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# A Practical Guide for Designing Track and Trace Systems for Teaching and Learning Materials



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### **ABOUT REACH**

Results in Education for All Children (REACH) seeks to help countries strengthen their education services by focusing programmes and initiatives on results, with the ultimate goal of boosting learning outcomes, especially among the most vulnerable populations.

Established in 2015, the World Bank programme funds results-based financing projects and provides technical support and advice on results-based financing in education to other World Bank teams and development partners. One of its main goals is to contribute to the evidence base around results-based financing in education, gathering data and knowledge that can be used to develop better education programmes and policies, with the goal of boosting education outcomes.

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***“Lack of good, accurate, up-to-date, reliable, and accessible information on schools, grade level enrollments, TLM availability in schools and classrooms, current prices, wastage levels, book life, and so on. In many countries the basic information needed to plan and manage an effective TLM system either doesn’t exist or isn’t readily available when required”***

- A key reason for low availability of textbooks in Sub-Saharan Africa (Read, T, 2015, p.13)

## Purpose of these guidelines

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These guidelines are geared toward helping key country stakeholders understand and make the various decisions they must make in designing a Track and Trace (TnT) system, from initial conception through the “nitty-gritty” details of implementation. We begin with some of the biggest questions that need to be answered first when designing a new TnT system, such as “why are we designing a TnT system?” and “what do we want our system to be able to do?” This will help narrow the focus as we shift into more detailed discussions of technology options, deciding who will use the system and how they will interact with it, identifying key data pieces and their source, considering options for training users of the system, and identifying key performance indicators. Annexes at the end of these guidelines will discuss master datasheets, indicator reference sheets, additional technology considerations, and a longer form case study.

Throughout this guide you will find text boxes that will help you to gain a deeper understanding of the material. These include:

- **Definitions:** These define key terms that will be used throughout this guide
- **Best practices:** These identify what years of experience have shown to be best practices in monitoring distribution of teaching and learning materials. Not every best practice will be practical for every country’s situation, but it is worth knowing what is considered the gold standard practice as you make your decisions.
- **Real examples:** These describe how the topic or decision being discussed has been implemented in the real world, identifying key challenges and lessons learned so that you can learn from other countries’ experiences.

## Introduction

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### **WHY ARE WE DESIGNING A TRACK AND TRACE SYSTEM?**

Despite decades of investment in supply chains for teaching and learning materials (TLMs), the unfortunate reality is that in many places in many countries, there simply aren’t enough TLMs in classrooms to meet the needs of students. The reasons for this are legion. Central government may lack the accurate and timely information, such as TLM availability and needs at schools, that is required for correct forecasting and financing projections. Lengthy TLM requesting and procurement processes may result in outdated needs estimates that result in allocations that do not match the true needs before TLMs even start to be delivered. Supply chain streams can be opaque, resulting even under the best circumstances in TLMs stalling or going missing somewhere along the way, often with no visibility into whether or not TLMs arrive as planned. Re-packing and storage of TLMs at various points in the supply chain can result in damage, loss and mis-allocation of each schools’ orders. The lack of visibility into the progression of TLMs as they move along the distribution chain can provide little incentive for regional or district officials or distributors to deliver to all schools equitably, in the right numbers, at the right time, or to identify and correct errors as they come up (Crabbe, Nyingi, and Abadzi, 2014; Read, T, 2015; Fredriksen, Brar and Trucano, 2015; Elliot and Corrie, 2015;

Read, N, 2016, 2017; UNESCO, 2016, 2021; All Children Reading, 2018; Smart and Jagannathan, 2018; World Bank Group 2019, 2020a, 2020b; USAID Education Links, 2020). Last-mile actors in schools and communities may not understand how TLM allocation decisions are made at the higher levels, may not know how many TLMs they are supposed to receive, or when, and may not feel empowered to speak up when things go awry.

## REAL EXAMPLE

### The textbook supply chain in Ethiopia

A study commissioned by the Ministry of Education (MoE) in 2018 on Textbook Utilization in Ethiopia identified various challenges in book provision such as books remaining in the distribution centres throughout the year with no accountability and adequate distribution system to ensure the books get to schools on time. The study recommended the use of a system that would inform the schools and the relevant stakeholders on the location of books, delivery status, date of book delivery and where to report in case of delays or non-delivery. As a follow up to this recommendation, Creative Associates under the Reading for Ethiopia's Achievement Development (READ) II project, with the technical leadership of BlueTree Group and support from the Ministry of Education (MoE), piloted Track and Trace (TnT) in Ethiopia (BlueTree Group, 2021, p. 1).

## WHAT IS A TRACK AND TRACE SYSTEM?

Track and Trace (TnT) is a technology driven solution that increases accuracy and visibility into the TLM supply chain, thereby enabling decision makers (i.e. Ministry officials, partners, distributors, and last-mile personnel) to monitor ordering, allocation and distribution of learning materials and ensure that they reach the intended communities in a timely manner and in the right condition. TnT platforms can provide accurate and easy-to-access information on the status of books all the way along the supply chain, and can make that information available to a range of stakeholders.

With access to more accurate information, decision-makers can also measure the performance of different players along the chain, track progress towards targets, and gauge where improvements are needed. For example TnT enables the Ministry of Education to hold distributors accountable for delivering TLMs as planned, while empowering school-community bodies such as school administrators, school management committees, and Parent-Teacher Associations with the information they need to advocate for improved supply chain performance.

At its most basic level, a TnT system is composed of a system for tracking distribution, and a system for reporting and visibility. In addition to these two elements, many countries choose to include a system for communication and expectation management, as well as a system for collecting the data required for TLM forecasting and allocation.

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## DEFINITION:

### Teaching and Learning Materials

This term is used to refer to the range of educational materials that are used in the classroom to support learning objectives. They might include textbooks, teacher guides, reading books, reference materials, teaching and learning aids, other supplementary materials and, in some contexts, multi-media and digital resources. Some Ministries of Education set an official TLM profile that lists the minimum books, materials, and aids necessary to achieve curriculum objectives (UNESCO, 2021; Read, T, 2015)

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## Distribution tracking

As denoted by its name, the primary purpose of a TnT system is to track TLM deliveries as they happen. Every TnT system therefore includes the capability to confirm deliveries at the last mile of the supply chain. This can take the form of simple paper receipts whose data gets compiled into a digital tracking system at a higher level, or can be captured electronically at the time of delivery, either by the recipient or by the distributor, or both. This tracking can also vary in detail, from barcodes on each material that allow tracking of the location of individual TLMs at various points in the distribution chain, to tracking of boxes or pallets, or the most basic tracking system that doesn't track the movement of TLMs at each point in the delivery, but simply involves entering data on the TLMs that are received by each school.



▲ Using TnT to confirm quantities and types of books that were delivered

## BEST PRACTICE

**TLMs packaged per school and delivered to school Ideally, a TnT is built for a supply chain in which TLMs are packaged**

per school from the outset at the central warehouse, with low-cost location identification technology such as bar-codes for each TLM unit and/or the school consignment, and no re-packing further along the supply chain. This is the best way to identify specific school packages of books on their route from point-of-entry/central warehouse to a school, and to be able to verify whether the assigned books got to their intended school. The TnT system would monitor delivery all the way to the school, and not to an intermediary point, such as a district/zonal education office. All evidence indicates that this final district/zonal-to-school leg tends to be a problematic part of the chain, in terms of storage of TLMs and distribution, leading to leakage, damage and delay. Errors are rife where books are unpacked from a larger consignment and redistributed per school order at this point. Delays also often occur in getting books that final leg to schools. (*All Children Reading [ACR]*, 2015b; Fredriksen, Brar & Trucano, 2015; Read, T, 2015)

## Reporting and Visibility

Each TnT system also includes the capability to generate reports in order to make data visible and usable by stakeholders at multiple levels. This allows users of the TnT system to make sense of the data and use it to make decisions. The further step of an online dashboard that is accessible to multiple stakeholders greatly expands visibility into the system,

and allows simple at-a-glance tracking of key indicators on completeness and accuracy of deliveries.

### **Data collection for TLM forecasting and allocation**

Many TnT systems also include features to collect the data needed to make TLM allocations, whether that be actual TLM orders from schools or data on TLM availability and class sizes that can be used by the higher levels of the ministry to provide an accurate projection of national TLM requirements. Digitally collected data enables automated consolidation and calculations, as information is generated, speeding up the forecasting, requesting and procurement processes and helping to ensure that the request data upon which allocation decisions are made is as accurate and up-to-date as possible. This functionality of a TnT system can make a tremendous impact on sufficient TLM availability in the classroom, the end goal of any TLM supply chain. Furthermore, over time, analysis of TnT data on the number of usable TLMs at each school can provide a useful indication of TLM classroom life and annual loss and damage rates by grade level and location - crucial data for longer-term budget and procurement forecasting (Read, 2016; UNESCO, 2016).

*“Lack of good, accurate, up-to-date, reliable, and accessible information on schools, grade level enrollments, TLM availability in schools and classrooms, current prices, wastage levels, book life, and so on. In many countries the basic information needed to plan and manage an effective TLM system either doesn’t exist or isn’t readily available when required”*

- A key reason for low availability of textbooks in *Sub-Saharan Africa* (Read, T, 2015, p.13)

### **Communication/Expectation Management**

Many countries find it useful to include functions that allow for communication and expectations management in their TnT systems. Such functions can be used in every step of the process and by various users. Distributors and local education officials can use the functionality to gain status updates on deliveries. Before TLM allocation decisions are made, functions can be developed to communicate with last-mile communities to remind them when it is time to submit request data for the next round of distribution. Once allocation decisions are made, built-in communication functions can inform those last-mile communities about what they have been allocated, and advise them on the timeline for their deliveries. Finally, communication functions can allow communities receiving deliveries to flag any problems, such as an incorrect number of TLMs or having received damaged TLMs.

Throughout the process, communications functions can allow the last-mile communities to stay informed about the process and report any problems they are having. Functionality can either be one-way or two-way. One-way communication systems allow the higher levels of the system, usually the Ministry of Education, to push information and notifications down to the lower levels. Two-way systems add the ability for the lower levels to request data from the higher levels. The different kinds of communication systems are discussed further below.

### **Post-distribution Monitoring**

Finally, once books are delivered, some countries include a mechanism for collecting information in the classroom after all deliveries have been completed to verify the level of book availability and usage in classrooms. This is distinct from tracking the deliveries them-

## REAL EXAMPLES

### Value of alerts and notifications throughout the system

A number of TnTs exhibit best practices where schools/communities are sent SMS, voice or instant messages to receive status updates each time a record is updated or alerts about items dispatched, items ready for collection, changes to delivery or location of orders, etc. Users at other levels can get status reports or get alerts when orders are outside of set parameters relating to time or location (ACR Grand Challenge for Development, 2015b). For instance, Creative Associates' Book Tracker provides SMS notifications to schools, actionable email alerts and daily summary reports to staff (Creative Associates International, 2018).

At the very least, alerts address the common issue of schools not being informed that books are available to pick up. A World Bank study in Zambia found that providing information to schools about the arrival of textbooks to the district offices or zone-center schools increased the probability of them receiving textbooks by 33 percentage points, increased the textbook pupil ratio by about 23 percentage points, and increased the probability of schools receiving their textbooks within a month by 20 percentage points at 1 percent significance level (World Bank Group, 2020c).

In Cambodia, if a school has not submitted its book request, the TnT system sends it a chatbot alert as a reminder. At the other end of the book cycle, alerts are sent to school directors through the chatbot that books have been dispatched. The dashboard also notifies central MoE staff of problems logged by school directors (World Bank Group, 2019, 2020a, 2020b).

As to whether or not the intended deliveries arrive as expected, the outcome wished for is that children have the appropriate TLMs available to them in the classroom. Measuring these kinds of outcomes alongside the logistics measures of deliveries can help identify improvements in overall system performance as well as highlight problems in the TLM supply chain beyond the deliveries themselves.

## WHO IS TRACK AND TRACE FOR?

There are four main groups of beneficiaries of TnT systems. The first is the central level, most often the Ministry of Education or equivalent, but this may also include other bodies that are involved in the financing and distribution of learning materials such as the Ministry of Finance. By improving their own visibility into the supply chain for learning materials, these ministries will be better able to understand how these materials move through the country, where they end up, and how many of the TLMs bought each year ultimately reach the students for which they are intended. This can help to identify places in the supply chain where TLMs go missing, which is key to addressing these problems. Ultimately it helps these ministries, which often spend huge sums of money each year procuring and distributing TLMs, identify where that money goes, and help them hold those responsible for distribution accountable.

