IN PARTNERSHIP WITH

COLD CHAIN EQUIPMENT (CCE)

Costing framework, considerations and guidance

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1. Background

The Cold Chain Equipment Optimization Platform ("CCE Platform") was borne out of the Alliance Supply Chain Strategy approved by the Gavi Board in June 2014. The CCE Platform looks to address the need for additional CCE, given the increase in the number and volume of vaccinations required and new types of CCE available to suit different environments. Application for funding from the CCE Platform is contingent upon certain criteria, one of which is a costed maintenance plan for all CCE. The CCE Platform will also provide technical assistance in the form of individual experts to support countries in development and implementation of their plans and of tools that can help countries make decisions about their CCE structure and budget.

A desk-based review of one of these tools, the PATH Total Cost of Ownership (TCO) model, was performed. This tool is intended to be used prior to procurement of new equipment under the CCE Platform, for both budgeting purposes and equipment selection. Insights on the tool components and key output elements were reviewed during a discussion with one of the developers, Matt Morio of PATH. While the model is well-thought through, user-friendly and flexible, its effectiveness in the field may be varied. And even if the tool is used to show the TCO of different models of CCE, it does not necessarily dictate or capture final decision-making. However, with limited refinement, the TCO tool will still be useful and fills a gap in overall CCE management.

Following the exercise of using the TCO tool to drive budgeting and procurement decisions, it is recommended that a comprehensive plan for an overall consistent maintenance management system (MMS) for equipment (and vehicles) should be put in place and costed. This MMS should be viewed as a continuous cycle, starting with upfront planning and budgeting, procurement, training and setup activities, through ongoing operations, including maintenance, all the way to the disposal and replacement of the asset at the end of its useful life. Each of these areas has its own challenges, but taking a holistic view will minimize equipment breakdowns and costs, as well as the risk of interruptions of the cold chain for lifesaving vaccines.

The ongoing maintenance challenges for all assets can be broadly outlined in three categories: (1) lack of a clear and detailed maintenance plan, which can reach the lowest level facilities of the health system and is integrated into an overall asset management system, (2) lack of funding to implement the plan on an ongoing basis and (3) lack of a dedicated staff member assigned to this task. Although the CCE Platform tries to address the first challenge by requiring a maintenance plan with the funding application, it is unclear how rigorously the plans will be scrutinized and by what level of expertise. Also, without a dedicated steward, it is difficult to maintain equipment, which is one reason why maintenance is outsourced to a dedicated entity with expertise in this technical area. Further, a maintenance plan is only one aspect of the overall management and is not comprehensive enough on its own to ensure reliability and effectiveness of equipment and vehicles. Finally, there is the challenge of insufficient government funding being made available for maintenance. Thus, with the additional demand of new CCE and limited public resources, it remains unclear how these plans will be funded, even if they are robust.

2. PATH Total Cost of Ownership (TCO) Model

2.1 Overview

The first objective of this project was to review the TCO tool. The model, which is an important tool in the CCE Platform, supports decision making in terms of high-level budgeting and CCE procurement. The tool, which is a series of worksheets in an excel workbook, provides a framework to capture data points to analyze options in terms of the total cost of ownership for one CCE unit over its useful life. This includes capital and operating costs, estimates for CCE procurement, spare parts, travel for both fueling and maintenance. The "total solution cost" then also adds related user training and presents the cost across an entire segment of the health system, taking into account the total units required. In other words, total solution cost is the TCO unit cost multiplied by the number of units needed over a certain period of time and adds in the training costs. In this way, total solution cost accounts for differences in capacity or useful life of CCE.

Collating and capturing the data into the model enables decision makers to take into account more than just the "sticker price" of a piece of equipment. It enables analysis of other capital and operating expenditure elements needed to create a budget estimate for CCE and to make an informed decision during the equipment selection process.

The TCO model in its current format does not include detailed cost considerations for the implementation of maintenance systems of the procured CCE. For example, it does include unit costs for maintenance as follows:

- Hourly wage of a cold chain technician
- Average travel costs for onsite repairs
- Average travel costs to obtain fuel annually
- Average travel cost for technician
- Average equipment transport cost

These unit costs are important in determining a high-level estimate on maintenance, but depending on the design and implementation of a maintenance system (hub-and-spoke versus milk-run), costs could be very different and this level of detail is not required for the TCO tool's purposes.

