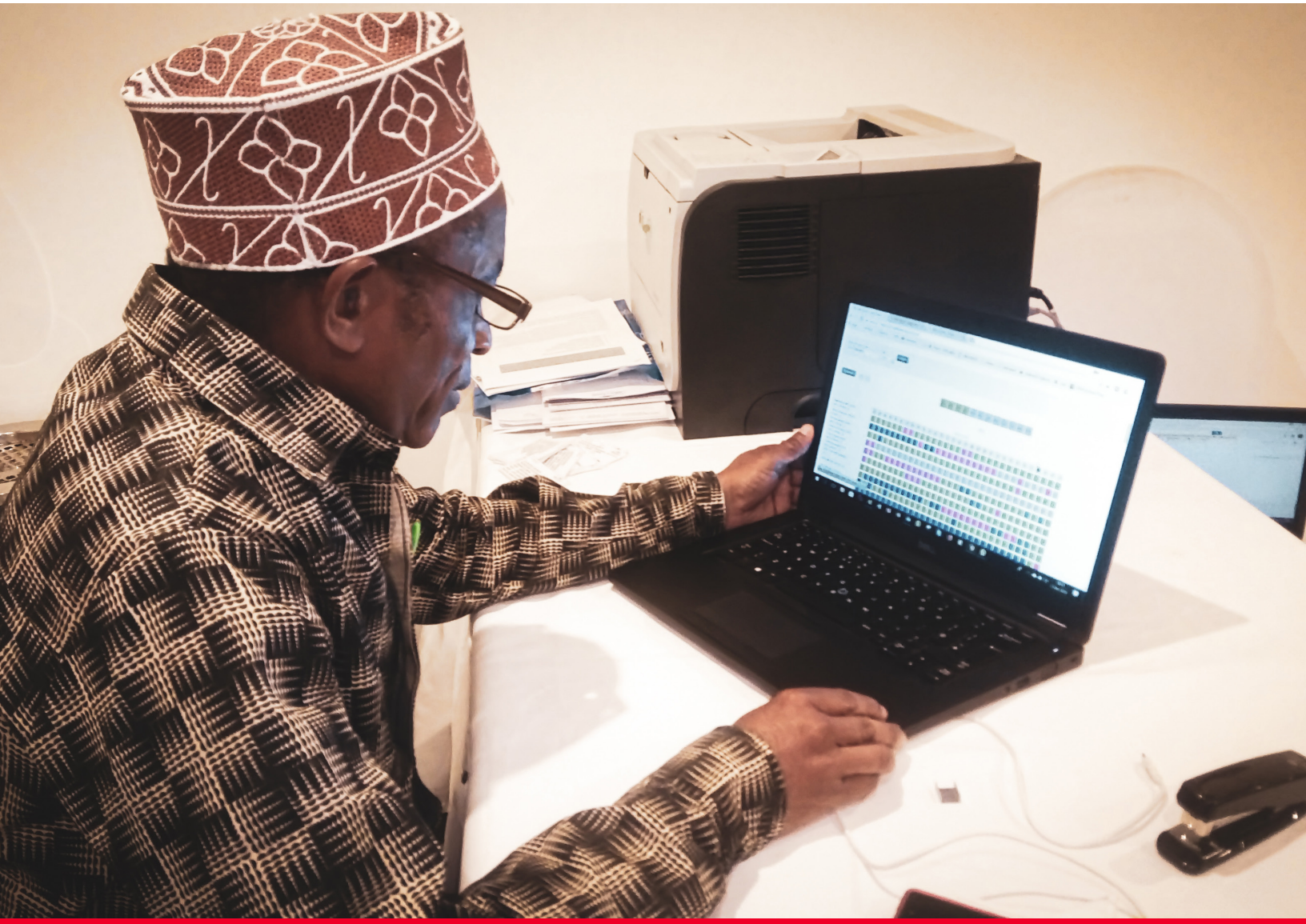


# Tanzania Remote Temperature Monitoring

March 2020

Cover Photo Credit: JSI
Caption: RIVO from Morogoro region reviewing RTM dashboard.

