

# **System Design approach for comprehensive immunization supply chain strengthening - a case study of the Dedicated Logistics System (DLS) in Mozambique**

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## **Abstract**

In Mozambique, the original expanded program on immunization (EPI) supply chain was designed around multiple tiers of storage and administration, and in many circumstances had become inadequate and under-performing over time. Poor iSC performance was linked to poor or inequitable vaccine coverage rates, delayed new vaccine introductions, excessive waste of expensive vaccines, and reduced availability of all vaccines at the point of immunization. Based on modelling and the bottlenecks countries are now experiencing in iSC management, it was evident that the long-standing iSC design could not accommodate the requirements placed on it.

System design led to a Dedicated Logistics System (DLS) in Mozambique, which uses transport loops, level jumping, direct data collection and utilization, and dedicated logisticians to create a more efficient vaccine supply chain. The components of the supply chain were rearranged and configured to fit the new circumstances for each of the provinces. DLS improved system performance such that stock-outs of vaccines was consistently less than 5%.

System design approach helps managers to think about how to optimize the supply chain in the long term, using tools like modeling and electronic LMIS to generate and critically examine evidence each step of the way. This approach should not be linked only to specific projects but applied to all activities undertaken to deliver commodities to the last mile. Supply chain managers can use system design to create blueprints for optimization and also master the skills needed to be agile and adapt the blueprints as evidence about their efficiency and effectiveness is gathered.

## **Key words**

- Commodity
  - Vaccines
- Industry
  - Pharmaceutical

- System Design Strategy
  - Various / comprehensive redesign
- Country- Mozambique
- Partners
  - Mozambique Ministry of Health
  - VillageReach
  - UNICEF
- Supply Chain Level
  - National
  - Provincial
  - Sub-regional
  - Health Facility

## 1. Problem Statement

A high performing supply chain is critical for ensuring that health products are available at service delivery points where people need them. Without a full supply of health commodities, a clinic cannot provide services that people have come to rely on. This is true for immunization supply chains (iSC) that must be able to safely and reliably manage, store, transport, and deliver vaccines to all people.

Since vaccines were first introduced at scale in low-income countries more than 35 years ago, conditions and circumstances have evolved. Population and birth rates have changed; new vaccines have been and will continue to be introduced; currency and politics fluctuate; and new technologies and supply chain practices are constantly being developed. The original expanded program on immunization (EPI) supply chain was designed around multiple tiers of storage and administration, and in many circumstances have become inadequate and under-performing over time. Poor iSC performance has been linked with poor or inequitable vaccine coverage rates, delayed new vaccine introductions, excessive waste of expensive vaccines, and reduced availability of all vaccines at the point of immunization. Based on modelling and the bottlenecks countries are now experiencing in iSC management, the evidence is clear: the long-standing, iSC design simply cannot accommodate the requirements placed on it.

## 2. Theory of Change

Transformative changes in supply chains are required for high performing iSCs in order to achieve better immunization access and coverage. EPI programs have implemented incremental, and often necessary, supply chain improvements, such as investing in additional storage capacity or outsourcing transportation. However,

coping mechanisms such as these do not solve underlying structural problems. New approaches must reconsider the complete supply chain system, from distribution and inventory policies to the changing role of information systems and supply chain managers.

Using a system design approach to the iSC can bring those needed transformative changes across the supply chain system. System design is a process which creates the plan, or blueprint, for how the iSC should run, including how all of the components of the supply chain system (network, storage, human resources, planning, monitoring, and data) fit together and interact. System design is critical for the required transition to new supply chain models which can better meet the rapidly changing needs of current immunization programs.

A system design approach will allow emergence of next-generation supply chains that are flexible and able to adapt to changing circumstances based on a continuous improvement approach using evidence to drive decisions. They have an end-to-end perspective, ensuring efficiencies throughout the supply chain until the vaccines are administered at the service delivery point.

Next-generation iSCs fundamentally shift the way vaccines are managed and delivered to communities. They may look different from country to country, and even within a country, yet they all share certain fundamental characteristics:

- Holistic design: They are designed to optimize the safety, reliability, and efficiency of immunization services.
- Management: They are led by competent, professionally trained supply chain managers who can consolidate logistics tasks and direct resources toward activities that improve the effectiveness or efficiency of the supply chain.
- Data: They use data from all levels of the supply chain to monitor day-to-day performance and support evidence-based decision-making.
- Equipment: They use well-maintained, WHO-prequalified cold chain equipment and temperature monitoring devices and systems to sustain proper temperatures along the supply chain.
- Continuous improvement: They are continuously improved based on regular, system-wide assessments, and improvement strategies are supported in comprehensive multi-year plans.

In practical terms, a high performing immunization supply chain (iSC) ensures that all children have access to vaccines, delivered in the most effective and cost-efficient way.

The theory of change for system design identifies this as a process that can take many forms from simply establishing regular review processes of logistics data for a continuous improvement management approach, to changing the responsibilities of supply chain managers, and even to a complete system overhaul of altering transport loops and reducing the number of tiers in the iSC. Regardless of the changes to make, the process begins with identifying the gaps in the performance of the iSC and generating support, both political and financial, to address those gaps. This first step is critical to introducing the concept of system design and to developing the leadership capacity to question the status quo of the iSC and not accept underperformance.