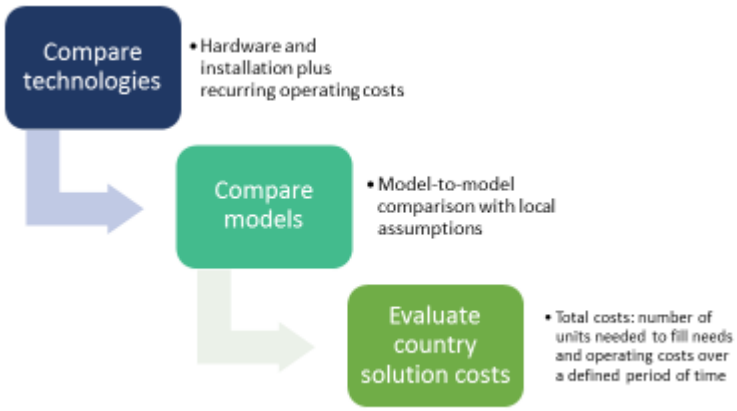
Thus, while the tool provides analysis for decisions on CCE selection and/or procurement specifications, there is a need for a follow-on plan with a costed framework for a CCE management and maintenance system specifically. That said, the TCO model is the only tool identified that is widely available to collate and analyze this level of detail to estimate costs for equipment ownership.

2.2 High level component overview

The TCO tool includes the following key components:

- **Overview and instructions –** provides guidance on utilization of the tool.

- **Technology decision tree**[1] – developed through the WHO cold chain working group to help visualize decision-making process on CCE.



Source: TCO tool v1.0.2

[1] Courtesy of Dan Brigden, WHO

- **Key Inputs**
  - **Country input**- key inputs to drive costing scenarios, such as the number of facilities to equip, deliveries per year, percentage safety stock and percentage of refrigerator utilized.
  - **Labor and maintenance** – allows for wage and travel costing to be localized.

- **Key Outputs**
  - **Total solution costs** – total costs for certain segment of the health system for all facilities, and taking into account the useful life of the equipment.
  - **Cash flow comparison** – cumulative costs per year for selected equipment.

- **Other comparisons**
  - **TCO comparison** – capital/operating costs during the useful life per unit of equipment.
  - **Cost per liter comparison** – average total costs divided by storage capacity for comparative purposes between equipment types.
  - **Opex comparison** – annual costs per category over full useful equipment life.

- **Data and assumptions** – for all of the different types of equipment below, by manufacturer and model
  - **Walk-in cold room/freezer room**
  - **Ice-lined refrigerators**
  - **Solar direct drive**
  - **Solar with battery**
  - **Gas**
  - **Kerosene**
  - **Freezer**
  - **Long-term passive device**

The tool helps in decision making by providing qualitative cost comparisons over the lifecycle of the equipment. For example, it shows that while solar direct drive refrigerators may be more expensive to procure upfront, their low ongoing preventive maintenance costs may make the total cost of ownership over the lifetime of the equipment more attractive.

2.3 Tool status

The TCO tool is currently in the very final stages of review and will soon be publicly listed on PATH's publications catalog. The tool will also appear on the TechNet Country Technical Assistance (TA) Resource page and the Gavi CCEOP guide. After that, the tool will be translated into French and both versions will be updated quarterly by PATH. It has also been shared at country level and with technical partners/experts, feedback from which has been incorporated. PATH also mentioned that two countries have used the model in their CCE Platform applications, although the results are unknown.

2.4 Recommendations

The TCO tool is well designed for decision makers to use during the upfront CCE budgeting and procurement process and there are only minor suggestions for improvement. The main recommendation for the TCO model is that it is integrated as one part of an overall asset management system, which will require a more detailed level of planning, budgeting and implementation (more information on this total asset management system is in the following sections). Different tools and models will need to be leveraged at the point after procurement to inform a comprehensive analysis for management of equipment/assets. Other considerations for the TCO tool, mainly adding suggested guidance around the tool (not changing the model itself), and capturing the decision points for future reference, are explained below.

The model is developed for a wide range of refrigerated and frozen storage equipment, including long-term passive storage devices. However, the tool does not incorporate costing for refrigerated trucks, which were deemed out of scope for both the tool and the CCE Platform funds. It may not be feasible to do the same detailed level of costing for trucks, replacement parts, maintenance, etc., but it would be good to develop guidance separate from the TCO tool as many countries have procurement of refrigerated trucks in their improvement plans. Even rough estimates on purchase price, makes/models, approximate percentage to set aside for preventative and curative maintenance, etc. should at least be available.