## REAL EXAMPLES

### TnT for Spotchecks of TLM Usage in Classrooms

In Rwanda, the MoE's Learning and Teaching Materials (LTM) Management Information System (MIS) enables inspectors to access a list of all materials supplied to each school so they can check their presence in the school. This, in turn, allows the system to generate loss and damage rates, which can be used for forecasting (Read, 2017).

In Cambodia, school communities can use an online form accessed via the TnT chatbot to enter data on book availability in the classroom gathered during spot checks post-delivery to ensure textbooks have actually reached students' hands and to assess whether book shortages still remain. As noted in a World Bank Evidence Note, this provided the government *"with an important source of information that had previously only been available by arranging expensive visits to a sample of schools"* (World Bank Group, 2020b,p. 4).

*BlueTree Group* have also developed TnT 'polling' functionality that, on an automated schedule such as six months after delivery, would send out a message to request registered community users to check whether books were being used or still present in the school, for instance, and to respond back to the system using a short code (S. Lacey and M. Ochako, personal communication, November 11 2021).

The second group of beneficiaries of a TnT system are the communities for which these learning materials are targeted. Improving visibility into the TLM supply chain as well as lines of communication about how many TLMs they should expect to receive and when they should expect to receive them can empower these communities to advocate for themselves. With real-time tracking of TLM deliveries, these communities will be able to report when things go wrong such as when they receive a delivery that is incorrect or contains TLMs that are damaged and unusable. Ultimately this increased visibility can help these communities hold their central governments accountable to their young students.

The third group of beneficiaries of a TnT system are the distributors themselves, whether public or private. This encompasses supply chain actors ranging from the pickers and packers, to local officials responsible for overseeing TLM provision to schools at zone, district or cluster levels, to private distribution company managers. With a TnT system they can more easily enter information about orders that have arrived or been dispatched, in real time, and they can receive status updates. Because TLM shortages have been so persistent and visibility into the supply chain is so often lacking, the blame often falls on the people and organizations responsible for distributing the TLMs, fairly or not. Increasing the visibility of the supply chain can help distributors and supply chain actors show that they are doing their jobs and delivering materials as promised. Once they are able to do that, any questions about why children still do not have the materials they need must necessarily be focused elsewhere.

Finally, the fourth group of beneficiaries of a TnT system are donors that support TLM procurement and distribution, whether domestic or international. Increasing visibility and accountability in the supply chain for learning materials will make these organizations more

## BEST PRACTICE

### COMMUNITY USE OF TNT

A core judging criteria for the All Children Reading Tracking and Tracing Books Prize Competition was whether the proposed TnT platform would provide parents, teachers and local officials with answers to these four questions -

1. What textbook and materials will be provided to students in a specific grade at a specific school?
2. When are the textbooks and materials scheduled to arrive at the school?
3. Where are the textbooks and materials now?
4. Who can I contact to advocate for the receipt of these textbooks and materials?

(ACR, 2015a,p. 1).

confident that their money is well spent, and may encourage additional funding over what these organizations would be willing to provide without this accountability.

## HOW DO WE DESIGN A TRACK AND TRACE SYSTEM?

The rest of this document will assist you in designing a Track and Trace system that is appropriate for your goals and in your context. We will start with the big questions: identifying what you want to accomplish with your TnT system, as well as identifying what your system will look like in broad strokes. From there we will flesh out the design more - will your system include a digitized platform for TLM ordering? Will it include a full platform for communicating between all the actors in the TLMs supply chain? Finally, we will drill down into the nitty gritty details, discussing technology options, key performance indicators, and training.

## REAL EXAMPLES

### Community Involvement in TLM supply chain monitoring

*“The more knowledge a community has of a book delivery schedule, the more accountability and pressure to deliver on time can be pushed up the delivery chain, starting from the level that is closest to the student.”* (ACR, 2018, para. 5)

Where communities are alerted about book deliveries, pressure is put on local officers/ schools if TLMs do not arrive as expected. Community involvement has also proved effective in verifying deliveries. See the Philippines Check My School initiative ([www.checkmyschool.org](http://www.checkmyschool.org)) for a full description of a community-led initiative that gained official (national) recognition. During its operating years, Textbook Count, a precursor of Check My School, tracked millions of textbooks. It managed to reduce the price of textbooks by 40 percent, to improve the accuracy of textbook deliveries whereby delivery errors were reduced to as low as 5% on average, and to shorten the Department of Education’s procurement cycle from 24 to 12 months. Indonesia, Romania and Moldova have replicated the approach, and a similar initiative in South Africa is tracking textbooks down to the classroom level through mobile technology (Crabbe, Nyngi & Abadzi, 2014). In Cambodia, community members previously had no role in ordering or tracking books. During the initial pilot of TnT, 92% of School Support Committees in target schools used the TnT tool on their phone to conduct spot checks of book availability in classrooms after books were delivered (WBG 2020b).



***“Ministries of Education will need to invest in data input, custom software, and discrete devices. Similarly, training, system updates, and support can increase as feature sets are added.”***

*—(All Children Reading, 2018, final paragraph)*

# The Big Questions: Building a Frame

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## DECISION 1: WHERE TO START

If you are finding the size of this guide and the number of decisions that need to be made intimidating, then let us assist you by using an old business management mantra: crawl, walk, run. A child does not just start running one day, they must first learn to walk, and before they can walk they must learn to crawl. Trying to skip the first two steps is a recipe for falling flat on your face, as any parent can tell you. In the same way, too many times people try to “run” with a complicated system that does everything before they’ve mastered the fundamentals; this is a recipe for failure. To use a more age-appropriate analogy, casual runners that decide to train for a longer race like a marathon often injure themselves before they ever reach the starting line. The problem is not that training for a marathon is dangerous, but rather that runners that set their goals high often try to start their training closer to the endpoint they desire than the place they are currently, and train some combination of too much, too soon, and too fast, and this almost invariably results in injury.

Indeed the history of Track and Trace systems is littered with examples where countries started out trying to make a system that tracked everything, only to discover that this was way too complicated to use, time-consuming to manage, and expensive to run at national scale. Do not fall into that trap: a system that works at the scale of a small pilot but not at national scale does not, in fact, work.

For this reason, we recommend that any country just starting out with digital tracking of their distribution system for TLMs start with the simplest system possible: track whether or not TLMs reach schools. Being able to reliably identify, in real time, whether or not TLMs are reaching schools opens up a wide range of possibilities for identifying how to improve distribution and ensure TLMs reach their intended recipients. Additionally, a less complex system will be much less costly to set up and run, require much less training of users, and will be much less costly to change should the need arise. Once you have a proven system that does that, you will generate momentum for expanding your ability to monitor and improve distribution. Then come back to this guide and we’ll help you think through adding additional functionalities to your system.

## DECISION 2: WHO OWNS THE SYSTEM?

The first decision that must be made when designing any TnT system is the most practical one: who will own, operate, and pay for the system? This decision will inform all the other decisions that will be made in determining the design of the system, as well as who has ultimate authority in making those decisions, as well as making any changes as you move forward from the system design to implementation. Some key questions that will be informed by the answer to this question include:

### **What does the system owner need TnT to provide for them?**

System ownership determines not only what data the system will need but also who will need to have access to that data. Different actors in the TLM supply chain may have different

goals for data visibility. For example, a Ministry of Education, responsible to teachers and students, may be primarily concerned with using a TnT system to determine book needs for the coming school year or being able to see where books are along the supply chain so they can identify when and where shipments get stuck along the way. This may require the ability to collect book availability and needs in order to do forecasting, or the ability to track books as they move through intermediary levels of the supply chain. On the other hand, a Ministry of Finance, responsible to the National Government and international donors, may be primarily concerned with verifying that a contracted distributor has fulfilled their contractual obligations in delivering TLMs before making payment. In such a case, being able to confirm book deliveries at the last mile may be the primary goal of the system.

### **How much are you willing to spend to develop the system and keep it running?**

This is an important and often overlooked element of the system design. A TnT system can vary greatly in how expensive it is to set up and maintain, depending on how complex the system design is. A relatively simple system can be quite economical to run and be robust to changes in the TLM supply chain, requiring minimal resources to allow it to continue working as intended. A complex system may be able to provide additional functionality, but it will also be more expensive to set up and maintain, and will be more susceptible to needing to change as the structure of the supply system evolves around it, and will be more expensive to change when required. Before answering questions about what the system will do, it is important to have an understanding of the limitations that it will face in terms of the budget and technical capacity of the organization that will run it.

Throughout this guide we will try to indicate where a particular decision has an important financial impact for the overall cost of the system. Unfortunately it is difficult to give exact numbers, as the overall cost of a system depends on many factors that all influence each other. However, here is a quick guide to the important decisions that will influence cost. For a more in-depth look at the cost for a system as a whole, see Appendix V: Case Study: Final Costs for Cambodia Track and Trace.

**Complexity.** Systems can vary greatly in their level of complexity. A relatively simple system might only ask one group of respondents to fill out one response (such as school directors confirming when they receive a shipment of books). A much more complex system might involve several different groups of respondents to do several different tasks, such as school directors sending in book needs data, warehouse workers scanning incoming and outgoing shipments, local education administrators officials confirming book deliveries, and community groups performing spot checks in classrooms, all with a system of various alerts and notifications being triggered at various stages. In general a simple system will cost much less to develop than a more complex system. Complex systems can take orders of magnitude more time for a software developer to set up and test, and software developer time is generally expensive. For the same reason, the cost of making changes will be much greater in a more complex system, as a complex system will take much more time for software developers to untangle and reform and re-test should you need to make any changes. In general it is easier to add complexity to a simpler system than it is to simplify a more complex system.

**Technology choice.** Perhaps counterintuitively, a TnT system based on smartphones and using online forms or smartphone applications can be less costly to run than a TnT system based on SMS or IVR (see the technology section below to review technology choices). This is because once set up, the data needed to operate a smartphone-based system is usually quite modest, such that system users are likely to be willing to use their own phone data to use it. General messages sent over a messaging application to a listserv are generally free of charge. Conversely, in a system based on SMS or IVR technology, each time a message is sent between the system and an individual user, there is a cost. Though the cost of any one message is small, these costs can add up quickly when you have thousands of users entering and receiving data. For example, in the pilot Track and Trace system in Malawi, the government negotiated a toll-free number for SMS messaging with one of two major network carriers in the country, which cost about \$200 USD to set up, and about \$140 USD per month to maintain. Had the system expanded, the government would have needed to negotiate an additional toll-free number with the other major carrier to ensure maximum geographic coverage. On the other hand, in Cambodia the government runs a message board on the Telegram messaging application, where they can post general messages that any school director that is subscribed to the channel will be able to see; there is no cost to this setup, though the additional chatbot functionality that Cambodia has included does come with additional costs.

**Main software choice.** How you develop your software can change the running costs of the system significantly. For example, if you choose to use an open-source platform that you can access for free, you will need to hire developers to customize the system to your needs, and to continually update and maintain the system. On the other hand, while proprietary software with a paid license usually comes with such updating and software maintenance functions included and can be free to the average user of your system, the cost of these software packages can be quite sensitive to the number of administrator-level users that will need to have access to your system. For example, licenses for a proprietary software system might cost \$100 per month for each person that needs administrator-level access to the system (to be able to make changes to the system and the data it contains), while costing only \$10 per month for each person that needs basic access (ability to access the dashboard and export data). Proprietary software licenses can also be sensitive to who is paying, with many companies offering discounts to nonprofit organizations, but considering country governments as corporate entities and charging much higher prices. While you may find that you can negotiate these down by appealing to the public good that the system will have, this is nonetheless a consideration that should be made before selecting a software platform.

**Additional software pieces.** In addition to the main software that forms the backbone of your system, you may need additional software packages to enable additional functions. For example, if you use online forms that need to connect to your main database, you may need an additional software package to form that connection. If you use a chatbot to send two-way messages, you may need an additional software package to run the chatbot. If you will have warehouse managers scanning barcodes on their phones, you may need an additional software package. Each of these additional software packages may carry additional per-user fees. For example, the pilot version of Cambodia's Track and Trace platform used TaroWorks software to enable warehouse workers and district officials to scan delivery barcodes to

track specific deliveries as they received them. The cost of TaroWorks varies by the number of users, from about \$458 per month for up to 20 users (\$23 per user) to \$1,100 per month for up to 100 users (\$11 per user). Ultimately Cambodia decided that they could not support these costs at national scale, and instead removed all tracking from their system design after the pilot.