## Background

JSI Research & Training Institute, Inc. (JSI) and Nexleaf Analytics (Nexleaf) are collaborating with the Tanzanian Immunization and Vaccination Development (IVD) of the Ministry of Health, Community Development, Gender, Elderly and Children (MoHCDGEC), with support from Gavi, the Vaccine Alliance, Google.org, and the ELMA Foundation to install WHO-certified Remote Temperature Monitoring (RTM) System using ColdTrace 5 (CT5) devices in up to half of all health facilities and District Vaccine Stores (DVS) in Tanzania to strengthen vaccination management in the country. The RTM system is designed to monitor the temperatures of the cold chain equipment (CCE) used to store vaccines. The devices send data to a dashboard which is linked to the Vaccine Information Management System (VIMS). The ColdTrace system also sends SMS alerts to responsible health workers for immediate action to help prevent vaccine spoilage and reduce wastage. The objectives of the RTM System include improving cold chain storage performance, reducing vaccine wastage, ensuring potent vaccines are administered to the clients, and monitoring the performance of CCE for better long-term planning of equipment needs.

This project is directed and coordinated by the MoHCDGEC, IVD, and President's Office-Regional Administration and Local Government (PORALG) for sub-national implementation and monitoring.

Overall RTM activities are mapped out in phases:

- Pre-deployment phase consisted of installation, support and monitoring of 120 devices in Morogoro as a test bed for scale up; integration of the RTM dashboard into VIMS. Early 2017 through mid-2018.

- Phase 1 involves installation, support and monitoring of 1,800 devices in 52 districts. This report summarizes these activities to date, from mid-2018 through the end of 2019.

- Phase 2 will continue scaling up with an additional 3,000 devices, expected to continue until the end of 2020.

## Implementation Summary

Details of the pre-deployment phase were described in a report released in May 2018, noting practical lessons learned that were incorporated into Phase 1 of the project with the next 1,800 devices. A summary of activities for each phase is included here, as well as insight into analytics and performance of the CCE and RTMD.

### Pre deployment

*Site selection.* The pre-deployment phase of this project began in 2017 with the first 120 devices installed in health facilities and DVS in six councils in Morogoro region. (Ifakara TC, Mvomero DC, Kilosa DC, Morogoro MC, Kilombero DC, and Ulanga DC). The Technical Working Group for IVD decided to start with Morogoro due to the ease of access for monitoring and responding to issues, and because it is a region with diverse weather conditions, potentially affecting the performance of the CCE. The councils shared information on the health facilities regarding network and power availability to help selection process for the facilities, procurement of network service providers, and other relevant requirements.

*Training.* Nexleaf and JSI conducted 3 days training in November 2017 to IVD, PoRALG, RIVOs, Assistant RIVOs and installation teams that comprised of DIVO and assistant DIVO from the six councils. The training covered theories of basic RTM, practical sessions for Installation, installation data collection tools (LogME and Paper Version), and access of RTM data on the dashboard.

*Installation.* After training, two installation teams from each council were tasked to install the RTM devices at the DVS and selected health facilities. The installation started in late December 2017 and completed in January 2018. The installations were planned together with PoRALG and IVD; as directed by PoRALG, councils provided shared vehicles for the installation process, which caused some delays with coordinating the vehicles. The DIVOs lead the activity.

**Distribution of RTMD, Pre-Deployment Phase**

| | Council | DVS | Health Facility |
|---|---|---|---|
| 1 | Ifakara TC | 1 | 4 |
| 2 | Kilombero DC | 1 | 23 |
| 3 | Kilosa DC | 2 | 23 |
| 4 | Morogoro MC | 1 | 33 |
| 5 | Mvomero DC | 1 | 24 |
| 6 | Ulanga DC | 1 | 6 |
| **Total** | | **7** | **113** |

*Monitoring and maintenance visits.* DIVOs conducted maintenance visits to few facilities with challenges of CCE and minor RTM problems to resolve when possible and escalate complicated issues to the higher level. Through these visits, four councils invited national technicians to resolve complicated CCE issues. JSI provided addi-


**DIVO and Assistant DIVO from Morogoro Municipal Council observing ColdTrace device.**

tional monitoring visits to help the DIVOs resolve some of the issues that were beyond their capability, such as replacement of SIM cards on the areas with network problems.