Following the use of the TCO model, there is no push to document the final decision-making used for CCE selection. It is therefore recommended that the final outcomes of the analyses and any relevant decision points are captured, regardless of the TCO tool's output. This information will be helpful when performing historical reviews and identifying lessons learnt.

There is a current push toward shifting responsibility of training, installation and initial bundling of parts to the manufacturers and, further, to have these costs bundled into the initial upfront equipment procurement cost (deemed "capital costs" in the model). This is a very good initiative and is similar to bundled contracts used in laboratory equipment management and maintenance. It also aligns with our in-country experience that the private sector service providers would be more willing to engage with (and get paid by) the manufacturers directly as they are hesitant to engage with the public sector given the risk of delayed or non-payment. An independent review of the proposed costs by the funder and an expert review on the parts required would also be welcomed by the private sector service providers. The TCO model can accommodate this change in responsibility/pricing, but it would be good to continue to negotiate with the manufacturers/distributors to set up these agreements.

It is important for users to note that there are considerations of CCE selection other than cost, such as the skill/capacity of technicians available for maintenance and the standardization of manufacturers/makes/models as fewer types of equipment may be easier to maintain both due to technicians' skill and standardizing the supply chain for parts. For example, the Coca Cola model limits the CCE to two manufacturers and three different models, allowing the economies of scale of parts required and the skills development of the technicians.

Currently the model recommends procuring alongside the CCE a "parts kit" of recommended replacement parts (from model PQS specification sheets) over the useful life of a piece of equipment. WHO/UNICEF

guidance is that initial parts' procurement should be for operation and upkeep over five years. In other words, the replacement parts are included in the capital costs for upfront procurement of CCE. It is a good suggestion to procure replacement parts upfront, so that the country can take advantage of bulk pricing and there is a stock of readily-available parts in country for preventative maintenance and curative repairs, if necessary. However, these costs should be included instead as part of ongoing maintenance or operating expenses. It should also be understood that although the parts are procured upfront based on estimated preventative replacement or repairs, there may be need for additional procurement throughout the lifecycle of the equipment, and/or certain parts may never be used. To assist in the estimation, the critical review of an expert in maintenance practice on-the-ground is necessary at the procurement stage.

3. Costing framework for maintenance management systems (MMS)

3.1 Overview

Further to the recommendations for the TCO model, in particular, CCE maintenance should be part of an overall equipment (asset) management and maintenance system (MMS). Ideally, equipment MMS would go beyond just CCE and look at a plan for all assets/equipment (including vehicles) at a certain facility. Maintenance is a challenge across equipment and vehicle assets, not only for the Expanded Program on Immunization (EPI) program and certain assets, such as vehicles, especially at lower levels of the health system. Therefore, maintenance should be expanded to include other equipment, especially at lower tiers, and an initial assessment/inventory exercise should include data gathering on other types of equipment present at a facility.

A system like this looks at the management of assets, in this case for CCE, as a continuous cycle of upfront planning and budgeting, procurement, training, setup activities, ongoing operations including maintenance, all the way through disposal and replacement of the asset. There is not one prescriptive model or associated costing that can be used; instead there are considerations, some of which are listed in the following sections that should be made when costing an equipment management system.

Vehicle MMS

One example of how and where this type of management system can be applied is by "Riders for Health". Riders use this methodology for setting up and running vehicle management systems for public health systems across sub-Saharan Africa. The asset (vehicles, in this case) management system incorporates much more than upfront budgeting and procurement decisions, and extends to costing, planning and implementation of maintenance, training, ongoing operations, etc.

Riders for Health employ two main models of management:

- When Riders for Health owns the vehicles and leases them as a full service solution to the client, this is called Transport Asset Management or TAM.
- When the client retains ownership of the vehicles and Riders for Health manages them, it is referred to as Transport Resource Management or TRM.

Riders operates across seven countries in Africa and offers a range of services to help keep vehicle fleets running efficiently, all based on preventative maintenance, which means regular, scheduled servicing, including all replacement parts fitted at Riders' maintenance units, or through outreach maintenance. Riders' partners include ministries of health, non-governmental organizations, bi-lateral and multi-lateral organizations that pay Riders for their expertise and service in running ambulances, trucks for distribution, motorcycles for outreach health work and logistics systems.