**Training.** The largest running cost of many systems is the training that is required for users. A more complex system with more users performing many different functions within the system will require much more complex training, which can be much more expensive. However, a smartphone-based system, particularly a less complex one, carries with it the possibility of remote just-in-time training that can be conducted by sending out training materials, nearly eliminating the need for people to travel to get together and hold a training or retraining session. Because of this, the cost of training can vary widely, from tens of thousands of dollars to rent venues and pay for transportation for hundreds or thousands of people for in-person training, to essentially free for distribution of electronic just-in-time training materials.

**Country size.** Of course the size of the country, in terms of the number of schools that are included and the number of other users that might be included, will have an impact on the overall costs. The most direct impact this has is simply on the number of interactions with the system. Again in an SMS- or IVR-based system each interaction generally has a cost. Additionally in smartphone-based systems that send individual alerts and notifications to users (as opposed to entirely generalized messages), the number of users and the number of alerts/messages set up will vary greatly between a small and a large country. This gets even more complicated in systems that include 2-way messaging capability, where users have the ability to initiate queries or messages at any time, because you will not be able to set a cap on the number of total interactions the users initiate. For example, the Cambodia Track and Trace system uses a software system called FlowXO to run its chatbot; this costs \$19 per month as a baseline package of 5,000 interactions, plus \$25 per month for each additional package of 25,000 interactions that are allowed in a month. During low activity months, sometimes only the baseline cost covers the needs. However during high-activity months, such as when schools are submitting their book request data or confirming book deliveries, up to nine additional packages of 25,000 interactions may be needed, in a country with about 9,000 schools, costing closer to \$250 per month for those months.

### DECISION 3: WHAT IS THE GOAL OF THE SYSTEM?

The second major decision to make when designing a TnT system is identifying the purpose of the system in your specific context. One size does not fit all, and having an understanding of the particular goals your country, and more precisely the system owner, has for the system will help guide all the other decisions you will need to make during the design process.

The primary goal for a TnT system for most countries will fall into one of two categories. For countries that are most concerned about increasing visibility into whether or not TLMS are reaching their intended recipients in schools and families, a relatively simple First and Last Mile system will best enable them to answer that question. On the other hand, for other countries that may be concerned with identifying where along the supply chain leakage or delays are happening and enabling users to access real-time, actionable information on the

status of books along the supply chain, a more complex Full Tracking system will be needed. It is important to note that one model is not inherently better than the other. Each model has its place, and each will be capable of greatly expanding visibility into the TLM supply chain. The golden rule to keep in mind is that you should identify the question you want to answer, and collect only the information that will help you answer that question.

A key consideration for the goal of your system is agreeing on:

1. Who are the users?
2. Who needs access and to what functions do they need access?
3. What information do they need to measure the success of the supply chain?

For help thinking through how the users of the TnT system will measure success, skip ahead to the below section on dashboards and key performance indicators, then come back.

## **DECISION 4: IDENTIFYING YOUR TNT MODEL**

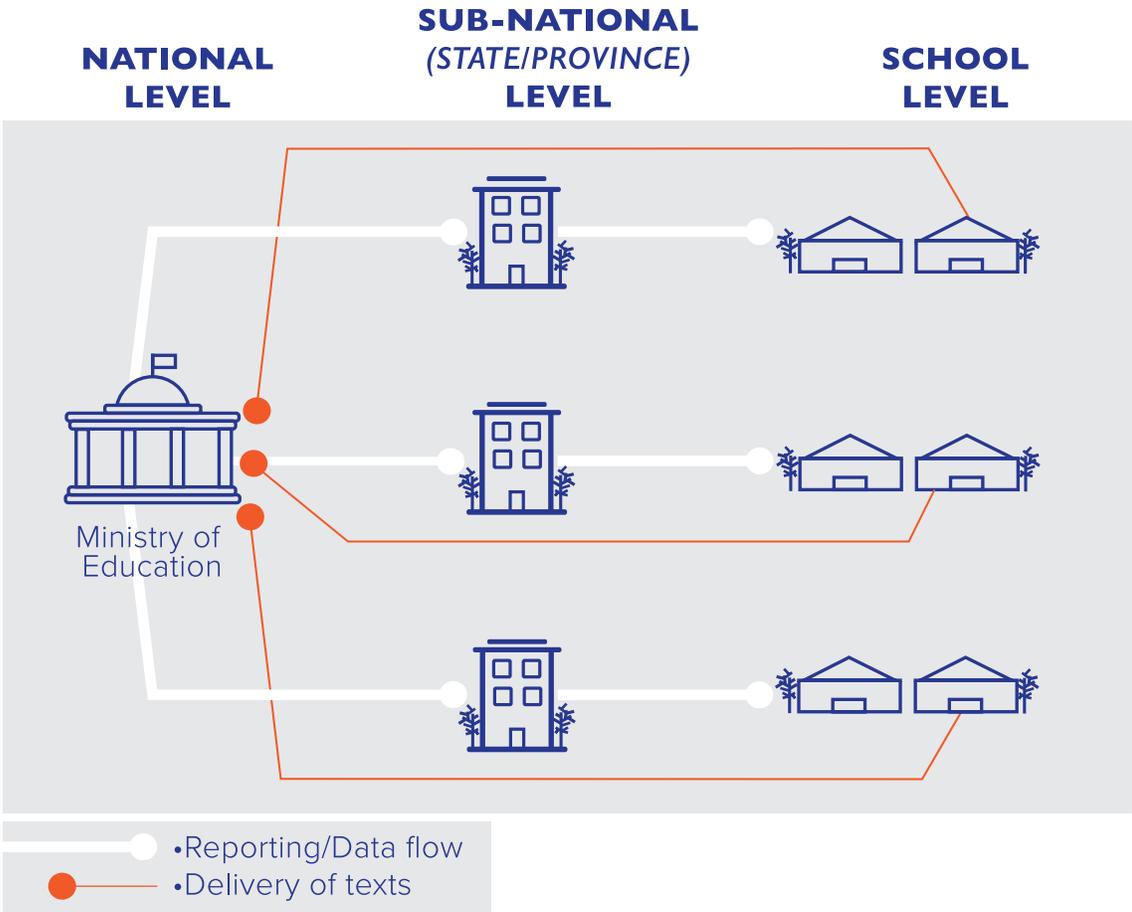
The next decision to make is what level of detail your TnT system will track. There are two main options: a First and Last Mile model, and a Full Tracking model.

### **First and Last Mile Tracking Model**

In general, a First and Last Mile model will track learning materials at the first mile and last mile of the supply chain, without tracking what happens in between. The main advantages of this kind of model are that it is cheaper to develop and implement and can often use simpler technology, yet it allows great visibility into the key question that a TnT system should be able to answer: whether or not TLMs are reaching their intended recipients. Another advantage is that it allows a much greater degree of flexibility should the structure of the supply chain change over time. For countries that do not currently have accurate, real time visibility into what TLMs are ultimately delivered to which recipients, this kind of model provides a large jump in the ability to monitor the supply chain, with the lowest initial setup effort and the highest likelihood of a successful, long-lasting implementation. Keeping the system simple requires less training time for users, which is important as the costs/feasibility of national-level training are very important to consider during design decisions for TnT. Lastly, for countries that rely on third party contractors to distribute learning materials, a full tracking system may not be practical for application, while a First and Last model will allow you to start incorporating robust performance measures into your distributors' contracts.

The drawback of this kind of model is of course that it does not provide visibility into the in-between spaces in the supply chain. For countries that are most concerned about leakage and delays in the points along the supply chain, this model can identify the overall amount of leakage and delay in the system, but does not allow you to pinpoint where leakages or delays are taking place. More concretely, this kind of model will not allow schools to track their incoming deliveries through alerts or communications about the status of TLMs along the supply chain, nor will it provide the central level actionable information as TLMs travel through each node along the supply chain. That is, a first-last system can provide a notification to schools when books leave the central warehouse, but it cannot provide updates to the schools as the books travel through the supply chain. Similarly, although it will allow central level staff to monitor the overall level of delay in distribution, it will not allow precise

identification of where distribution has stalled at a particular point along the supply chain. For example, central level staff may be able to see that schools in a particular district have not received their TLM deliveries, but will not be able to see whether the problem is at the



Pros:	Cons:
Allows visibility into schools to see whether TLMs are ultimately reaching their intended recipients	Schools will not be able to receive updates about the whereabouts of their shipments in transit
Cheaper and easier to set up	Does not provide precise information on where delays and leakage are happening
Allows greater flexibility in system design, increasing likelihood that it will be able to be used over the long term with minimal changes	Without actionable information on where delays are happening, central level supply monitors are not as easily able to address distribution problems in real time
Involves less training	
Where contractors are used for distribution, this system will allow close monitoring of contractor performance, including incorporation of performance-based payments in contracts	

district office level, the regional office level, or the schools themselves. Alternatively, a First-Last system may identify that more damage has occurred to books in a particular district than in other districts, but will not identify where the damage occurred.

### **Full Tracking Model**

As indicated in the name, the Full Tracking model will not only track learning materials at the first mile and last mile of the supply chain, it will also track what happens during the intermediate levels. The full tracking model allows you to track shipments along the supply chain, providing further insight into your supply chain to help identify or pinpoint issues such as delays, damages, and leakages in the system. This kind of model can allow schools to receive updates on the status of their incoming shipments as they move through the supply chain, which can improve their own planning ability and can empower them to raise an alarm when shipments are not moving along as expected. Similarly, it allows the central level to check in on the status of distribution, and can provide actionable information that enables them to move things along when needed.

Of course there is a cost to this level of visibility. While providing more robust data and a more detailed picture compared to a First and Last Mile Distribution model, Full Tracking models require strong supply chain capacity and human resources at the intermediate level(s) as TLMs are tracked and reported on as they enter and leave the intermediate locations. These models are inherently more expensive to design and operate, as they involve additional training and more person-hours to track the movement of books, as well as additional costs for tracking technologies, equipment such as barcode scanners/smartphones, and internet connectivity at each of the intermediate levels of the supply chain.

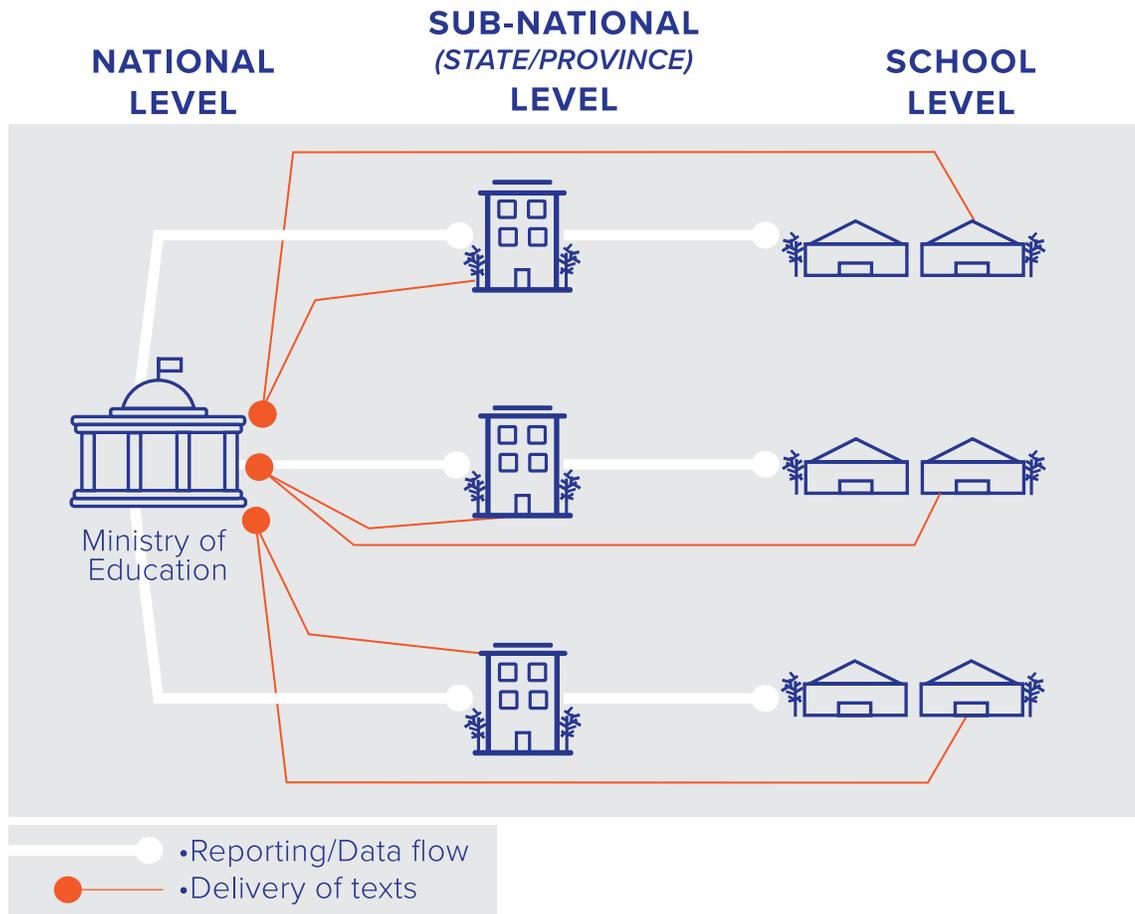
Additionally, because they necessarily map every movement along the supply chain, the design is more rigid, and any changes to the structure of the supply chain require a potentially expensive system update. This can vary in complexity from simply adding a new school (which will require mapping from where that school should receive its TLMs), to adding a new warehouse (which will require changing the relationships for schools that it will now supply), to adding or removing an entire supply chain level (which would require remapping all other nodes).