### 3. System Design in Practice: The DLS in Mozambique

Mozambique offers a concrete example of system design in practice and the benefits of developing, testing and implementing a new system design. The Provincial Directorates of Health (DPS) asked the tough questions about the status quo of their system design and reconfigured the components of the iSC to optimize and find efficiencies. The result, the Dedicated Logistics System (DLS), uses transport loops, level jumping, direct data collection and utilization, and dedicated logisticians to create a more efficient vaccine supply chain. The components of the supply chain are the same; they have simply been rearranged and configured to fit the new circumstances for each of these provinces. With this experience, the evidence of improved system performance with the DLS is clear with stock-outs of vaccines consistently less than 5%, improved vaccine coverage rates, and cost efficiencies documented.<sup>1,2</sup> Now in five provinces in Mozambique, the Ministry of Health has expressed interest in national level system design to apply many of the lessons learned from these initial five provinces to the remaining five provinces in the country.

With support from the Bill & Melinda Gates foundation through VillageReach, the DLS began in 2002 in the northern province of Cabo Delgado to address some of the typical challenges seen in iSC in low- and middle-income countries. The provincial capital would receive vaccines from the national level and deliver the vaccines to the district level. While the district was then responsible for delivery to health facilities, the process was ad hoc as funds and transport were not consistently available. This last segment of the iSC often fell onto health workers from the health facilities to arrange their own money for transport and be away from the facility for a day or more to go

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<sup>1</sup> Kane M. Evaluation of the project to support PAV (Expanded Program on Immunization) in Northern Mozambique; 2001-2008: An independent review for VillageReach with program and policy recommendations. Nov 2008.

<sup>2</sup> VillageReach. Comparison of costs incurred in dedicated and diffused vaccine logistics systems: Cost-effectiveness of vaccine logistics in Cabo Delgado and Niassa provinces, Mozambique. June 2009.

and fetch vaccines. This resulted in facilities closing for the time needed to fetch vaccines, unreliable vaccine availability, and an added burden on health workers.

Additionally, supervision and training of the health staff was often inadequate or absent, health budgets were insufficient, and shortages of funds for supplies were common. Accurate and timely data was unavailable as data collection and reporting relied on a large number of workers who are trained on clinical care rather than data collection, thus pushing this important task to the bottom of an already overwhelming list of tasks to be performed each month. In this province, iSC challenges were greater than in other areas of the country and the need for support to EPI was the greatest.

Although the management principles that led to the implementation and rise of the DLS as a next-generation iSC in Mozambique can be applied in many contexts, the on-the-ground interventions that make up the Dedicated Logistics System respond specifically to the context of each province. Six core elements were considered for the system design intervention in Mozambique:

A. Processes. The DLS introduced demand-driven elements by allowing dedicated, trained logistics personnel to make changes to the forecast-driven allocation plan based on up-to-date service delivery-level consumption data gathered at the health facility during distribution. Vaccines and supplies from the provincial level are delivered by these dedicated logisticians directly to the health facilities using optimized transport loops on a monthly basis. During these distribution runs, the dedicated logisticians, one for each of the delivery zones, collect data, provide maintenance on the cold chain, deliver appropriate quantities of vaccines and supplies based on real-time consumption data, and provide supervision to health workers.

Due to the lack of resources and infrastructure at the lower levels of the supply chain, the DLS moves supply chain management functions as high up in the supply chain as is geographically feasible. It consolidates functions at the provincial level where the limited resources that are available can be focused.

B. Data. The DLS takes advantage of the fact that the last mile of delivery is the first mile of data, and it is built to facilitate use of data for decision-making and continuous improvement. In the DLS, data collection responsibilities at the district and health center levels are shifted to the dedicated logisticians. Using a tablet running *Sistema Electrónica de Logísticas de Vacinas* (Electronic Vaccine Logistics System) or SELV, an implementation of OpenLMIS, the dedicated logisticians collect data from different sources to confirm validity, compare actual stock on hand with stock records, and provide immediate feedback to health workers on data quality. This direct data collection component reduces the opportunity for human error seen during the typical data aggregation process up the

administrative tiers. This approach also provides the provincial and national levels with relatively real-time data from the lower levels.

For data visualization, the DLS information system uses a dashboard with alerts for quick reference (Figure 1). Monthly reports contain the full information in an easy to use searchable format to enable managers to drill deep into the data to solve problems highlighted by the dashboard. The data can be viewed in aggregate or separately for any level or service delivery point within the provinces operating the DLS.



Figure 1. Example of SELV Dashboard

The next step in the continuous improvement approach is a systemized process for data analysis and utilization. After each monthly distribution, participatory follow-up sessions are held where the dedicated logisticians review the dashboard

and monthly reports with the provincial EPI manager, medical officer, and logistics supervisor. With this monthly review, the team can identify bottlenecks and ways to improve subsequent distribution activities. Additionally, this review process enables the team to check against previous deliveries and consumption figures to find gaps in data that may not have been properly recorded during the month.