*Integration of information systems.* Integrating RTM data into VIMS took longer than originally expected. Extra effort was required to ensure consistency of facility names in both platforms and serial numbers of the cold chain equipment, delaying the overall process. The integration of RTM data into VIMS prompted the IVD team to ask for additional data reports based on new visibility of CCCE performance.

*Lessons learned.* Through the pre-deployment phase, IVD, JSI, Nexleaf, RIVOs, and DIVOs have learned a lot about the entire process required to set up the RTM system in the country. The nuts-and-bolts lessons in terms of importation process, site preparation, device installation, and coordination have been incorporated into Phase 1 activities. These are also detailed in the report from May 2018.

*Data sharing.* RTM data is shared during regional Maternal and Child Health quarterly meetings to bring attention to the need for high performing CCE, linking the supply chain to the programmatic aspects of child health. The team also closely collaborates at the national level, regularly sharing RTM data through IVD's Technical Working Group, and particularly the Logistics Sub-Committee. Additionally, these data were presented during the IVD annual meeting and Joint Appraisal, contributing to overall program planning and performance review.

*Coordination.* A key success to implementation has been using the WhatsApp group since the beginning of the project. DIVOs often share experiences of how they have managed to resolve some of the CCE and RTM issues; the platform is used to share issues and seek for assistance from colleagues and peers, especially technicians.

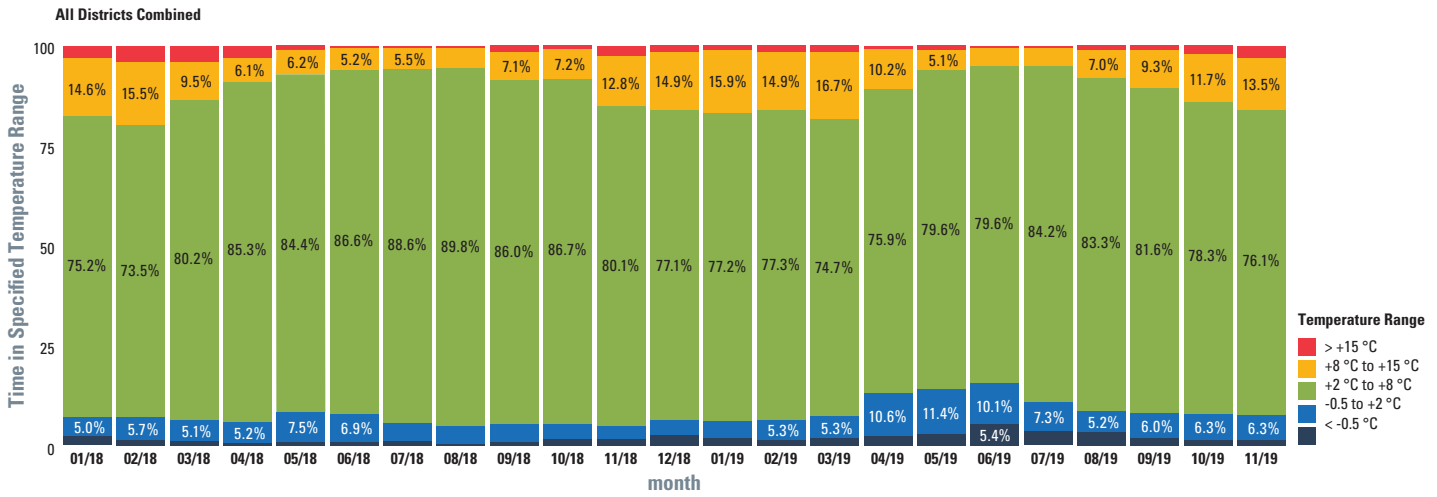
### Phase 1 Deployment

*Site selection.* The TWG agreed to prioritize seven Regions (Dar es Salaam, Morogoro, Dodoma, Tabora, Shinyanga, Mwanza and Kagera). We collected data on the facilities in these regions to determine the readiness, power, and network availability to facilitate the smooth operation of RTM devices.