*“Ministries of Education will need to invest in data input, custom software, and discrete devices. Similarly, training, system updates, and support can increase as feature sets are added.”*

*(All Children Reading, 2018, final paragraph).*

### **HOW TO DECIDE**

Experience has shown that a simpler system is much more likely to be implemented and sustained in the long run, while providing most of the functionality that is needed to determine whether or not TLMs are reaching their intended recipients. For this reason, if you are not



Pros:	Cons:
Provides actionable information to central level planners to allow them to identify problems such as delays and damaged shipments and address them in real time	More expensive to design and operate
Can allow schools to monitor their incoming deliveries, empowering them to raise a red flag when the process is not going as expected	Involves more training and requires more human resource capacity at intermediate levels of the system
As with a First and Last model, provides visibility into whether TLMs ultimately reach their intended recipients	Design is more rigid, more resistant to any future changes in the system, which can require significant investment to adjust the system
	May not be suitable for countries that contract for distribution of TLMs

currently able to track in real time whether or not books are reaching their intended recipients, we recommend you start with a First-Last tracking model. You should only consider moving to a Full Tracking model once you already have a system that reliably tracks the last mile. Again, it may help to skip ahead to the Dashboards and Key Performance Indicators section below to get some ideas for what you would like your system to track. The most important indicators in that section can all be tracked in a First-Last model system; adding tracking to the in-between levels for the most part only gets you additional details.

## CASE STUDY: FULL TRACKING AND FIRST-LAST MODELS

### REAL EXAMPLES

#### Scaling Back from Full-Tracking Models to First and Last Mile Models

The evolving iterations of Track and Trace in Cambodia and Afghanistan demonstrate the trade-offs that have to be considered between simplicity and visibility of TLMs as they move across every step of the supply chain.

In **Cambodia**, the first pilot Track and Trace was the full-blown full tracking model. TnT tracked books at numerous points along the supply chain. Upon dispatch in trucks, warehouse managers scanned barcodes on shipment paperwork attached to pallets of books packed to district level requirements. Upon arrival at district level, truck drivers scanned again to update the location in the system and district education officers scanned the shipment lists once the pallets were unloaded to confirm delivery at the district level. School directors received a notification by chatbot that their books had arrived, and once they had journeyed to the district education office, they used an online form accessed through the chatbot to enter the number and types of books that were allocated to them out of the district shipment. School support committees were then notified by chatbot that books would be arriving at their school, and in turn used an online form to enter data on the books they unpacked at the school once the school director had returned with the books.

This full-tracking model was short-lived. While this approach yielded much valuable data, it proved to be inflexible in face of frequent, unexpected changes in the supply chain process made by the MoE. For example, the system was designed for a single book distributor but the government ended up using two distributors which generated multiple records and significant confusion among users. The MoE then decided that books should be distributed to cluster level, not district, again incapacitating TnT, whose architecture was based on district level distribution. These changes required redevelopment of the TnT platform, proving costly and time consuming. Before moving to nation-wide scale-up, it was concluded that such kinds of changes to the supply chain processes were likely to continue to occur in the future and thus a streamlining and simplification of the Track and Trace system should be made before final hand over to MoE to ensure its long term use and sustainability.

The TnT model in use today in Cambodia, at national scale, now takes more of a First and Last Mile approach. Upon getting a notification by chatbot, schools use TnT to enter book need data. This is converted into a national book allocation list and used for procurement by the MoE. When school directors receive their books they enter data into TnT on the number and type received. Other chatbot buttons allow school directors to i.) get data on the books approved by MoE for their school and ii.) to notify MoE of a problem. Functionality allowing school community members to enter book spotcheck data was also retained. However, no data is now available on TnT about books during any of the distribution stages until school directors receive them. This simplification has been a major factor behind the government's takeover of the running costs of TnT. At just \$9,000 per year for the whole country, TnT is an affordable and durable tool for the Cambodian MoE over the long term. This was only achievable by reducing functionality.

Interestingly, a similar scaling-back of functionality occurred in **Afghanistan** with the Online Textbook Inventory Management System (OTIMS) platform. Initial versions of the platform supported by Creative Associates had users at every level of supply chain, and tracked specific boxes of books through scanning and GPS. Over time, the costs and complexity associated with that has resulted in significant streamlining. Later versions no longer track books right from the printers, but instead from warehouses in Kabul, and no longer attempt book confirmations at schools, but ends, instead, at the district level.

The moral of these stories? If there is a likelihood that TLM supply chain processes may change it might be better to develop a simpler platform that does not require later re-development. While this reduces visibility into every stage of the chain, the TnT platform will be able to accommodate any further changes to the TLM supply process the MoE may decide on. Furthermore, simple tracking of dispatch from the central warehouse and final receipt at the last mile reduces a range of costs (technology, materials, training and HR) and can be enough to achieve the majority of a government's objectives.

(Creative, 2018; A. Kishore, *personal communication*, April 13 2021; Kishore & Sadat, 2019; Lovenburg, 2017; WBG 2019, 2020a, 2020b.)

## REAL EXAMPLES

### The Ever-Shifting Nature of TLM Supply Chains and the Impact on TnT platforms

Since its inception in 2007, the Rwandan LTM MIS has been through three iterations brought about in part by major shifts in the government textbook policy, including a move from decentralisation back to centralisation (Global Partnership for Education Secretariat, 2013; N. Read, *personal communication*, April 19 2021; Read, N, 2016, 2017). Cambodia's TnT has also seen three re-developments/revisions just since 2017 to account for shifts in MoE requirements and textbook supply procedures. Afghanistan's OTIMS similarly saw a major revision when adapted for national scale (A. Kishore, *personal communication*, April 13 2021). All countries had multi-feature TnTs with complex architecture that collected and provided data to and from different types of users at different points in the chain. Changes to any element in the supply chain and users compromised the existing TnTs significantly, requiring costly redevelopment.

## DECISION 5: WHAT ADDITIONAL COMPONENTS WILL BE INCLUDED IN YOUR SYSTEM?

At its most basic level, a track and trace system tracks TLM deliveries through the supply chain. However there are other functionalities of a digitized system that greatly expand the functionality of the system. We will review these below.

### 5A : COMMUNICATION AND EXPECTATION MANAGEMENT SYSTEM

The most basic tracking system would simply collect information on the location of TLM shipments and make this information available to supply chain management personnel at the central level. While this may increase the timeliness of data available to the central level, it does not go very far to expanding visibility and usability of that data. To go further, adding communication and expectation management functions takes this basic functionality much further, and opens it up to users at all levels of the system.

These functions can include everything from broadcasting simple reminders, to allowing distributors, local education officials, and last-mile communities to access the system to find the status of their shipments, to automated alerts that notify the appropriate supervisory personnel when a shipment arrives damaged or goes missing to enable them to quickly act to correct the problem.

The following are some examples of the kinds of communications that can be included in a Track and Trace system:

Communication and expectations management components can vary significantly so selection of tools or platforms depends very much on your communication objectives and goals.

## REAL EXAMPLES

### Communications: alerts, notifications, reminders used in TnT systems

In Afghanistan, Creative Associates' Book Tracker had a range of specific, actionable, and automatic reports and alerts that were sent to users at various levels (Creative Associates International, 2018). For instance, as books moved along the supply chain, if a user at province level entered data into the system indicating that some of the books received were damaged, this would activate emails to appropriate people to get them to start to take action, such as to send more books, even before the books had arrived at schools (A. Kishore, personal communication, April 13 2021).

In Rwanda, under the decentralized school-based book ordering approach used by the Rwandan Education Board (REB) in 2010, when schools received their 2010 order form using their digital LTM Management Information System it was found that they did not order up to the budget allocation provided by REB. In subsequent years, a threshold setting was applied within the LTM MIS during ordering that flagged any schools not ordering up to within 10% of their budget allocation. REB officials with access to the MIS platform could see which schools were not ordering correctly, contacted the schools and provided additional support in completing the ordering process to the affected schools. (Read, N, 2017).

## **Messages automatically generated by TnT - Sent out to users:**

### **School Directors:**

#### **Reminders:**

- You haven't... (submitted your book request, confirmed your delivery, etc.).

#### **Alerts:**

- You can now... (submit your TLM request data. Please submit before XX. Please watch this video to remind yourself how.)
- Your books have been dispatched
- You can now check here to see what books have been approved for your school
- Your books are now ready to be picked up.  
Distributors/MoE staff

#### **Alerts:**

- School Shipment XX is missing/delayed/damaged
- District Shipment XX has been dispatched

## **Communications sent in from users:**

### **Queries -**

- What has been approved for school XX?
- When will school shipment XX be dispatched?
- Where....?
- How do you.... request/confirm books?
- This shipment has X damaged

For this reason it is very important to define the requirements, beginning with whether or not you need/want an interactive program where users can receive and respond to messages as well as make queries, or simply a way to send out notifications. Typically for reminder messaging or semi-regular updates (event reminders, general tips) it's sufficient to send one-way messages. For more complex interactions allowing users to run queries or when it's necessary to collect data from your users, a two-way interaction will be more appropriate.

Another key consideration is whether the system needs to be able to send messages to particular individuals or if communication will be entirely general. For example, if the system is set up to send an alert when a shipment is reported as damaged, who will receive that alert? Will it be the same person or group for all such alerts, or will the person alerted depend on where the shipment was reported - such as alerting a particular district supply manager when a school in their district reports a problem. For another example, if the system is to be able to identify when a particular school is late in sending its book request and send them a reminder, will it simply send a reminder to all schools? Or does the system need to have a list of the particular person responsible for each school and their contact information, and be able to contact that person directly? In the simple case, the system can simply broadcast a message to all schools, such as to a messaging channel for all school directors, which requires only that the school directors know to subscribe to the channel. In the more complex case, the system must have a complete record of all relevant contacts, and this list must be constantly updated as personnel changes or even as their contact information changes.

When defining requirements, it is also important to have in mind funding constraints on both the short term (during initial the development phase) as well as the longer term for running costs and routine maintenance. Often the more complex a system, the more expensive it is for development (e.g design/programming costs, purchasing of software/hardware, Telecom fees) and running costs (e.g. routine subscriptions, Telecom fees, air time, etc.). Additionally, training needs and associated costs related to use or maintenance and staffing should be taken into consideration.

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**DEFINITION:**

A one-way system works by pushing messages out to subscribers either scheduled or as needed, whereas a two-way system involves either pushing messages that prompt the user to interact and respond, or receiving messages initiated by a user that prompts the system to respond, moving through a series of questions in a pre-determined pattern.

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## Key questions for defining communication objectives and goals:

- What type of content are you sharing? When, to whom, and how often?
- What type of content do you want to receive (if any)?
- How should content be managed and responded to (if received)?  
(Artificial intelligence (AI)/chatbot vs human moderator)
- What kind of communication devices do your users have access to? (simple phone, smart phone, tablet, computer)
- Do you want to include two-way capability or one-way messaging only?
- Do you want to visualize your communication related data?

What are your constraints, including budget, timeline, and capacity?

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## 5B : WILL THE SYSTEM COLLECT SCHOOL-LEVEL TLM NEEDS DATA?