The final step in the cycle is for the dedicated logisticians to implement their improvement plan during the following month's distribution to their respective districts and health centers. The effectiveness of the improvements can be assessed based on the data collected in the following months.

C. *Equipment*. At the facility level, the DLS approach takes a simple but innovative approach to cold chain maintenance by integrating maintenance activities into vaccine delivery. This approach was created to fit current equipment, infrastructure and transportation conditions, human resource capacity, and personnel expertise. It builds on other global experience in cold chain maintenance. Dedicated logisticians are responsible for distribution of vaccines and data collection. To address the challenges maintaining the cold chain, they are also trained to provide basic maintenance of equipment during distribution visits. This approach broadens the capacity of the system to maintain the cold chain. The dedicated logisticians serve as an extension of the one cold chain technician in each province and can provide an extra set of eyes to monitor the cold chain. As a result of this more proactive approach to equipment monitoring and repair, the uptime of the cold chain increases.

D. *People*. Primary operational responsibility for inventory management and reporting, cold chain maintenance, and distribution tasks is shifted away from health facilities and district level personnel and consolidated to dedicated logisticians stationed at the provincial level. These trained dedicated logisticians can focus on supply chain management which frees up health workers' time to focus on patient care and district managers' time to focus on supervision. This task shifting is drawn from pieces of the five building blocks for human resources with clearer job descriptions that match qualifications and professionalization of supply chain managers.<sup>3</sup>

While logistics tasks are consolidated and professionalized, the DLS also includes district EPI managers and health center workers in the vaccine supply chain process. District level EPI managers accompany the distribution to provide

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<sup>3</sup> People that Deliver. A step by step approach for HR capacity development in health SCM. <http://peoplethatdeliver.org/content/technical-guidelines-and-tools>. Accessed Nov, 2015.

supportive supervision to health workers, maintaining the lines of responsibility for district-level supervision while efficiently using the skills of a logistician. In effect, the DLS creates a regular network between the various levels of the health system on which more than just vaccines and supply chain data can flow.

- E. *Funding*. One of the key challenges to any distribution system is having funds available for operational expenses when and where needed; this is particularly challenging in low-resource settings where many health programs must negotiate for these scarce resources. This challenge is additionally strained at the district level which is dependent on higher administrative tiers to allocate resources. Introducing the DLS consolidated distribution responsibilities, and thus key expenses, at the provincial level, where government resources are more likely to be available. Using a cost-share approach, both the DPS and VillageReach contribute to the operational costs of distribution. At the province level, fuel is purchased, per diems are paid for, and vehicles have more opportunities to be maintained.

With this system design, distribution costs are transparent and easily analyzed. The drawback to knowing the true costs of a distribution system, however, is it appears to be more expensive, particularly when compared to an ad-hoc, multi-tiered system which masks true costs borne by health workers filling in the distribution gaps. Ensuring vaccine availability at health centers costs money. Expenses that have historically been out of sight should be included in budgets based on true costs, and funds must be available at the distribution point.

- F. *Political will and leadership*. It is stating the obvious to say that any system redesign takes leaders who are willing to question status quo practices and are committed to using innovation to improve the performance of their vaccine supply chains.<sup>4</sup> The DPS decision makers in these provinces in Mozambique demonstrated this leadership capacity and willingness to test innovations to improve the vaccine supply chain. The medical officers and EPI managers have seen the positive results of the DLS and are now active proponents of the system, becoming advocates for national-level decision makers.

The DLS has gone through transition as it is moving towards sustainability. What started as a project with 100% financial and management support from an NGO has transitioned to a cost-share approach with government personnel and management, and with only minimal financial and technical support from VillageReach.

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<sup>4</sup> Haddad S, Bicaba A, Feletto M, et al. System-level determinants of immunization coverage disparities among health districts in Burkina Faso: a multiple case study. BMC Int Health Hum Rights; 2009, 9 (Suppl 1).



#### 4. Results and Impact

The advantages of the DLS system are best described by comparison. In the common multi-tier system, a typical province in Mozambique would need a vehicle, driver, and vaccine program specialist at the provincial level to distribute vaccines to the ten districts. Each of the ten districts would then need the same human resource and equipment components to reach about ten to twelve health centers in each district. This also requires about 100 health workers at the health center level who perform supply chain tasks as a minimum part of their overall responsibilities. Total equipment and human resource requirement is 11 vehicles, the accompanying fuel, and more than 130 personnel who are adequately trained and skilled in supply chain management. On the other hand, in the DLS, supply chain tasks are consolidated in the hands of two to three dedicated logisticians and drivers, each with a vehicle, (one for each delivery zone) who do the job full-time in each province. The dedicated logisticians determine the quantities of vaccines to distribute based on actual consumption at the health center, requiring less forecasting skills from a health worker and freeing up time to focus on patient care. As such, training and provision of technology can be focused on these key supply chain personnel. The placement of these personnel at the provincial level also matches the reality of the system as financial resources required for distribution are more likely to be available at the provincial level than the district level. With dedicated personnel at higher levels of the system instead of at every health center, there is more efficient use of human resources.