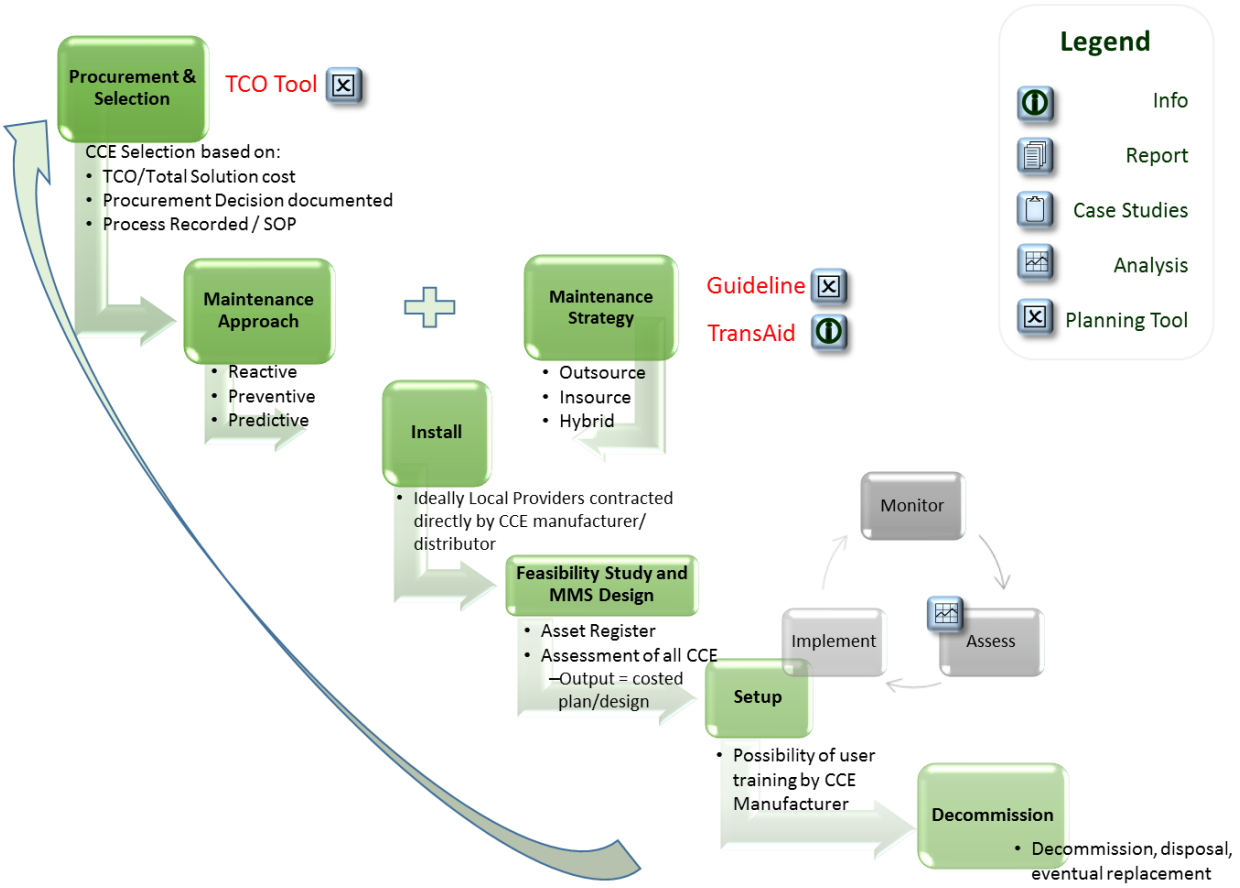
The leasing system was explored during the formulation of the CCE Platform and was not the chosen model, but Riders for Health's TRM system is similar to what can be used for CCE. The structure and components that follow are largely based on this model.

3.2 Proposed maintenance management systems (MMS) structure

The MMS costing framework is drawn from the equipment management plan, i.e. costs are derived from activities needed to manage the equipment over its lifecycle. Therefore, the following sections discuss activities that should be implemented to help guide associated cost estimates.

While the specific systems structure should be defined according to the organization's requirements, a multi-tab Microsoft Excel workbook is potentially a good medium for costing and setup, and could look similar to the TCO model. Each tab can represent a component such as training or maintenance.

The following diagram depicts the components for the maintenance management system's structure:



3.3 Key considerations

Costing should be done per phase (feasibility and design, setup, implementation, decommissioning) and grouped by category of activity (i.e. training, maintenance, fuel, etc.).