Another function that adds greatly to the usefulness of a Track and Trace system is including an ordering or requesting component. These systems can leverage the digital nature of

### REAL EXAMPLE

#### The Importance of Communications During TLM Delivery

*“Even when the MoE is able to deliver stock to local education authorities, the final stage of transporting the books to the school is often beyond the resources either of the local authority or the school. According to textbook specialist Vincent Bontoux (personal communication), Timor-Leste is typical of many lower-income countries: the textbooks distributed by the central Direção da Logística to the regions do not reach schools because there is no transport or budget. Schools that are closer to district stores may collect their stock, and may even take more than their official allocations, while schools in rural and remote locations may only hear later that books have arrived at the district warehouse. By the time they find out, they discover that much of the stock has been taken.” (Smart & Jagannathan, 2018, p. 4)*

the Track and Trace system to collect vital information used to determine or forecast book needs in a fraction of the time it would normally take to collect this data on a paper system, and with less propensity for errors. This greatly speeds up the budgeting and procurement processes, which means that the data used to determine book orders can be collected much closer to when those books will actually be needed, providing a more accurate picture of the true need.

However, it is important to note that not all countries order TLMs based on school-level input. Many countries use other methods to determine what will be ordered each year, such as ordering according to the available budget, or ordering according to what was ordered the previous year. For a country that does not have a robust system of using school-level data to determine needs or for schools to themselves place orders, an ordering/requesting

component to TnT may not be appropriate or may present a level of added complexity that would be better saved for later addition to the system, after the TnT system has first been proven effective at tracking books.

It is therefore not recommended that a country attempt to institute an entirely new data collection and TLM needs forecasting process while setting up a new Track and Trace system. For a country that already has this system in place, the next step is to determine whether or not this data will be collected by the new Track and Trace system. A key consideration in this decision is where and how needs are calculated and with what data.

### **At what level are TLM needs calculated?**

TLM needs can be determined one of two ways: by the person or school that will be using those books, or by someone higher up the education system hierarchy. In supply chain terms these are known as pull and push systems.

#### **Pull system**

In a pull system, the needs for TLMs are determined by the person or school that will ultimately use them. In a pull system, the user determines their own need for books, and places an order for a particular number of each type of book, according to what they think they will need. Higher level officials may approve a different number of books for allocation if there are budget constraints, but the key is that the needs are determined at the last mile.

#### **Push system**

In a push system, the needs for TLMs are determined by higher levels of the supply chain. Ideally these needs are calculated based on data from each school such as the number of students expected to be in each grade and the number of usable books of each type that the school currently has available for use. However these needs can also be determined by less precise methods such as allocating a fixed number of TLMs to schools based on population size.

#### **Hybrid system**

Ordering systems do not have to be purely push or pull, and indeed many are not. Many systems include both at different levels; for example, a regional or district office may calculate the needs for the schools they serve, and place an order to the central level (or to book publishers directly) for specific numbers of books (pull), but may then allocate books to the schools under them (push).

## **WHAT DATA IS REQUIRED?**

The amount of data used to determine TLM needs can vary greatly across different ordering systems, from simply requiring national budget figures in a system that simply allocates TLMs based on a predetermined budget, to requiring a detailed set of instructions in a system that asks end-users to order individual book titles.

#### **Individual TLM title data**

A true pull system requires a complex ordering process, with the end user typically ordering many titles from a long list of approved books. Some push systems rely on a similar level of

complexity, requiring data on the number of usable copies of each TLM title available at each school. This level of complexity is not practical for SMS- or IVR-based ordering systems. Instead, incorporating this into a Track and Trace system requires that the end user have access to a smartphone, computer, or tablet that allows use of an application with a graphical user interface, and either reliable internet service to be able to use the application reliably throughout the ordering process or an application that allows offline use for upload at a later time.

## REAL EXAMPLES

### TnT for quick and accurate forecasting and procurement

Ministries of Education (MoE) must have accurate and timely information on TLM levels and needs at schools to accurately determine procurement needs. Even in a country that has a system for collecting school data, such as an Education Management Information System (EMIS), the information might not be up to date and might not have the data points required for accurate forecasting and projections for TLMs (Read, T, 2015). Paper-based book request processes tend to be prone to error, incomplete and can take a long time to reach the central MoE (WBG, 2020a). Track and Trace systems can have features that automatically provide an accurate projection of national book requirements based on up to date data provided by schools. This, in turn, means that national budgeting and procurement processes can be accomplished more quickly and efficiently than paper-based systems. In Rwanda, due to their online textbook management platform, they are able to forecast stock and budget requirements five years in advance which allows the government to ensure they have lined up sufficient funds (Read, T, 2015). In Cambodia, school directors now use TnT on their smartphones to report timely data about student numbers and stocks of usable books, and TnT then assists in accurately calculating book needs for next school year. Before TnT, school directors had to make complex calculations on paper-based forms, leading to errors, and this was followed by a lengthy, and also error-prone, process whereby the request forms moved from district to province to central level where officials entered the data manually into Excel spreadsheets. This process took up to six months, and as a result, school directors were asked to calculate book requirements for distribution two years ahead. Now TnT automatically sends the information directly to the central government so that it can be used for budgeting and procurement by the central ministry for the current year (WBG, 2020a).

Additionally, each end user will require training to be able to use the system, and because end users typically only make orders or report this data once a year, they may need refresher training each year. Although there are ways to help mitigate this, as described below in the section on training options, these training costs greatly add to the overall cost of the system.

### Enrollment data

Enrollment data is significantly less complex to capture than title-level data, and may be entered at the school level or at an intermediate level. A push system may rely simply on the number of children enrolled in each grade year; this level of detail is feasible to collect at the school level by an SMS-based system, as it simply requires entering one number for each grade level. More complex enrollment data, such as

individual types of students within each grade, or where an intermediate level in the education system is entering data for multiple schools, is less feasible to collect on an SMS-based system. In general if there are more than 10 individual pieces of data to collect then an SMS-based data collection system is not well suited, and a smartphone application system is more appropriate.

Keep in mind that some training will still be needed for users entering this enrollment data, and if the users entering this data are at the end-user (school) level, this may still require a significant investment in training for users. And while an SMS-based system is well suited for collecting this lower level of complexity of data, relying on an SMS-based system also means that many of the virtual training options discussed below will not be practical, and more in-person training is needed.

### **Population data**

Some countries use population data to calculate TLM needs. Whether it refers to an overall enrollment number in a school (the total school population), or to a wider community figure (overall community population, school-age population), population data is simpler still than enrollment data, and can relatively easily be entered into an SMS-based system either at the school level or, often, at an intermediate level even where that level is entering data for multiple schools. The flip side is that this information is often already being collected and available at the central level through other means, though it may not always be updated regularly. In this case, a country implementing Track and Trace must weigh whether it is worth the added complexity and expense to add this level of data collection to their Track and Trace system in return for possibly more up-to-date figures.

### **Other centrally-available data**

Many push systems rely on other data that is available at a central level. Some may base ordering decisions on the amount of budget available, or the number of books bought the previous year. Since such data is by definition already available at the central level, this data does not need to be collected by a Track and Trace system.

## **5C : WILL THERE BE POST-DISTRIBUTION MONITORING?**

The final component in designing your TnT system is deciding whether to include functions that allow for routine monitoring or stock taking using digital means that enable stakeholders to have another avenue of real-time visibility of the system. Post-distribution monitoring at schools, including the use of spot-check surveys or stock taking, are useful for a variety of reasons. They can provide a whole range of other helpful information to stakeholders outside of the immediate delivery order. For example, checking the condition of the TLMs in use in classrooms can indicate whether the quality of the supplied materials is sufficient, or even that the delivered textbooks are those that have been approved by the government. Checks of actual student numbers or usable stock can help gauge whether schools are misreporting student numbers or stock levels during TLM need data collection (Smart & Jagannathan, 2018; Read, 2017). By digitizing the process and linking it with the TnT, post-distribution monitoring also creates a way to quickly and systematically check that the data generated and transmitted through the TnT platform is correct by enabling immediate analysis against historical requesting, approval or delivery data already in the system.



## REAL EXAMPLE

### EXAMPLE OF HOW SMS COULD BE USED FOR SPOTCHECKS

A report on the alpha testing of a TnT system in Malawi gave the following recommendation of how SMS could be used for spot checks/audits (Lacey, 2016, p7)

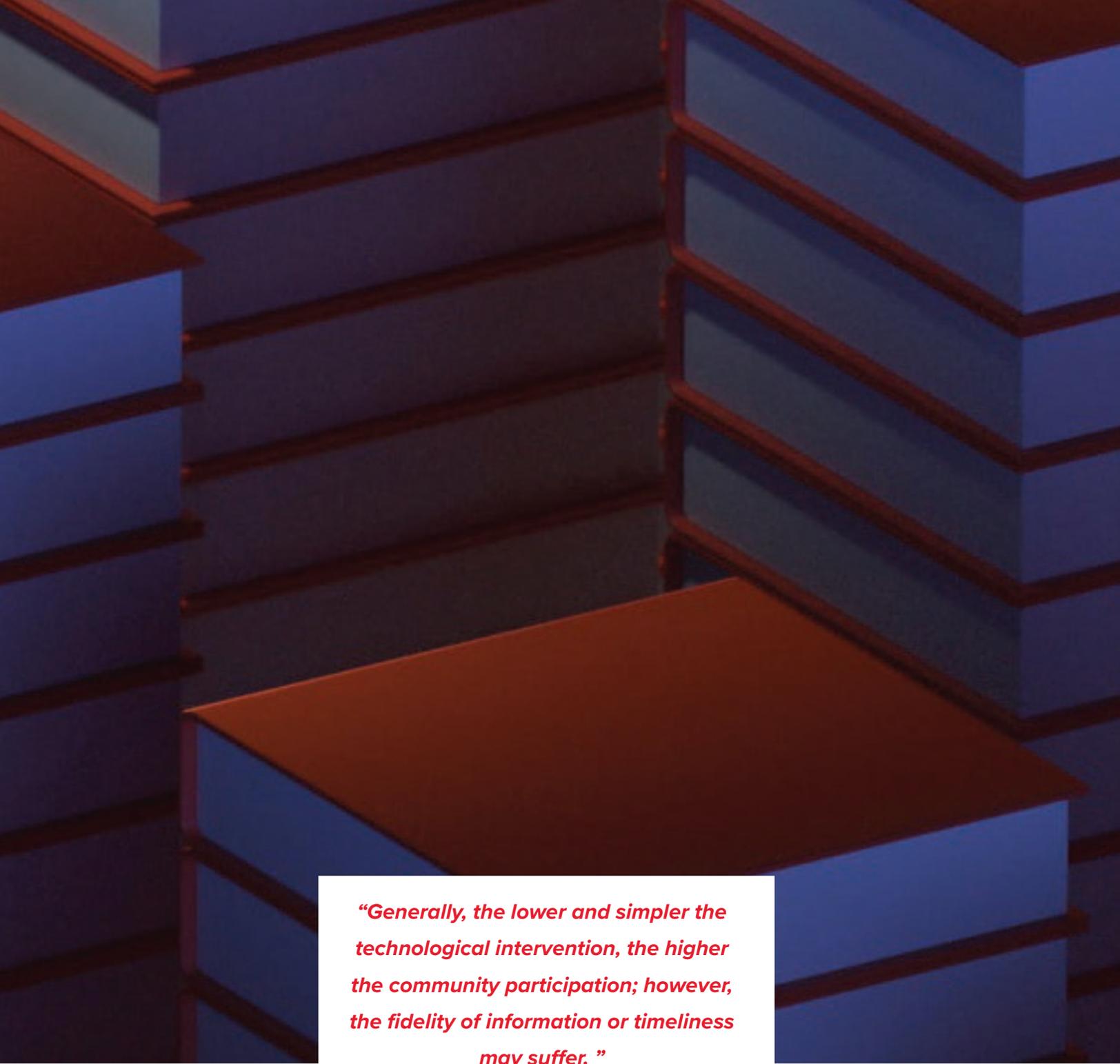
#### AUDIT FUNCTIONALITY FOR BOOKS

As a means to gauge whether or not the delivered textbooks are being used (or not sold off, subsequently) in their school and community, an audit feature can be a useful item. This could take the form of having a deputized, or responsible community member (such as a PTA, SMC or Mother Group member) receive a message that asks for an audit of the quantity of a certain textbook title. Since the delivered quantity is a known factor within the system, having a “push” message feature to a known subscriber might appear as follows:

1. A flyer is sent out to a school’s area community (catchment zone) calling for responsible members to send a free message with the code \*4321
2. A responsible community member who sends \*4321 to the free number (shortcode) is registered within the system as the auditing actor for that particular school
3. 30 days after confirmed delivery and receipt of 180 copies of S1 English, a message is sent to the community member to “Please check the book locker and count the S1 English texts. Reply to this message with the number of books.”
4. The community member audits the book locker and responds to the system message with a number
5. The system reconciles the number with the previously-known delivered and received quantity and alerts higher-level actors if there are discrepancies”



▲ Community members who have registered on TnT conducting a spot check of book availability in the classroom in Cambodia. They record the spot check results on an online form accessed through the TnT chatbot on the Telegram messaging app. The data is then visible on the TnT dashboard, giving realtime visibility into book availability and use by students.