*Training.* Using the same curricula from the initial pre-deployment training, IVD, PoRALG, JSI and Nexleaf conducted a 3 day training two times in April 2019 to train about 110 RIVOs and DIVOs.

*Shipment and distribution of RTM devices.* Demonstrating ownership and leadership for RTM, IVD was responsible for delivering the devices to the regions, ensuring that the equipment followed government procedures from national level to the regional level.

**Figure 1: All RTMDs overall performance, 2018-2019**




IVD distributed the devices and other accessories using the Ministry vehicle while JSI supported fuel and allowances. Same government procedures were followed for distribution from the region to the council level and on to the facilities. Distribution included RTM devices, solar panels for facilities that would require it, electricity chargers or solar adapters (as appropriate), and wire bundles to ensure tidy installation.

*Installation.* During installation of the pre-deployment devices, the installation teams had to arrange minor things such as electricity sockets or extension cables for the RTM devices during installation. With this phase of installation and in an effort to facilitate installation, DIVOs instructed all facilities to have the location ready for the RTM devices, including access to a ladder for those devices requiring a solar panel to be installed on the roof. This instruction was somewhat adhered to by the facilities.

Installation began in October, 2019, beginning with Morogoro region. Installation was delayed from the original plan due to delay of clearing the devices from customs and then other IVD priorities, namely the measles-rubella campaign. Installation is expected to be complete by the end of January 2020.

The teams install the devices, place the excursion response SOPs in the facility, orient the healthcare workers on the proper use of the RTMD and what they need to do in case of temperature excursions. Finally, they track progress of installation on the LogMe application.

## CCE and RTM Performance

Through the use of the dashboard and RTM data, DIVOs are able to pinpoint the CCE issues and make better decision to resolve the issue or change the use of the CCE. Additionally, the improvement of the performance of the CCE in terms of time spent in the ideal temperature range implies the SMS alerts are driving more immediate action to resolve issues with the CCE. The data below reflects the entire pre-deployment phase with 120 devices.

### *Indication of seasonality*

Looking at the overall performance of all 120 devices for the first two years of deployment, the data implies seasonality linked to the performance of the cold chain (Figure 1) with hotter ambient temperatures from November to February causing the CCE to have higher heat alarms. When looking at each district individually over the same time period, it is clear that the cold chain in some districts is better performing than in others. This overall performance also masks the nuances in each individual piece of equipment, and the actions that are taken based on the SMS alerts and visibility into the cold chain performance. In the case of CCE failure, health facilities will store vaccines at a neighboring facility until the CCE is functioning again.

### *Improved insight into CCE maintenance and use*

Certain patterns in the RTM data indicate common maintenance issues or adjustments that are necessary. Figures 2 and 3 show a CCE pattern of instability and hot alarms. An adjustment to the thermostat largely resolved the issue. Understanding the data patterns have allowed DIVOs to provide remote technical assistance, reducing the costs and time previously required for this type of assistance.

### *Overview of performance issues*

In preparation for full scale of Phase 1 with the additional 1,500 devices to be installed, the team analyzed issues in the system, both with the CCE and the RTM, identifying the main areas of issues (Figure 4):