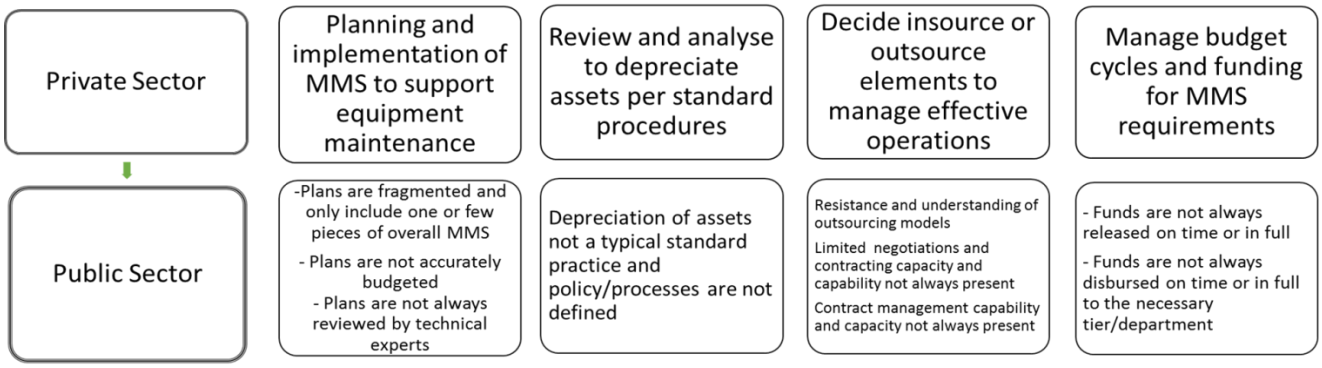
If public sector sets up and runs its own maintenance system for CCE, the sub-sections described below are all considerations to incorporate into the costing framework.

An early decision that should be made is on how the equipment will be managed and maintained: in-house (in this case, by the Ministry of Health), outsourced or a hybrid system. These decisions must be made both for different types of equipment and for different levels of the health system.

If the decision is made to outsource certain segments of equipment or tiers of the health system to the private sector, it will be more important to focus on public sector clearly stating *requirements* and not necessarily estimating costs – each private sector company will use its own internal costing model to determine a price for the service.

Further guidance on the options for maintenance management options and considerations are shared in Chapter 5 of the CCE Guidance document of the four part series on this subject.

This diagram provides examples of the best practices typically found in private sector and some of the potential challenges the public sector experiences.



3.4 Design and setup

3.4.1 Installation of equipment

In many cases, the installation of equipment may actually occur before the entire management and maintenance system is set up.

As part of the CCE Platform, consideration has been given to having manufacturers more involved in installation/training – to the point where they even act as an agent who could outsource the services to a local partner. This would be beneficial because the manufacturer can then provide technical assistance in contracting, although the cost could still be passed on to the public sector. It would be beneficial if this could also happen for ongoing maintenance, similar to what is done for expensive laboratory analyzers. It is noted, however, that the major difference between laboratory equipment manufacturers and cold storage manufacturers is that the former have an incentive to keep the equipment up and running as they make their money from selling reagents, which can only be used if the equipment is functional. Perhaps relationships established with a local third party during installation could be further utilized for ongoing maintenance.

3.4.2 Feasibility study and design

In the early phases of planning, an inventory assessment exercise should be designed, costed and conducted (which should happen as a pre-cursor to the TCO costing tool being run) to locate the equipment by GPS coordinate, equipment type, manufacturer, installed year, make, model, identification number (if available) and condition. To assist with this data collection, the cold chain inventory management (CCIM) tool can be used. This inventory and assessment should include the vehicle fleet (trucks, motorcycles etc.) for distribution of vaccines and dry goods (refrigerated or not) at minimum, in addition to the cold storage rooms/equipment (including cool boxes/insulated carriers and frozen water packs). It is recommended that