***“Generally, the lower and simpler the technological intervention, the higher the community participation; however, the fidelity of information or timeliness may suffer. ”***

*(All Children Reading, 2018, paragraph 7)*

it can be tricky to have them monitor themselves. Parent-Teacher Associations or School Support Committees can be ideally placed to undertake this data collection, but this involves a new layer of user training, and often members of these groups are not as technologically savvy as school staff.

## Next Steps: Filling Out the Design

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Now that you have identified the model and components of the TnT that you would like to implement, the rest of this guidebook will be dedicated to assisting you in identifying all the options and choices you will have to make to put your model into practice, no matter which model you chose.

### WHERE DOES PROCUREMENT HAPPEN?

Another consideration for designing a TnT system is where the procurement happens. Does the central government do one yearly procurement for all schools? Do district or regional offices organise their own procurement? Are schools expected to procure books for themselves? Understanding how book ordering and procurement happens is key to designing a system that is appropriate to the education system served.

#### Centralized procurement

In many education systems procurement is often centralized. The central government, often the Ministry of Education, collects or calculates the needs in TLMs for the whole country, places a large order with publishers, and allocates TLMs to the lower levels for distribution. These large orders are often done once a year, in advance of the start of the coming school year. In most cases this will mean that TLMs begin their travel through the supply chain at one centralized location, such as a national warehouse. Tracking for these TLMs in a Track and Trace system would therefore begin at this central point. In some cases tracking may begin at the printer where the TLMs are scanned as they are printed.

#### Decentralized procurement

In a more decentralized system, procurement may be done at an intermediary level, such as by regional or district offices of education. Orders may be placed with a central government warehouse, or, more likely, directly with publishers and distributors. When placed directly with publishers, the TLMs will often enter the supply chain with a delivery directly from the publisher to the intermediary warehouse for further distribution, and it is at this point that the shipments would begin to be tracked in a TnT system.

#### Last mile procurement

In a further decentralized system, TLM orders may be placed by the last-mile communities or schools themselves. For example, a school may receive a set budget for ordering TLMs for the year, and be allowed to order those books directly. What this looks like in practice can

## REAL EXAMPLES

### TnT for decentralised procurement

Some countries choose to remove centralised book procurement and provision entirely, with schools using their own allocated budgets for ordering books directly from book publishers/printers or distributors. Digital systems can be used for this supply chain structure too.

Recently in Nepal, for instance, World Vision, with funding from the World Bank, trialled this with reading books through an online “digital market place” called KITAB Bazar whereby schools could choose and place their orders for reading books, and later confirm delivery. The trial was a success, demonstrating how a platform can enable real-time book ordering based on actual needs, and also provide important data for local education authorities, central government and donors about how schools used their funds, which schools ordered, what and how much was ordered, and quantities delivered directly to schools (Myler, 2019).

In Rwanda, the Rwandan Education Board’s drive for decentralised TLM provision involved schools being provided a capitation grant and being able to select their TLMs from an approved materials list using an online ordering system. Schools unable to use technology themselves to place their orders were able to get assistance from their local education authorities (N. Read, personal communication, April 19 2021).

## BEST PRACTICE

### Automated Ordering System for Textbooks If A Decentralised System Is In Use

Some governments have chosen a decentralised TLM ordering approach whereby schools can select their own materials from an approved list issued by the MoE. Such an approach can also be fraught with difficulties. A key recommendation in an evaluation of the Namibian Education Project, part of the Millennium Challenge Account Namibia Compact, sums up succinctly why automating and digitizing TLM ordering in these sorts of decentralised systems could be considered a best practice.

MEAC [Ministry of Education Arts and Culture] should replace their spreadsheet based textbook procurement/ordering system with an automated ordering system to simplify order entry of alpha/numeric details (ISBNs and book titles do not lend themselves to being handled on Excel spreadsheets, as observed in considerable detail in the Namibia Textbook Baseline Study 2010). An automated system would reduce the number of errors and the ordering of the wrong edition of titles. With an automated system the details of all Approved Textbooks, Teacher Guides and publisher details could be on the system or linked to the system in the form of a database (e.g. the content of the MEAC Primary Textbook Catalog and the MEAC Junior and Senior Secondary Textbook Catalog could be accessed online). With a live online automated system, it should be possible to monitor that regions are adhering to the ordering timelines (IMC Worldwide, 2018, p. 206).

vary widely, from the school procuring books internally from a district or the national warehouse, to the school procuring from national regional suppliers, to the school procuring from local booksellers in their community. Where these orders are placed, and where the books enter the supply chain, will dictate where tracking can begin.

## ASSESSING TECHNOLOGY PENETRATION

Track and Trace is by definition a platform that relies on digital technology to improve existing paper-based processes, and while this reliance on technology is the source of the greatest potential for improving existing processes, a lack of technology availability will be the greatest limiter in any system's potential. Where computers and smartphones are common and cellular data network coverage is widespread, the potential for an individual user to be able to regularly enter detailed information is immense. Where this is not the case, and a system needs to rely on basic phones, for example for data entry through IVR systems or by SMS, the potential for data collection is much more limited. For example, while in theory it would be possible to replicate any amount of data entry or system functionality through an automated SMS system, in practice navigating such a system would be a much more cumbersome process, taking much longer and potentially being significantly expensive for the end user. This both reduces the quality of the data collected (a user may get tired or frustrated after spending a long time entering data, or may simply get interrupted in the midst of data entry), and discourages the entry of data in the first place.

A key decision point in designing a Track and Trace system is therefore identifying what technologies are feasible for the users of your system to use, and to what degree will your system design be focused on including the parts of your country that have the least technology penetration. Identifying the right balance of system functionality and ease of use vs. inclusion of the hardest-to-reach users will be a key decision point in any system design.

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### Quick Device Facts:

**Basic phone:** Device with basic phone functionality (e.g., SMS and voice), very limited computing power, few connectivity options, and a basic user interface and numeric keypad.

**Smartphone:** Mobile phone that performs many of the functions of a computer, typically having a touchscreen interface, Internet access, and an operating system capable of running downloaded applications. Runs Android, iOS.

**Tablet:** Larger screen device that performs many of the functions of a smartphone with the benefits of more processing power, longer battery life, more memory and easier data entry and viewing. May have a stylus and be able to use an auxiliary keyboard to assist in data entry. Runs Android, iOS, Windows

## HOW WILL DATA BE COLLECTED?

A TnT system can rely on varying levels of technology for data collection, depending on the level of technology penetration where it is being implemented.

### Basic phone

Simple phones can be used to capture data in real time through SMS-based systems or through interactive voice response (IVR) systems that use an automated recording to guide the caller through a series of steps to enter data on the phone's keypad. Like smartphones and tablets, they allow real-time data collection. Unlike smartphones, most people in most countries have access to at least a basic phone, and cellular voice and SMS network coverage is also much more widespread than cellular data network coverage.

The drawback of data collection with simple phones is that both SMS and IVR data collection make the process quite cumbersome compared to smartphone apps. Automatic data quality checking will be limited, and due to the slow nature of data input, the amount of data that can be collected is limited before you start to risk user fatigue and sharp drops in reporting rates and data quality. Additionally, collecting a lot of data by SMS or IVR can quickly consume users' voice minutes and SMS messages, resulting in significant costs for the users. Though there are workarounds to this, such as working with telecommunications providers

Pros:	Cons:
<ul style="list-style-type: none"><li>● More available than smartphones and tablets</li><li>● Do not rely on data network coverage</li><li>● Allow real-time data collection</li></ul>	<ul style="list-style-type: none"><li>● Cumbersome data entry process limits the amount of data that can be collected</li><li>● Data entry process generally inflexible and vulnerable to incorrect entries (e.g. sending a message that a shipment was “Received” rather than “Received”, or using a space or other character in the wrong place)</li><li>● Requires phone network coverage</li><li>● Costs born by users (for cellular minutes and/or SMSs) can be considerable, which can discourage reporting</li><li>● These costs can instead be born by the government or an NGO, but the costs of implementing this at national scale can impede scale-up of the system and threaten the sustainability of the system</li></ul>

to set up toll-free lines that are free to the end-users, these kinds of contracts generally involve significant time and expense for the central (government) level.

*“Generally, the lower and simpler the technological intervention, the higher the community participation; however, the fidelity of information or timeliness may suffer. For example, SMS is a feature that exists on almost all feature phones in rural areas, but features that can determine where a message was sent from can be difficult or impossible. This limits the use of geo-positioning features that improve transparency by confirming the exact location of a delivery.”* (All Children Reading, 2018, paragraph 7)

### **SMS/MMS (Stands for: Short/Multimedia Messaging Service)**

Often known as a text message, SMS is available on any mobile phone. There is typically a cost to the user to send and to receive SMS messages, though programs can figure out ways to make sending these messages free to their clients, such as reverse billing or setting up a toll-free number. Some TnT pilot initiatives have also encountered willingness by local telecommunications providers to consider providing reduced rates (S.Lacey and M. Ochako, personal communication, November 11, 2021). SMS messages are great for simple or short interactions, such as an alert that a shipment has arrived or a confirmation response.

Although all mobile phones can send SMS messages, text entry using a basic phone is typically done through the keypad. Although most users will be familiar with the process of entering a message on the keypad, it can be confusing for users that are not accustomed

## **REAL EXAMPLE**

### **SMS Delivery Confirmations**

During pilot testing of Track and Trace in Malawi, a double confirmation system was used for delivery of shipments. Each shipment was labeled with an order code as well as the information on the destination school for which the delivery was intended. Upon delivering the shipment, the delivery person or courier would send an SMS to the Track and Trace number saying “Delivered<space>[Order Number]”, for example “Delivered 00275”, and would then receive a confirmation message confirming the order number. The status of this shipment would then change in the Track and Trace System to “Delivered - unconfirmed”.

A school official from the destination school would then need to confirm the delivery by sending a text message saying “Received [Order number]”, or “Received 00275” in our example above, and would receive a reply confirming receipt of the message. The status of this shipment would then change in the system to “Delivered - Confirmed”. School officials could similarly use the Track and Trace SMS number to report that a shipment was received damaged, was incomplete/incorrect, or was lost, which would trigger an investigation of the situation by higher level officials (John Snow, Inc, World Education, Inc & Vera Solutions, 2016).

## REAL EXAMPLE

### SMS FOR COMMUNITY-LEVEL COMMUNICATIONS

A pilot TnT in Malawi used SMS to enable two-way communications with community and school members regarding book delivery. The following gives details how.

Notifications, Querying and Help

#### **Registering to receive notifications - Parents**

1. To register, send a text message to the Track and Trace number that says: “Parent] [SchoolCode] [ClassCode] [Parent’s Name--one word]”, e.g. Parent S0001 C111 SarahBrown
2. An automated reply SMS is sent back: “Thank you, you have successfully registered to the textbook alert service for School S0001 Class C111.”
3. “Your Class C111 will receive the following books: [Textbook Names].”

#### **Querying the system**

A non-registered user can request information on their child’s books via SMS by:

1. Send an SMS to the Track and Trace number that says: “Books [SchoolID] [Class ID]”. E.g. “Books S0001 C111”
2. An automated SMS reply will be was sent to the sender: “Textbooks for Class C111 are: [Item Names] and are expected to arrive on Day Month Year”

#### **Asking for help**

A registered user can send a help message at any time.

1. A parent or teacher or courier can send an SMS to the Track and Trace number that says: “Help”.
2. An automated SMS reply will be was sent to the sender: “Your help request has been received. A member of our staff will be in touch within 48 hours to provide support.”
3. An alert will appear on the website and will be attended to by the administrator as soon as possible.

(John Snow, Inc. [JSI], World Education, Inc. [WEI] & Vera Solutions, 2016, p. 25).

## REAL EXAMPLES

### Problems encountered with SMS in TnT

In **Nigeria**, SMS messaging to track TLM deliveries worked, but users found typing in letters and code numbers to be complicated (S. James, personal communication, March 24, 2021).