**Figure 2: Health facility with thermostat adjustment**

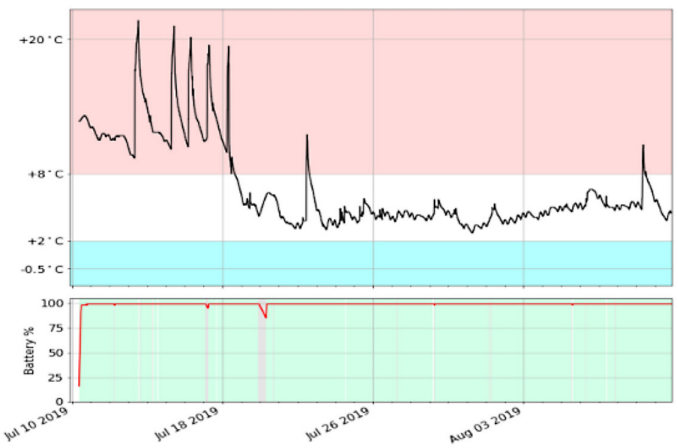
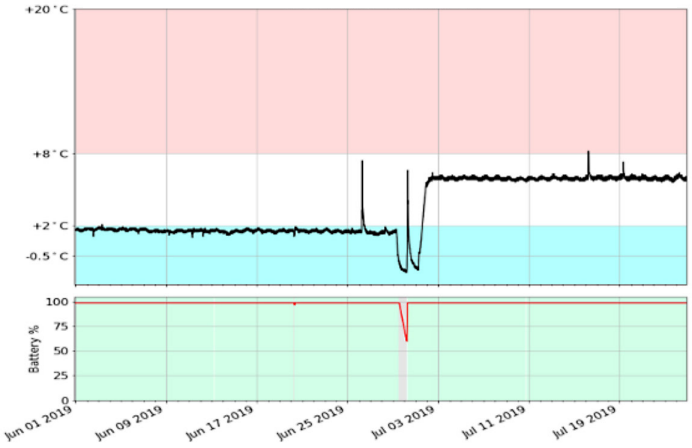



**Figure 3: Health facility with thermostat adjustment**




1. Cold chain equipment: Underperformance can be categorized into simple fixes such as a thermostat adjustment and larger problems that require more skilled technical maintenance.

    a. Thermostat adjustments: The RTM data indicates this issue when the CCE operates just above +8oC or below +2oC for a long period of time. This may be due to the older age of the equipment, or health care workers who have not been oriented on the cold chain management at the health facilities. At the time of the analysis, the data indicated that the issues in 77% of CCE could be resolved through adjusting the thermostat.

    b. The remaining 23% of CCE with issues need more complex corrective maintenance and most likely require spare parts and a technician.

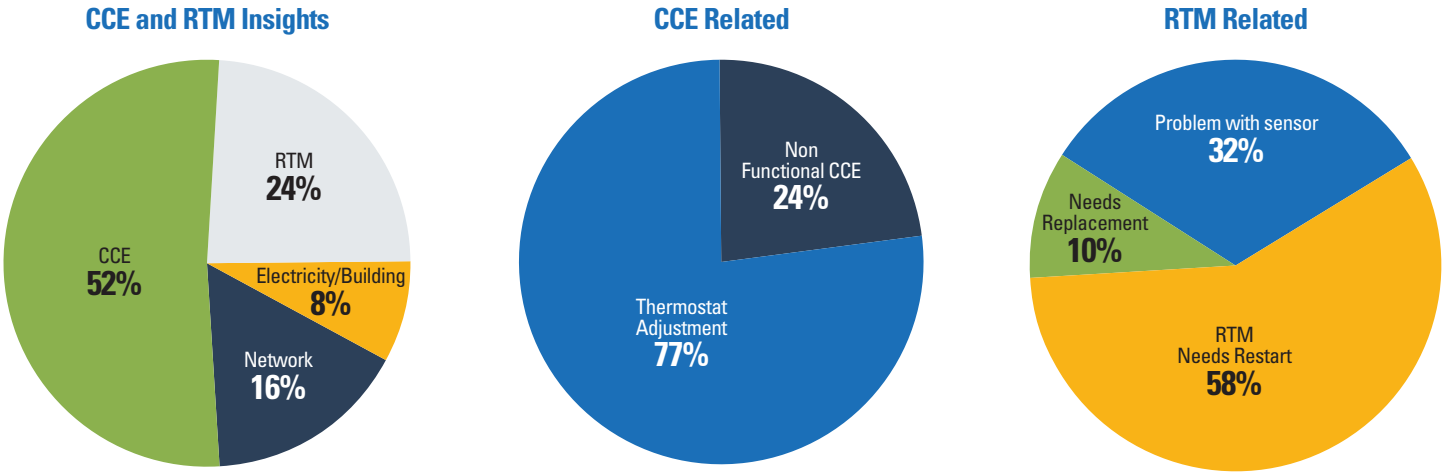
2. RTM devices: Issues with RTM devices fall into three categories:

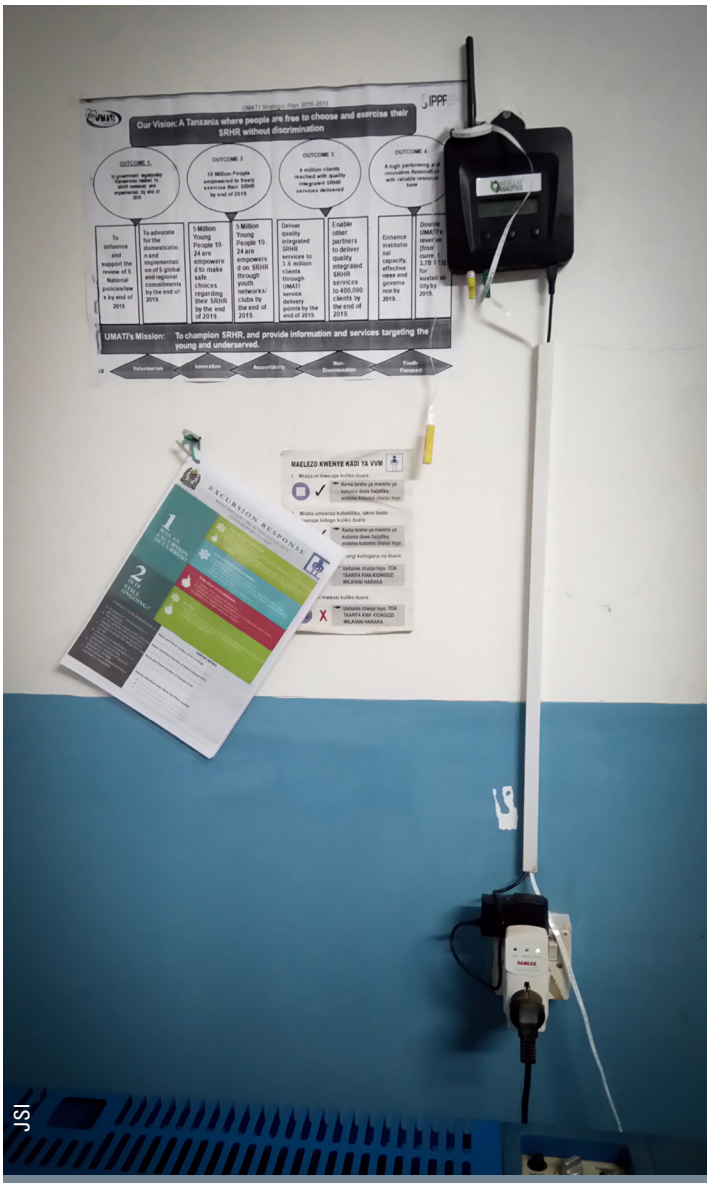
    a. The device needs a restart (58% of the devices at the time of this report). This can be done by a simple phone call to the facility.

    b. Problem with sensors. The sensors of the RTM Device have proven a bit sensitive in some cases at the door of the CCE or due to tray movement within the piece of cold chain equipment. This is resolved through replacing the sensors and must be addressed through a technician, DIVO or RIVO.

    c. At the time of this report, about 10% of devices are either defective or not performing properly and need to be replaced.

**Figure 4: RTM and CCE underperformance and insight into the reasons.**






**Fully installed in Umati health facility in Morogoro Municipality.**

Other general issues are related to the health system and the context of the facility:

1. The telecommunications network doesn't allow for sending data to the dashboard consistently due to:

    - Unreliable network in some areas due to long distance from the cell towers
    - Procured service providers do not operate in some areas or their network is very weak
    - Removed cell towers due to change of land use and service providers shutting down operations for different reasons.