As distribution is initiated from the provincial level, cold chain storage and vehicles can also be concentrated at the provincial level instead of diffused through many levels. For example, the district level holds buffer stock for emergencies but no longer acts as a warehouse for health facilities, thus removing the requirement for additional cold chain capacity. Similarly, vehicles, financial support for fuel, and required maintenance are also concentrated at the provincial level, reducing the need for a vehicle in each of the ten or more districts to only two or three (depending on the size of the province) in order to serve the optimized delivery zones.

The results of an independent evaluation of the pilot project in the initial province was completed at the end of the pilot in 2008 show that the DLS and the management approaches accompanying it played a significant role in the marked improvement seen in immunization coverage in the province. The DLS directly improved the cold chain, reduced vaccine stockouts from 80% to regularly about 1% per month, helped to reduce dropout rates between DTP-1 and DTP-3 from 12% to as low as 3.8%, and greatly improved the supervision and training of health facility staff.

The cost evaluation also showed significant improvements in the cost-effectiveness of this optimized iSC, resulting in 17% more cost effective than a similar comparison

province without the DLS, at \$5.03 per child vaccinated with DTP-3 compared to \$6.07 per child vaccinated in the comparison province. The DLS is also 21% less expensive per vaccine dose delivered (\$1.18 per dose compared to \$1.50). These cost efficiencies allow for more to be spent on vaccines rather than the distribution system, as with the DLS, 61% of the vaccine logistics system expenses were dedicated to vaccines and syringes, compared with 46% in the comparison province. Figure 2 shows the qualitative differences, as well as the cost savings, in the DLS versus a common multi-tiered system.

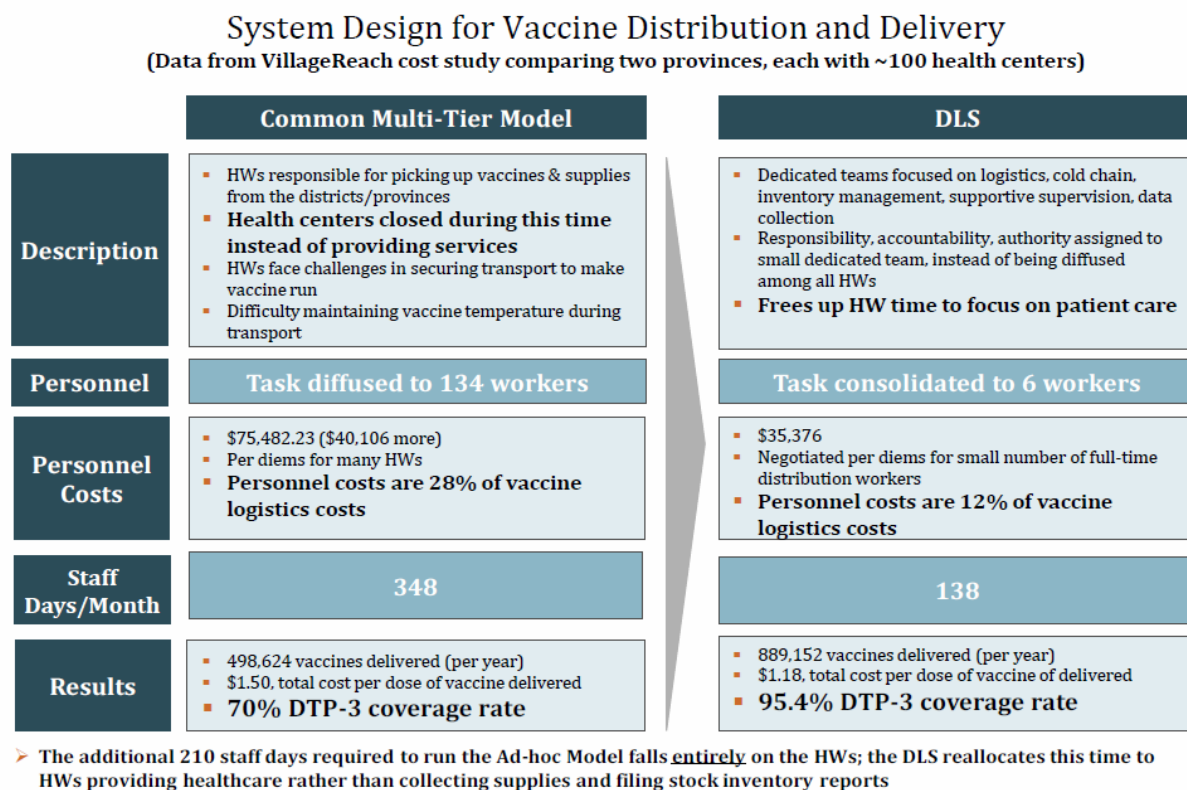


Figure 2. Comparison of a common multi-tiered system and the DLS

Since the pilot and expansion to an additional four provinces, on-going monitoring of logistics data still indicates a high performing iSC with stockouts regularly less than five percent, as shown in Figure 3. Figure 3 also shows that since all provinces adopted the DLS and began using SELV in early 2012, stockouts have, on average, fallen for all vaccines.