In **Malawi**, JSI and World Education had to limit the book receipt data that could be entered by users through SMS due to the complexity of typing in data by SMS. Communities and schools only confirmed whether books had been received, were incorrect, lost or damaged - with no data entered on the amount or type of books that had been received. Further, spelling mistakes in user inputs confused the system and resulted in non-delivery of status indicators or follow-up notifications. Alpha-numeric codes and the need to enter spaces also was problematic (Lacey, 2016). In **Ethiopia**, BlueTree Group also had to keep the SMS code entry basic, for similar reasons - meaning that last-mile community members and school personnel could only confirm that they got a package of books and whether or not it was damaged. They were not able to provide any data on the contents of the book packages or the particular location where the package was received (S. Lacey and M. Ochaka, personal communication, November 11, 2021).

to sending SMS messages. Also, because there is typically no automated assistance when typing messages, spelling and punctuation can present problems for users, which in turn can lead to a failure of the receiving system to correctly recognize the intent of the user. It is therefore important that any input that will be required from the user be as simple as possible, ideally using only numbers and without punctuation. Additionally, some mobile phones and operating systems do not allow for texting in local languages, especially where the local language is not based on roman script. This can make widespread use by community members difficult in these places.

### IVR (Interactive Voice Response) and USSD (Unstructured Supplementary Service Data)

In an IVR system users access information via an automated voice response system of pre-recorded messages rather than talking to an agent. USSD uses keypad and text, but establishes a real-time connection with the system, rather than SMS which does not establish a connection. An IVR system is similar to the kind of system many users will be familiar with, whereby they call their phone company to access a menu to check the balance of credit on their phone or load new credit. Users can individually select messages from an IVR/USSD menu, or the IVR system can push messages out by calling users directly. A key advantage of IVR systems is that they can include step-by-step instructions including pre-recorded messages in local languages, and do not require that the user's phone can type in non-roman scripts.

## REAL EXAMPLES

### Use of IVR in TnT systems

IVR was not used in the Malawi TnT pilot as during design interviewees unanimously agreed that it would not be a useful design feature. The main reasons given were that if a user was not at their phone to hear a message, it would not be recorded. Furthermore, in areas of minimal reception, IVR voice packets would become dropped whereas SMS messages could be delivered without loss. (Lacey, 2016)



ទម្រង់បំពេញតម្រូវការសៀវភៅសិក្សាគោលសម្រាប់ឆ្នាំសិក្សា ២០២០-២០២១

ចំណាំ: សូមលោកនាយកបញ្ជូនតម្រូវការសៀវភៅសិក្សាគោលនៅក្នុងទម្រង់នេះឱ្យបានត្រឹមត្រូវ

ឈ្មោះសាលា

ភោគ្តនាម

នាម

សូមជ្រើសរើសប្រាក់វិសាលភាពក្នុងសាលារបស់អ្នក \*

- ប្រាក់ទី 1
- ប្រាក់ទី 2
- ប្រាក់ទី 3
- ប្រាក់ទី 4
- ប្រាក់ទី 5
- ប្រាក់ទី 6
- ប្រាក់ទី 7
- ប្រាក់ទី 8
- ប្រាក់ទី 9
- ប្រាក់ទី 10
- ប្រាក់ទី 11
- ប្រាក់ទី 12

ចំនួនសិស្សជាន់ស្ថានសម្រាប់ឆ្នាំសិក្សាថ្មី

ចំណាំ: សូមបំពេញលេខនៅក្នុងប្រអប់ជាលេខខ្ទាត់៤

▲ Track and Trace Cambodia: The online data collection form, accessed on a smartphone, allows school directors to submit information for each grade and each subject to the central level, which is then used for calculating book needs.

Although an IVR system can be used in areas that lack cellular data network coverage, they can be difficult to use where the cellular voice network is not strong, as messages can be clipped. Additionally, the amount of data that can be entered is similarly limited to what can be accomplished via SMS. Finally, interacting with an IVR system can become expensive for the user, eating up their phone credit, and there is often a need to purchase or negotiate with Telecom companies for a short code number. For most situations where the end user must use a basic phone, we recommend an SMS-based system over an IVR system, as SMS systems are generally easier to use and cheaper for users.

**Smartphones/Tablets**

Modern smartphones and connected tablets are ideal data collection devices. Apps can be configured to be extremely easy-to-use while collecting sophisticated data. They can have instructions and data quality checks encoded to assist users during data collection, and can even serve as training platforms for users to receive training materials, including video, audio, and written materials. Some apps include barcode scanning ability, enabling supply chain workers to use the phones they already have rather than buying dedicated barcode scanners. Additionally, most users that have smartphones already have data plans for their phones, and most data-collection platforms use a relatively small amount of cellular data to transmit collected data to a central server. Taken together, the cost burden to users associated with submitting data is generally quite small, and most users are willing to use their own data plans to use their Track and Trace system, particularly since their use of the system is often limited to a few times a year.

The main drawback with smartphones and tablets is of course that not everyone has access to them, or to reliable cellular data networks to connect them. You will need to carefully consider the level of technology penetration in your country to assess whether or not this tech-

## REAL EXAMPLE

### Use of a Chatbot in a TnT System

In Cambodia, where feasibility research indicated that over 90% of school directors use a smartphone, the ministry's TnT system was designed around the use of a chatbot that was integrated with the Telegram messaging app (the platform of choice by the ministry for official use). The chatbot provides the main portal for school directors and school management committee members to access and use TnT. Easily found on Telegram by typing in 'tntcambodia\_bot', the chatbot guides the user to use one of the nine 'buttons' displayed at the bottom of the screen that can be chosen from.

- Button 1 'how to use TnT': contains links to digital training materials about how to use TnT (short videos and brief instruction guides that can be saved to their phone)
- Button 2 'register': enables the user to register onto the TnT platform, creating a distinct id for that user, tied to their school, with all relevant contact information.
- Button 3 'request': sends the school director to an online form for submitting the usable book and enrolment data required for TnT to automatically calculate that school's book needs. Once completed, the bot sends a message back to the school director containing details of the books that have been requested for that school.
- Button 4 'books approved': later on in the delivery cycle, school directors are notified by the ministry that they can use this button to find out what books were ultimately approved for delivery by the central level
- Button 5 'confirm books': each time books are delivered to the school, the school director can use this button to access an online form to record details of the titles received.
- Button 6 'unregister': for cases where there is a change in school director at the school
- Button 7 'register spotchecker': for community members tasked with conducting a check of general book availability in the classroom
- Button 8 'spotcheck': directs the user to an online form to record the number of books being used by students during that lesson.
- Button 9 'report problem': directs school directors to a free-form message box where they can alert the ministry of a problem with their delivery or request. The central ministry's TnT dashboard then displays summary information about schools that have submitted a problem using the chatbot button, with a tab/list view/report that can provide school-level details.



The chatbot has proved extremely successful and has been used for all school book requests. School directors around the country learned how to use the chatbot initially simply through digital training resources that included a [short video and one-pager hosted by the ministry on a TnT web repository](#). No face-to-face training was provided. Further training resources and reminders were disseminated at relevant points in the school year through the ministry's network of closed Telegram groups for school directors. With school directors willing to use their own data, the extremely low cost associated with using a chatbot as the primary data collection gateway has meant that the government has been able to take over all TnT annual running costs.

nology is feasible to use at each level of data collection. Additionally, some users may not be familiar with the use of smartphones and tablets beyond their most basic functions, and may require additional training before they are comfortable using them for data collection.

Pros:	Cons:
<ul style="list-style-type: none"> <li>● Enables relatively simple collection of a large amount of complex data</li> <li>● Apps can be programmed with validation alerts to prevent data from being entered incorrectly</li> <li>● Users can access training materials on the same device they are using to report data</li> <li>● Can include advanced features such as barcode scanning without the need for dedicated scanning hardware</li> <li>● Costs to transmit data are relatively small and usually easily born by users</li> </ul>	<ul style="list-style-type: none"> <li>● Though increasingly available, smartphone ownership is far from universal</li> <li>● Requires availability of cellular data network</li> <li>● Training may be required for less technologically savvy users</li> </ul>

### **Messaging Application (e.g. WhatsApp, Facebook Messenger, Telegram)**

Unlike in an SMS system, in a messaging application messages are sent both over mobile internet or wireless, making the cost per message lower but also limiting use to areas where connectivity is readily available. Because messaging apps are used on smartphones, they typically include a spell check component, which can help reduce errors. While an SMS system is limited to one-to-one interactions with the sender needing to know the credentials of each recipient they wish to include, and being charged for a separate SMS for each recipient, messaging applications make it easy to create large user groups that a user can simply join. They are great for creating user groups to share content (peer-to-peer), and are widely used already by most users with a smartphone. However, users that are not already using the particular messaging application would have to download it to their phone, potentially taking up valuable memory space.

However, although messaging applications are great for sharing information among a large number of users, by themselves they are not well suited to collecting or requesting user-specific information, as they often require a live moderator to respond to each individual message. However this problem can be solved by using a chatbot (discussed below).

### **Chatbot**

A chatbot is like an automated assistant that integrates into a messaging platform. A user finds and interacts with the chatbot in the same way they do so with any person on the messaging platform - by finding its name and sending it a message. The chatbot then presents the user with a menu of options for things it can do, and the user selects one of these by either selecting an on-screen button or by typing a prompt. The chatbot itself can have access to the Track and Trace database, so it can answer specific questions, for example about the status of a particular shipment, or the quantities of books that have been approved and will be delivered. In this way the chatbot acts like a human moderator on a message board, but has the ability to respond to queries from many users at once, at any time of day, instantly.

A chatbot can also send alerts and notifications. For instance, once registered school directors have used the TnTbot in Cambodia to fill out data on usable book quantities and school enrolment, the bot sends back a message with details of the numbers of books that will be requested based on this data. However, it should be noted that while a chatbot is well suited for sending individual messages to a user, such as notifying them that the request the data they just submitted was received, it is not well suited for broadcasting general messages to all users at once. Most messaging applications have limits on how many messages a user can send in quick succession, and from the application's point of view a chatbot is just another user. Such general messages are better sent on the messaging application outside of the chatbot, for example to a large group of recipients or on a dedicated channel for such messages that users subscribe to.



▲ *Using an online form to conduct a book spot check, Cambodia.*

### Online forms

An online form can enable a user to enter complicated data without demanding that they have a dedicated application on their phone or compute for the purpose. All the user needs is an internet connection and a URL pointing them to the online form (provided by a messaging application, by a chatbot, SMS, email, printed poster on the wall, QR code, etc.). The user can then open up the form and put in whatever information is needed; the form can be programmed to provide instructions on entering data, and can have validation checks to ensure that users are entering data correctly. Although online forms generally will require the user to be online at least when they first access the form, some forms (for example Microsoft Excel Online) can be completed offline and then synched when the user returns online.

## REAL EXAMPLE

### The 'BOOK TRACKER' Mobile APP

Creative Associates International has developed and implemented Track and Trace methodology for book delivery in a number of countries. Creative used a customized commercial technology in such initiatives in Afghanistan and Mozambique. Book Tracker is a combination of “mobile-app based and SMS-interaction technologies to enable data collection that proves confirmed book deliveries, and provides specific, actionable, and automatic report and alerts in real time. The

Book Tracker app is an iteration of CreativeMapper, developed by Geospago” (Creative Associates International, 2018, slide 4).

The excerpt below details the features of Book Tracker:

- Book Tracker is built on Geospago, a user-friendly logistics and data collection tool. The Book Tracker mobile app is available for use on Android devices, and features easy form creation and offline mobile functionality – the app can still be used on a tablet or smartphone when an internet connection is unavailable and will automatically sync data when connected. Collected data can include geospatial information allowing for data to be mapped in real-time and ready for sharing and analysis with project staff and stakeholders.
  - Book Tracker features mobile and web-based data entry, a simple form designer, project-specific dashboards, customizable alerts and automatic reporting. The online platform includes a public viewer, which can be used to share maps with stakeholders outside of the project. Users who have been given access to the projects will be provided a network link that allows them to view the live, cloud data in Google Earth or other software capable of displaying geographic data. Data can be exported from the CreativeMapper online platform as a CSV, KML, or Shapefile at any time.
  - Book Tracker has been integrated with other technologies (SMS and IVR) to expand options for user interaction with the tracking system.
  - Languages available: Both the online platform and mobile app are available in English, French, Spanish. The forms and data can be translated to Portuguese.
- (Global Reading Network, 2018, p. 3).

## REAL EXAMPLE

### Combination of mobile application and SMS in Ethiopia to address different levels of digital access

The BlueTree Group, in their beta testing of a TnT in Ethiopia used both an app and an SMS system. This was based on recommendations from the Ministry of Education that the TnT system provides full traceability of books and provides real time data, while at the same time recognising that school level personnel would likely not have access to smartphones. This meant that a mobile app could not be used for all steps of the distribution cycle. Thus, BlueTree’s final beta design used both their own proprietary Point of Delivery (POD) Android mobile application and an SMS system. The POD mobile app was used to track TLMs all the way from the printer in India to the Woreda and an SMS based system was used to track distribution at the school.