2. Power stability to the health facility and RTM device provides the lifeline of the operation of the RTM devices to send data to the dashboard. The following factors contribute to the issues:

    a. Frequently power outages contribute to the loss of RTM data especially when it takes a long time to return. The RTM device can turn off without an alternative power source. It may result in missing data if the battery of the RTM is also drained during power outage.

    b. Most of the health facilities do not have voltage stabilizers to accommodate both CCE and RTM devices. When fluctuation of the power source happens, both pieces of equipment may suffer the consequences.

    c. In some cases, the health facility management may delay in procuring or paying electricity bills for the facility, thus creating an artificial power outage, impacting both CCE and RTM.

### *Accuracy of data*

Health facilities continue to report temperatures through their monthly paper forms. It has been interesting to compare these data points with RTM and FridgeTag data as well. Figure 5 below shows one such case of a facility with a discrepancy in the reporting. The manual reporting missed a high temperature alert that was captured by the RTM and FridgeTag. This mismatch may be due to not properly filling out the temperature monitoring chart or using an outdated version of the chart without the minimum and maximum temperatures to record.

### *RTM as part of a system*

As we have seen, RTM provides greater insight into the performance of the CCE and when vaccines are at risk. The visibility is helpful for DIVOs, RIVOs and national level decision makers to provide maintenance, organize spare parts, and plan for long-term CCE replacement and procurement. At the facility level, the alerts drive immediate action to resolve an issue to prevent vaccine loss. It is important to note that RTM is just one part of an overall system that has to be supported and strengthened in order to ensure CCE is functioning well and vaccines are in the correct temperature range. The system depends on many things including, among other things: a budgeted and accurate CCE maintenance plan, spare parts that are inventoried and managed, trained technicians with the required resources such as vehicles and fuel to travel to CCE that need corrective maintenance, regular preventive maintenance of the CCE, daily temperature monitoring, and proper vaccine handling practices.

**Figure 5: Comparison of temperature data from three sources: manual recording, RTM and FridgeTag**

**1. Temp data recorded by HCW in VIMS**

| Refrigerators Temperature Monitoring | | | | | | |
|---|---|---|---|---|---|---|
| Refrigerator information | | | Temperature | | No. of Alarm Episodes | |
| Type | Model | Energy Source | Min | Max | Low Temp | High Temp |
| | RCW50EG | | 4 | 6 | 0 | 0 |

**2. Temp data from RTM in VIMS**

| Temperature | | Temperature Alarm Episode | |
|---|---|---|---|
| Min | Max | Low Alarm | High Alarm |
| 3.60 | 11.40 | 0 | 1 |

**3. Portion of fridge tag printout**

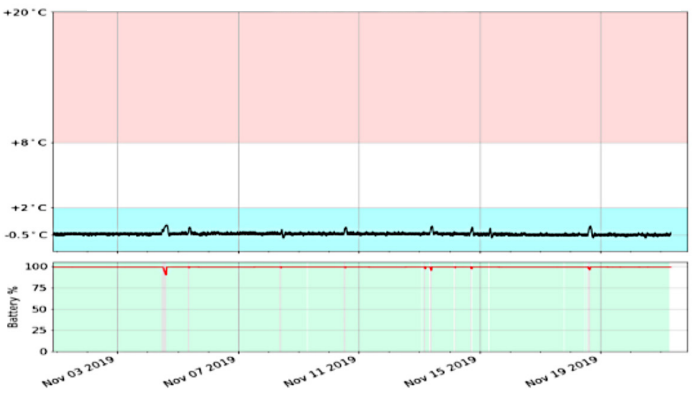
| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 36 | 26.09.2019 | | +4.6°C | ok | +3.5°C | 0min | | ok | +4.8°C | 0min |
| 37 | 25.09.2019 | | +4.5°C | ok | +3.5°C | 0min | | ok | +6.5°C | 0min |
| 38 | 24.09.2019 | | +6.1°C | ok | +4.1°C | 0min | | ok | +6.3°C | 0min |
| 39 | 23.09.2019 | | +5.4°C | ok | +4.3°C | 0min | | ok | +11.°C | 3h 20min |
| 40 | 22.09.2019 | | +4.7°C | ok | +3.6°C | 0min | | ok | +8.4°C | 4min |