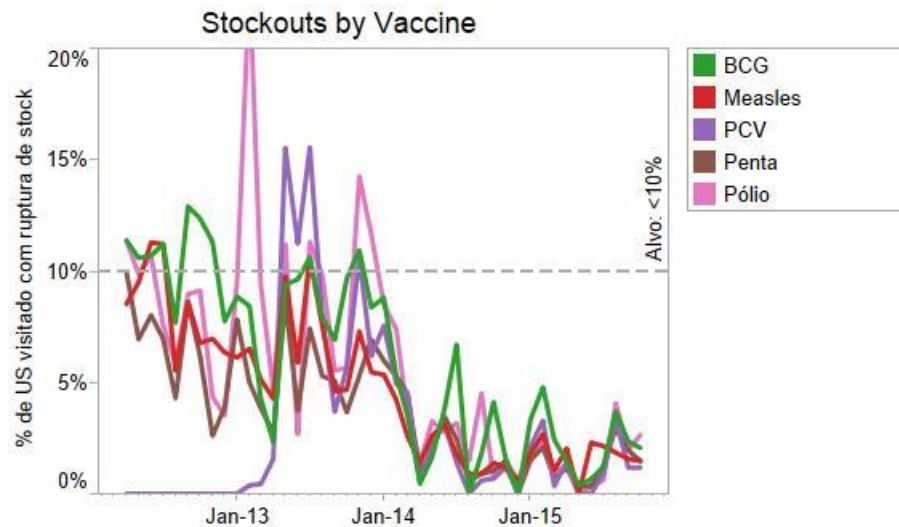


Figure 3. Stockouts by vaccine for all DLS provinces. Y axis shows percent of health facilities visited with a stockout.

Furthermore, since 2012, in DLS provinces, the percentage of health facilities visited has risen, as the percentage of the facilities that were visited and reported data (Figure 4). The sharp drops in performance are likely due to weather events that cut off access to some facilities.

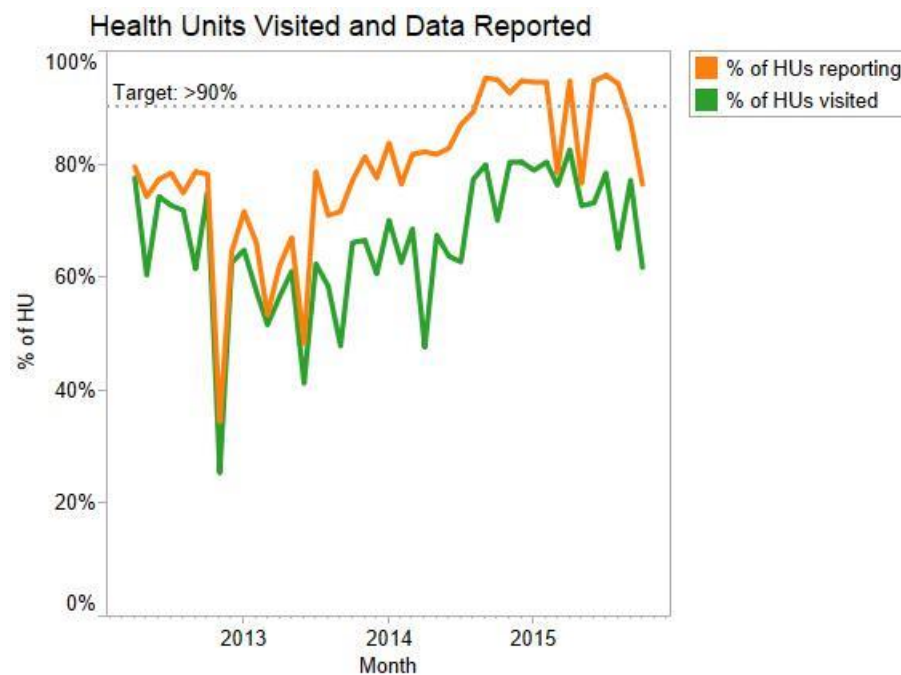


Figure 4. Percent of health facilities visited, and percent of those health facilities reporting data, in the DLS

Qualitatively, a key result has been the buy-in from the Ministry of Health at the national and provincial levels to explore new supply chain models and their openness

to considering significant shifts in system design. Data-based and results-oriented decision-making is the heart of the DLS management approach, but in order for this approach to be adopted, decision-makers must be open to the fact that data may show that the status-quo system design is not the most efficient.

The shift in management approach is evident in the implementation of DLS to five provinces with interest from national decision-makers to explore system design for all provinces. This shift is largely due to the efforts of champions at the provincial level advocating for the DLS management approach.