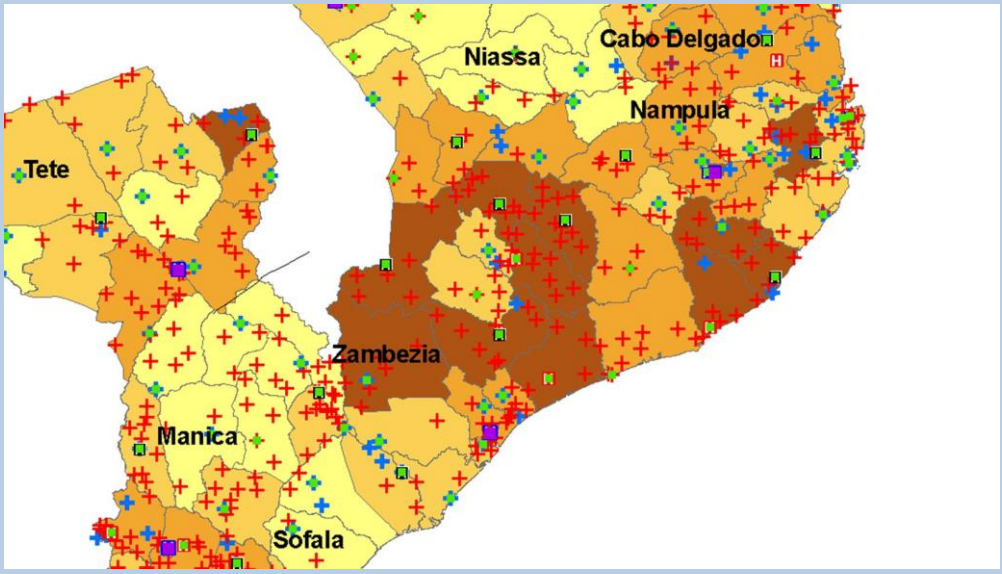
at least at the primary health facility level, all equipment is included in the assessment, not just CCE. Even if it is decided that the system will not cover the other equipment, it will be good to have it in the dataset. Costs associated with this activity include travel, per diems, relevant equipment for data collection, etc.

Determination of locations/inventory

To establish the scope of the MMS system, an equipment inventory and assessment should be performed, for which the location of all assets by type must be a primary activity.

Through the creation of an assessed inventory database and the application of the MMS, the required plan and associated resources can be established. The following is an example of work undertaken in Mozambique to first determine the type and location of facilities within the country.
The map highlights the location of:

- Provincial warehouses
- District stores
- Hospitals, and
- Health facilities



The facilities are all overlaid onto a population density profile (darker coloring signifies more densely populated areas). Each location has its CCE recorded, including type of CCE and numbers installed. This detail, when aligned to the maintenance intervals and the record of failures and break-downs, is being used to calculate the audit intervals and the checks that have to be put in place. From this data, the allocation of resources (human and spare parts) to each region and district can be determined.

Beyond what is found in the field, it is important to incorporate any procurement of CCE in the pipeline (possibly from the TCO costing tool) – both in terms of the inventory and in terms of costing.

The feasibility study can be done in-house or can be outsourced. Either way, the outcome of the study will be a costed proposal or plan, including the design of the overall equipment management system.

3.4.3 Setup of maintenance management systems (MMS)

Setting up a MMS requires a solid plan with clear responsibilities and an adequate budget. It is also important to consider the system's potential risks, as well as the likelihood and severity of those risks, and ways to mitigate them. During this time, the following activities need to be planned, all of which will require at least a minimal budget:

- Setting of asset management policies and further detailed plans (i.e. for equipment introduction/retirement, maintenance, etc.).
- Training of equipment users (health workers who use refrigerators at lower levels, drivers who drive trucks that are used for distribution, warehouse staff who use the walk-in cold room, etc.) and of technicians who will perform maintenance (both on the specific CCE maintenance and on data collection/record keeping/reporting).
    - Consideration: non-health staff could be trained to do maintenance at the facility level for all types of equipment, not just CCE.
- Procurement of any tools and maintenance equipment for technicians, where needed.
- Procurement of monitoring equipment, such as temperature monitors/alarms.
- Setup of supply chain for replacement parts – including initial bundle procurement and ongoing procurement and distribution to facilities where needed.
- Set up a financing and accounting system to ensure timely disbursement and to enable implementation in a sustainable manner.
- Setup a monitoring and evaluation system that includes data collection and analysis and a feedback system.

Although equipment procurement may have already occurred, it will be important to keep track of the capital expenditures of the overall system.