Examples of the system perspective that are notable through this RTM deployment:

- Documenting the inconsistency between RTM and FridgeTag data and the manually reported temperatures has prompted exploring other opportunities to sensitize health workers on temperature monitoring charts and how to adjust the current practices with the new technology that is available.
- When a CCE is not functioning, the healthcare worker will typically remove the vaccines and store them at a neighboring facility with more reliable CCE. This is not captured by RTM, but is captured by understanding the context and vaccine management practices.
- Also related to understanding the context, some CCE are used as freezers for either ice packs or freeze-safe vaccines (Figure 6).

The difference between freezer and refrigerator is indicated on the RTM Dashboard for clear understanding of the context.

**Figure 6: Based on the RTM data, this CCE will not be used for freeze sensitive vaccines.**



- Having access to funds for maintenance is a notable challenge for immunization programs. In Tanzania, some districts have allocated funds for repair of CCE in order to facilitate the process of arranging the national level technician to support any corrective maintenance if the district technician is not able to resolve the problem.
- The inventory and management of spare parts is still a challenge. Often, districts do not know what spare parts they need, and national level does not know what spare parts they have in inventory. Analysis of RTM data can provide insight into what spare parts are needed, but it still requires a technician (and the system to support it) to provide the maintenance.

## Total Cost of Ownership

We estimate the total cost of ownership (TCO) for operating costs is $46 per device annualized over a three year period. This does not include the actual cost of the device. This represents actual costs of training, distribution of the devices to the districts, installation of devices, assumption of follow-up visits to 20% of facilities to adjust the device or SIM card, and SMS and data costs.

| RTM TCO TOOL | 1419 devices installed in Oct - Feb (out of 1457 total, 38 to be used as spare parts) | | | |
|---|---|---|---|---|
| **Cost category** | **Unit of measure for unit costs** | **Quantity** | **Unit cost ($)** | **TOTAL Costs ($)** |
| Devices and Systems Costs | Not included in this analysis | | | |
| *Subtotal - Device and System Costs* | | | | |
| **Training Costs** | | | | |
| Training of District staff | | | | |
| Conference package (room rental) | each | 2 | $4,070 | $8,140 |
| Job aid for all facilities | each | 1180 | $0.98 | $1,156 |
| Per diem / sit in allowance | each/day | 135 | $77 | $31,185 |
| *Subtotal - Training Costs* | | | | *$40,481* |
| **Installation Costs** | | | | |
| Distribution costs (Dar to districts) | total cost to 5 regions | for 1457 devices | $1,875 | $1,875 |
| Installation kit (trunks, tape) | each | 1419 | $0.90 | $1,277 |
| Installation Cost for RTM | | | | |
| Fuel / transport costs | est. cost per device | 1419 | $9 | $12,104 |
| Per-diem for technician | est. cost per device | 1419 | $11 | $15,793 |
| Per diem for driver | est. cost per device | 1419 | $9 | $13,154 |
| *Subtotal - Installation Costs* | | | | *$44,204* |
| **Recurrent Costs** | | | | |
| Time period (months) | | | | |
| Communication / SMS costs | each device per month | | | |
| Tigo | per device per month | 510 | $0.91 | $16,708 |
| Airtel | per device per month | 1500 | $0.68 | $36,720 |
| Communication / SMS costs (Gateway) | fee per month | | | |
| Server / data storage (if any) | each device per month | | | |
| Fuel / transport costs for ongoing monitoring | each trip | 284 | $20 | $17,040 |
| Per-Diem Driver for ongoing monitoring | Per day | 284 | $50 | $42,600 |
| *Subtotal - Recurrent Costs* | | | | *$113,068* |
| GRAND TOTAL | | | | $197,753 |
| *Cost per RTM (over a 3 year period)* | | | | *$139.36* |
| *Annualized cost per health clinic* | | | | *$46* |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