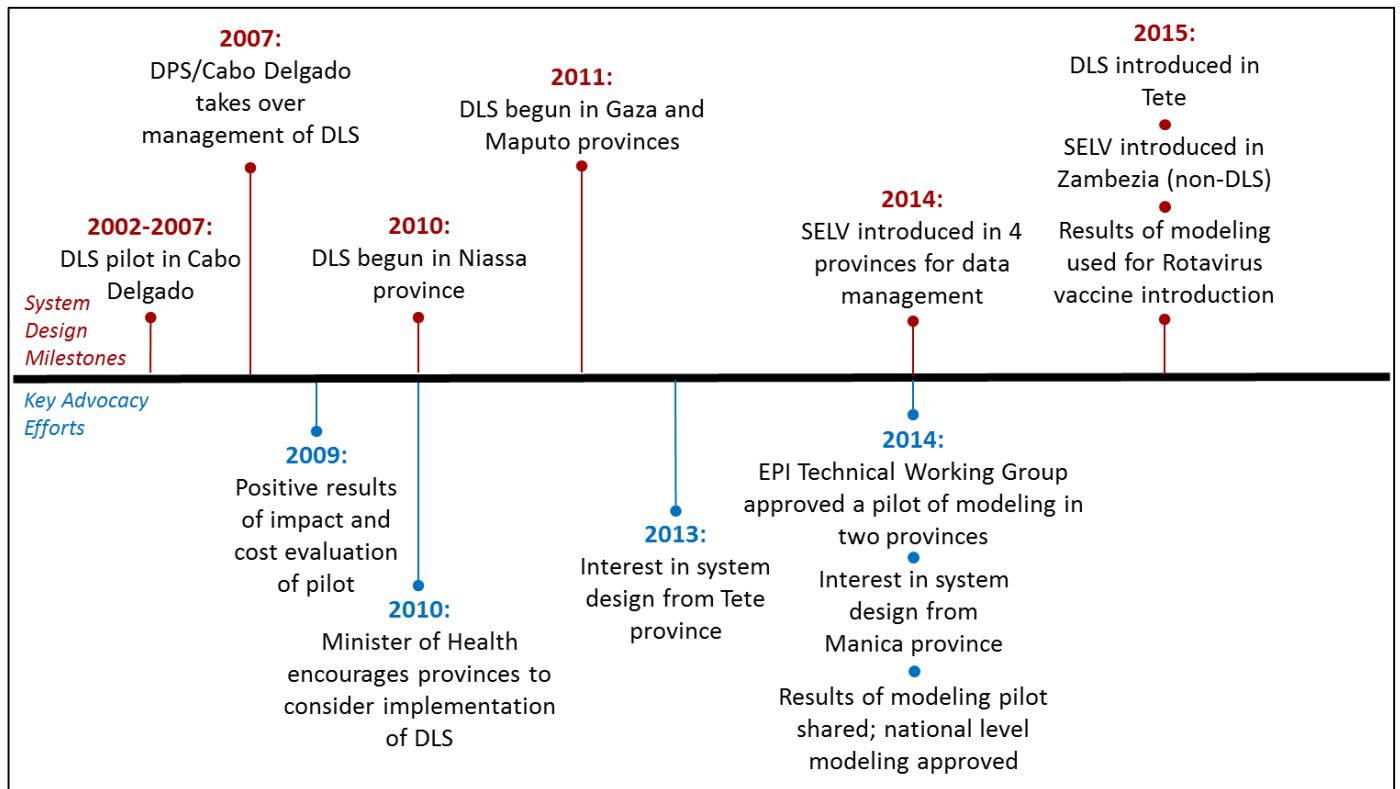
Bertur Alfaca, the medical officer of Gaza Province noted in a July 2014 blog that “the benefits [of DLS] have been phenomenal. I have seen more improvements in distribution and vaccine availability in the past few years than in the three years before that. Stock-outs of vaccines have dropped from above 15% to around 5%. This system gives us more visibility into the data coming from the health centers with improved frequency, regularity, and quality. And this has made the data credible, creating more confidence in the distribution system and in the government and providing more evidence for decision making.”<sup>5</sup>

This comes at a very opportune moment, particularly as the global conversation is also focusing on finding efficiencies in the vaccine supply chain. The recently approved Gavi Alliance immunization supply chain strategy calls for an in-depth analysis and redesign of country supply chains to improve their performance. Mozambique is leading the way as this initiative reflects the GAVI strategy and helps the country prepare for the implementation of the Health Systems Strengthening project from GAVI.

*Figure 5: Timeline of system design efforts in Mozambique*

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<sup>5</sup> <http://www.villagereach.org/blog/page/5/>



## 5. Lessons Learned and Implications for System Design Efforts Globally

The DLS has come a long way since its initial introduction and has made many strides in terms of performance of the iSC. An important challenge to the DLS has been reluctance to question and shift away from the status quo at the national level. The DLS management approach requires continuous analysis of the system’s performance to identify creative solutions to address inefficiencies. However, the traditional, multi-tiered vaccine distribution system has been in place for decades, and has become entrenched in the national psyche as “the way things are done.” As a result, departing from this system is a significant risk for decision-makers yet is possible with evidence and leadership. The global conversation has also been shifting during the same time to bring a more system design focus to general EPI management and support to countries interested in a more efficient iSC. The key influencers, main decision points, and lessons learned of the system design efforts in Mozambique are detailed here; these can be applied to system design efforts globally:

*Champions are important to advocate for system design.*

One key to the success of the DLS in generating the interest of national level stakeholders, and in spreading to additional provinces, has been the efforts of “champions” in DLS provinces in advocating for the system. These champions, such as Bertur Alface in Gaza, have spoken up to present the effectiveness of the DLS to decision-makers at the national level. This strategy has been successful largely because of the emphasis in the DLS on collecting reliable data. Without this data, collected with SELV, champions would have had to rely on anecdotal, qualitative evidence, and would not have been able to make a convince case, based on strong, quantitative evidence, that the DLS has been able to improve supply chain performance.