3.5 Ongoing operations

3.5.1 Implementation of asset management system

Once the system design is complete and setup, operations may commence (and this may not happen in a perfectly sequential manner, i.e. operations may start before setup is complete). During the ongoing operations, it is even more crucial to have financial disbursement on-time and in-full, or else the reliability of the system will decrease. Activities that need to be considered and costed appropriately are as follows:

- Management, including human, financial and material resources, for the oversight of the system, whether it is in-house, outsourced, or a mix of both.
- Running costs for the equipment, such as fuel or electricity (off-grid, on-grid or solar).
- Staff costs - mainly for technicians and related managers.

- Ongoing system for temperature monitoring, which enables the planned and predictive element of maintenance as the variability of temperature is a good "predictor" of how the unit is performing and whether, for example, there is a problem with some element such as gas in the current compressor units. The CCE platform document raises the issue relating to poor mobile connectivity in terms of a central point of contact, but if the monitors could be provisioned for all current and future CCE, it would enable temperature monitoring to be the first point of in-house ability to start to predict and prevent failure.
- Planned, preventive maintenance as a base, including technician daily allowance costs and replacement/spare parts, planned periodic travel to the equipment.
- Curative maintenance (repairs), including daily allowance technician costs, replacement/spare parts, call outs to travel to the equipment.
- Refresher training for users and/or technicians (recommended once per year).
- Any overheads for premises, such as technical workshops.
- Depreciation of equipment and vehicles, which requires data to analyze the life span of each type of CCE asset, to estimate values to determine the depreciation cost of each asset.

What is depreciation?
The monetary value of an asset decreases over time due to use, wear and tear or obsolescence. This decrease is measured as depreciation.

Depreciation may be caused by other factors such as unfavorable usage conditions. Some accounting practices take the level of depreciation for each asset and then create a procurement reserve to replace the asset at the end of its useful life.

3.5.2 Decommissioning and replacing assets

When equipment comes to the end of its lifecycle, there is often little thought or planning given to what will happen. Although there are sometimes guidelines on decommissioning equipment, these can be difficult to implement, especially when it comes to the disposal of government assets. Countries need to have the policies in place for decommissioning, and a budgeted plan for the removal/disposal, which is likely to include a truck to collect the old equipment and transport it to the disposal site.

Ironically, the replacement of old equipment, on the other hand, is usually fairly straight forward as much of the equipment capital expense is funded by donors. The more sustainable way to cost for replacement is to build in a small amount of funds accrual throughout the lifecycle of the equipment, so that when the equipment comes to the end of its life, there is enough funding to purchase a replacement. Riders for Health, as mentioned previously, adds this small replacement accrual to its running costs so that it does not have to go back to a donor and ask for additional donations after the vehicles have come to the end of their useful life.

4. Conclusions and recommendations

Currently, planning and costing are usually done to fulfill a requirement from a donor or a country government, and they are often done by health workers with program management experience, or by outside technical assistance (or a combination of both). Usually there is not adequate time or expertise to

create a technically sound budget that is accurately costed, especially in the specialized area of maintenance, or more broadly, management of equipment and assets. This causes more funds to go into the procurement of equipment than into its management. Therefore, it is recommended that countries try to consider the overall management, including total cost of ownership of assets, in this case CCE, and budget effectively. Budgets do not need to be complicated, but should be comprehensive, reasonable and as accurate as possible. From Gavi's perspective, it is also important that the individuals reviewing maintenance budgets aligned with the CCE Platform have actually implemented a maintenance system on the ground in a developing country. These technical experts could also help countries develop their plans (utilizing different individuals to support development and review, if possible). Otherwise, the countries are likely to submit a budgeted plan that cannot be technically reviewed to the level of scrutiny necessary for approval. Furthermore, these equipment management plans and budgets should be required regardless of application to the CCE Platform.

Costing to this level of detail will likely make equipment management look very expensive. For most countries, where limited funds have been set aside to properly maintain and manage equipment and vehicles, it will be even more expensive. However, the cost of not effectively managing assets has already been seen (and could be quantified). Preparing accurate plans and budgets is essential to understanding the gaps and which initiatives are therefore not fully executed due to limited resources, than to resort to ad-hoc planning and budgeting for maintenance, procurement, training, installation, disposal, etc.

In summary, the points below are the overall recommendations for maintenance and management costing:

1) Advocate for better costed, comprehensive equipment management plans, including maintenance, regardless of the CCE Platform applications.
2) Utilize maintenance experts to support the development and review of budgeted equipment management plans.
3) Dedicate an individual to equipment management, regardless of whether maintenance is in-house or outsourced.
4) Give more thought to how countries should finance maintenance management systems for an increasing amount of equipment/vehicles.