Champions of system design have also been instrumental in moving the DLS forward and creating an enabling environment for it to expand to other provinces. Armed with data and evidence of the success of this system in increasing the availability of vaccines at the last mile, these champions have become advocates for the DLS both within their provinces and at the national level. Their advocacy not only has helped open the eyes of decision-makers to allow for modeling of “crazy ideas” to occur, they have also driven forward the changes supported by modeling results.

*Computer simulation modeling can provide evidence to drive system design changes.*

Modeling has been an essential tool used by the DLS to mobilize a shift away from the status quo. Using modeling makes it relatively easy to look at different scenarios for the vaccine supply chain, include those crazy ideas that wouldn’t be possible to test in real life, and create supply chain blueprints. . For example, during the Rotavirus introduction in Mozambique, modeling results identified constraints in cold chain and transport capacity with the immediate introduction of this vaccine. Each province took a couple of days to plan for the initial distribution of this new vaccine and how to overcome the immediate roadblocks. It was an opportunity to be creative and identify innovative approaches to be able to distribute this new vaccine to all health facilities by the time of the official launch.

There is still a need to ensure this creativity for solving immediate constraints in the supply chain is translated into longer-term thinking on system design and how to continuously improve the performance of the vaccine supply chain, to always be striving for the best performing iSC. Modeling is one tool that can provide the evidence for system design and identify specific areas in the supply chain to address in order to improve efficiencies.

*Data visibility at the national level increases interest in the system.*

As mentioned above, the improvements in data visibility at the health facility level in the DLS, as opposed to a traditional multi-tiered system, due to the use of SELV have been key in generating interest in the system. Not only does this data provide a base of evidence that champions can use for advocacy, it also allows partners, such as

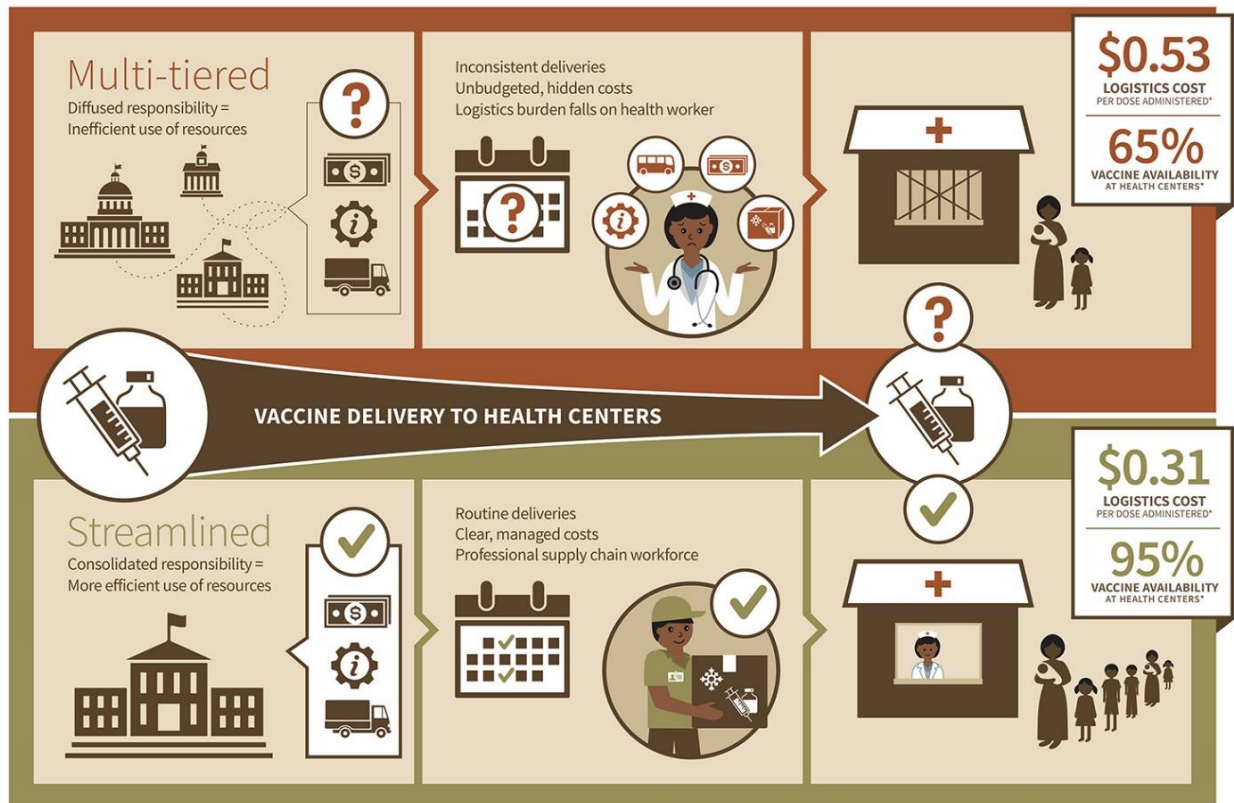
UNICEF and the MOH access to more complete performance reports and calculated indicators down to the health facility level based on more accurate and complete data. DLS Field Coordinators, equipped with tablets running SELV, are trained to collect data directly from facilities on a regular basis, and, because they are physically at the facilities, can verify it against physical inventories and provide supportive supervision to validate and improve facility-level record-keeping.

*Funds availability for true distribution costs should be a government priority*

Although the adoption of the DLS shows significant commitment to shifting the system design and management approach for vaccine supply chains, DPS commitment to fully financing the system has varied by province. With the current cost-share approach between VillageReach and the DPS, one province has committed a line item in their annual budget from the MoH to supporting the DLS and so has experienced few financing gaps. Other provinces have been unwilling or unable to do so, and have required more assistance from VillageReach in filling cost gaps.

Moreover, as discussed above, in a streamlined system design such as the DLS, the costs of delivering vaccines are transparent and easily analyzed as the responsibility for logistics tasks is concentrated at and paid for by the DPS. Deliveries are consistent and are done by a professional workforce employed by the DPS. On the other hand, in a multi-tiered system, logistics tasks are spread out across multiple layers of the system. In this system, deliveries, if they happen at all, are inconsistent, and the costs of vaccine delivery to the facility often fall on facility-level health care workers. Thus, in a system design that concentrates these tasks at the provincial level, the costs paid directly by the DPS may seem to rise due to the large proportion of costs that were hidden in a diffused, inefficient system. However, in reality, as show in figure 5 below, not only are the aggregated costs of a multi-tiered system higher, this system is also less effective at ensuring the availability of commodities at the facility level.





\*Haidari LA, Brown ST, Welling JS, Leonard J, Lee BY. Workshop on HERMES modeling. Maputo, Mozambique. 29 September – 3 October 2014.

Figure 6. Infographic showing advantages and cost savings of a dedicated logistics system

The prevalence of this “myth” that streamlined systems like the DLS are more expensive is another reason why an important step in system design must be to understand *all* the costs and financial flows in the current system and make them visible to stakeholders. Showing the actual costs of the system can serve as a key advocacy tool in system design. Globally, system design efforts should include mapping of financial flow in the early stages to understand gaps and inefficiencies. Significant advocacy to ensure buy-in, funds availability, and sustainability is part of the system design process.

System design should take local conditions and requirements into account

Although modeling can easily and quickly present different scenarios and determine which is most cost-efficient, political will cannot be included in the model and the local constraints related to administrative policies must be taken into account in system design. The core of a system design approach is a shift in the management approach used by supply chain managers, and changing a management style that has been embedded in the status quo for decades is a long process. Compromise between an optimal, efficient system and a politically realistic system must be made to start this



process and begin generating evidence to catalyze continuous improvements and open decision-makers' minds to changing policies to allow for increased efficiencies.

For example, the DLS has included a number of elements that are not optimal for supply chain efficiency but were necessary to allow the system to be implemented and supported by stakeholders. In order to respond to national-level stakeholder who felt the level-jumping approach used in the DLS was contrary to Mozambique's policy of decentralization, the districts offices do play a role in the DLS. District personnel accompany the Field Coordinators on distributions, even though it would lower costs if the Field Coordinators (housed at the provincial level) conducted distributions independently. Similarly, originally, cold chain equipment was removed from the district level, but was replaced because administrative tiers and structures require the districts to maintain an emergency store.

Still, with time, sustained advocacy, and evidence, decision-makers can be persuaded to try "crazy ideas" to increase access to vaccines at the last mile. One example was modeling a scenario of using delivery intervals to health centers of every two months instead of monthly in Gaza Province. Facilities in northern Gaza are very remote so were not included in monthly distributions due to the high cost of reaching these facilities on a monthly basis. The group was reluctant to include a bi-monthly delivery scenario the list of scenarios to examine, citing Ministry and WHO policies of monthly deliveries. Nonetheless, this scenario was implemented during the modeling activity to see the effects of such system on performance and operating costs. Results showed this option of distribution every two months to this specific area was feasible and cost-efficient. As such, after continued advocacy backed by evidence generated in the modeling exercise, distributions every two months in northern Gaza were approved and are moving forward.

## 6. Conclusion

System design should not be presented as a pilot or an individual project. Rather, it is an approach to supply chain management that helps managers think about how to optimize the supply chain in the long term, using tools like modeling and electronic LMIS to generate and critically examine evidence each step of the way. This approach should not be linked to only a specific project with concrete goals, objectives, and start and end dates, but should be applied to managing all the activities undertaken to deliver commodities to the last mile. By using a system design approach, supply chain managers can create blueprints for optimization but can also master the skills needed to be agile and adapt or rework those blueprints as evidence about their efficiency and effectiveness is gathered.