BlueTree’s Point of Delivery mobile application has offline functionality, so that it can be used even when there is no Internet. The data is subsequently synced automatically once Internet is available. The app can collect geospatial information allowing for data to be mapped in real-time. The app can use the mobile phone’s camera as well as a barcode scanner app to facilitate easier data entry. The online platform includes a dashboard accessible via a Web browser where stakeholders can view real time data, customizable alerts, and automatic reporting. The app was used

to track the books at these points: the printer (in India); upon arrival in Addis Ababa; arrival at the woredas.

The SMS system was developed by an Ethiopian based software development company in partnership with BlueTree Group. The SMS platform only required users to have a simple feature phone that can send a text message. The SMS system used a “short code” Toll-Free number (four numerical digits). The SMS system meant that last-mile community members and school personnel could subscribe to updates on when books would arrive and to confirm the TLMs deliveries. (*BlueTree Group, 2021, pp. 1-5; S. Lacey and M. Ochako, personal communication, November 11, 2021*)

The advantage of an online form over a dedicated application is that an online form does not require the user to download a particular application ahead of time. Because of this, online forms can be more dynamic, as the same URL can be kept while changing the form itself to suit the current need. For example, if users are having trouble understanding data they are supposed to enter in a particular field, the form owner can change the form to add instructions or otherwise solve the confusion, and any user that accesses the URL will then see the updated version of the form.

The disadvantage of an online form over a dedicated application is that it is more ephemeral. If a user opens an online form in a browser, but accidentally closes the browser window before they have finished, the data might be lost. Because of this, online forms can be harder to use where internet access is unavailable, as it is easier to accidentally lose the data than it generally is on a dedicated application.

### **Smartphone App**

Smartphone applications cover a wide range of possibilities, from a dedicated Track and Trace application developed just for a particular implementation, to a commonly used data collection platform such as JotForm, KoboToolbox, or Magpi. Like online forms, they can collect a wide range of complicated data, and can be configured to provide guidance to users on how to enter data, and can include validation checks to ensure that users are entering data correctly. Users can also attach photos such as of damaged cartons, and can record a signature by drawing with their finger.

The big difference between an online form and a dedicated smartphone application is in how the users access it. A dedicated application will require that the user has downloaded the application before they need to use it, which generally requires much more data than simply accessing an online form. After downloading the application, the user will generally also need to register an account and sign into the application, which can create an additional stumbling block for the user. In the case of commonly used data collection platforms, the user will also need to have downloaded the relevant form that they will need to fill out. However once the user has downloaded the application and any needed form, they will generally be able to use the application and fill out the forms while offline, with the application saving their progress, or even saving multiple completed forms, as they go along, for later upload when the user has internet access again.

## E-mail

The humble email can also be a great tool for communication in a track and trace system where users have access to smartphones or computers and internet access. Email is great for sharing longer messages, and can be used to send electronic training materials or links to online forms, and automated processes can make email simple to use to send messages to a large group of recipients.

The drawback of email is that the visibility of messages can vary depending on the subscribers inbox or spam filter settings. Also, although it is great for sending out messages, it can require an additional system or a large amount of human resource capacity to manage receiving response messages from a large pool of recipients. For these reasons, in some places email is increasingly being replaced as a means of communication between Ministry of Education staff by messaging platforms such as WhatsApp or Telegram, including for sharing documents, issuing directives, etc., as these apps are generally easier to use from a mobile device, while email is often seen as too cumbersome.

## REAL EXAMPLES

### Combined paper-based and digital data collection

To counter challenges related to digital access/capabilities, a number of countries take a 'hybrid approach'. In Rwanda, for example, hybrid approaches were taken at both the requesting and delivery stages for their LTM MIS. School directors complete TLM orders in hard copy and then take them to the district office where they are entered into the system. During TLM distribution, paper versions of Confirmed Delivery Certificates are still used at school level. Publishers print out their certificates in triplicate and these are signed by school directors with information recorded about how many TLMs were actually received. Copies are given to the school, publisher, and district office. For each district, publishers would take the signed Certificates to the MoE for entry into the LTM MIS at central level. The implications of such an approach are that there is no real-time visibility into delivery until the hard copy delivery slips are submitted at central level. However, submission on a district by district basis at least means that the MoE and other stakeholders do not need to wait until full distribution completion nationwide before any data is available (N. Read, personal communication, April 19, 2021).

## REAL EXAMPLES

### Connectivity issues at school level

In Afghanistan persistent challenges at school level of internet access, phone service coverage and digital skills meant it was very difficult to collect information at school level. As a result, the project eventually moved away from TLM confirmation at school level. At present, confirmation just occurs at district level, which is where school directors collect the books. As a result, only the handover of books from district to school at the district level is tracked; not what happens at school level. (A. Kishore, personal communication, April 13, 2021.)

## Hybrid

A hybrid system uses some combination of the above technologies alongside paper forms. There are many ways to split such a system. For example, a system might be split geographically such that some regions that have better access to technology use a technology-based system, while others use paper forms that then get entered into the technology system at a higher level; this can allow progressive rollout of a technology system that is feasible in some areas now, and may become feasible in additional areas over time. Another example is a system where all users at the last mile enter data on paper forms, and these data are then entered into the technology-based system at the next higher level, such as at a district supervisory level; this can be useful in moving a fully paper-based system toward full digitization where technology availability is not yet widely available enough at the last-mile level. Yet another example is a system that maintains paper-based backups of all data alongside a technology-based system; this can be useful in proving the viability of the technology-based system in places where a key stakeholder is reluctant to trust a new system.

The advantage of hybrid systems is that they allow a country to realize some of the benefits of a fully technology-based system, while allowing room to accommodate places or levels of the system where technology is not yet feasible. However these systems will share some of the downsides of fully paper-based systems, as well as some specific to hybrid systems. As in any paper-based system, data entered on paper cannot be centrally visible in real time and relies on the speed of travel of physical pieces of paper, which can get lost before they are entered into the technology system. Adding an additional data entry step of entering the paper-based data into the technology-based system also creates additional work and introduces another point for data quality problems to enter the system. Where there are parallel technology-based and paper-based systems, users may be slow to adopt the technology-based system when they are used to using the paper-based system; and there will inevitably be the question of how to reconcile when the data in the two systems disagree.

Pros:	Cons:
<ul style="list-style-type: none"><li>● Can accommodate for both programs that have Smartphones/ Internet/ Electricity and those that have less accessibility</li><li>● Provides choice to programs</li></ul>	<ul style="list-style-type: none"><li>● Time/labor intensive (data entry)</li><li>● Paper data will not be real-time data</li><li>● When using parallel systems, users may be slow to adopt the technology-based system when they're used to using the paper-based one</li><li>● Less standardized</li></ul>

## HOW WILL THE SYSTEM SOFTWARE BE DEVELOPED?

Some countries will already have an existing Education Management Information System (EMIS) that captures information such as school-level data on enrollments, teachers, facilities, drop-out and repeat students, etc. Some countries may have some other data collection system, while others may be just starting on the road to digitization. An important consideration will therefore be what systems already exist, and whether TnT needs to either be integrated into those systems or at least be able to communicate with those systems. Countries that already have an existing EMIS that they wish to add Track and Trace functionality to will

already be familiar with developing, updating, and maintaining their EMIS. For those countries that wish to develop a standalone TnT system, the next decision to make is whether to:

- A. Develop the software in-house
- B. Purchase an off-the-shelf software package
- C. Engage the services of an IT consultant or organization to develop custom software

These decisions are well laid-out in the USAID DELIVER's 2006 Guidelines for Implementing Computerized Logistics Management Information Systems (LMIS) (DELIVER, 2006) so we will quote extensively from this document below. Although the DELIVER document's focus is on LMIS, the concepts and considerations are just as relevant for developing a TnT system.

### **Developing the software in-house**

This can be an a great option if the required expertise is available within the Ministry of Education or other associated organization that will be implementing the system, as the people developing the software will be more familiar with the context in which it will be implemented, and as long as local experts remain available, then any required updates or maintenance to the system can be performed by the Ministry's own staff. However the drawback to developing the software in-house is that it can be very time and labor intensive for the development team with very specialized skills, and will require continual maintenance by dedicated staff.

### **Purchasing off-the-shelf software**

In general, it is better to buy packaged software than to develop software, for these reasons:

- Lower maintenance costs over the long term. While the initial cost for licensing and technical support may appear daunting, the long-term costs for maintaining packaged software are lower than the costs for custom-developed software. The cost for maintaining packaged software is spread across a large number

## **REAL EXAMPLES**

**Afghanistan OTIMS: from proprietary to open-source software** In the five years since Creative Associates International first started working with the government in Afghanistan to develop an Online Textbook Inventory Management System (OTIMS), the functionality and technology choices have gone through different stages. The pilot involved a vendor-provided commercial platform - Geospago (renamed to GraphLI). For scale up, Creative built a platform with the government that is open source and now being managed by the ministry themselves.

The Geospago platform is 'feature-rich' and was used to collect a multitude of information, scan boxes, and track books at box level throughout the nodes of the supply chain. The second iteration of the platform, the open-source OTIMS is described as 'feature-sufficient'. The implications are that the ministry can no longer precisely track each package, but the open-source OTIMS provides a low cost solution that enables efficient forecasting, logging data on book dispatch and receipt, and general inventory and stock management (A. Kishore, personal communication, March 24, 2021).

OTIMS is available to other developers on GitHub - <https://github.com/CreativeDC/otims>

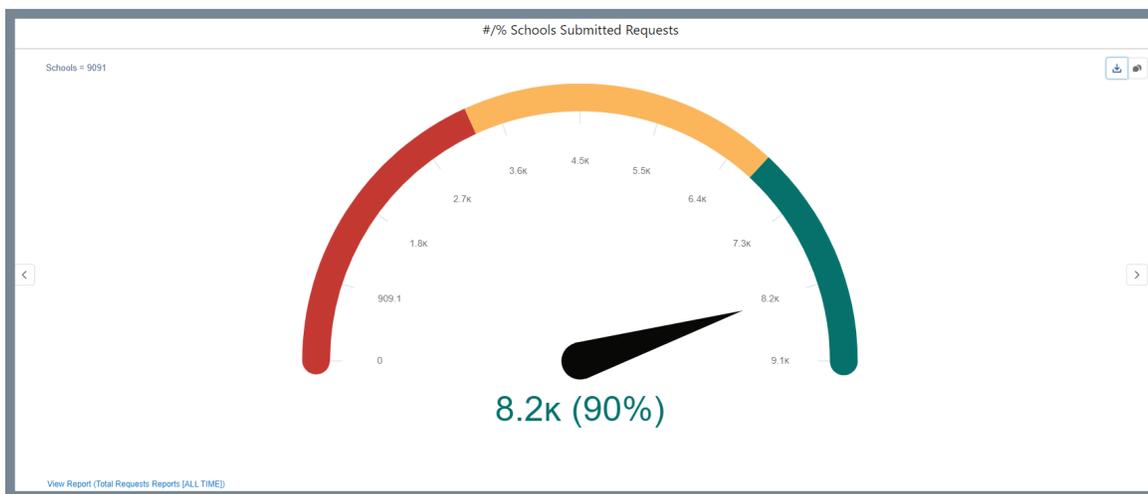
of clients, so each client's share of that cost is small compared to the cost for maintaining software developed specifically for one client.

- **Faster implementations.** Packaged software has already been tested by the vendor as well as by numerous clients, so unlike custom-developed software, it does not need to be tested thoroughly before implementation. It was also designed to be installed in a wide variety of client environments and includes utilities to facilitate installation.
- **Access to upgraded versions of the software.** Vendors continuously develop new versions of packaged software to fix identified defects and to include suggested enhancements from clients. Clients can then choose to upgrade to the latest version of the packaged software rather than spend time and resources developing custom modifications.
- **Access to product and user support.** When clients buy a software package, they also have the option of purchasing support from the vendor for some period of time, usually one year. This support helps address any technical problems clients experience using the software. In addition to support agreements with the vendor, clients can find answers to their questions from other users of the software, often via Internet-based discussion forums set up for that purpose.

Although all of these are powerful incentives to buy rather than develop software, even when purchasing an off-the-shelf software package some amount of customization to fit the organization's functional needs is still required (DELIVER, 2006, p. 37).

### Engaging a professional developer for customized software

Another way to implement a computerized LMIS is to purchase the services of an outside consultant or company to custom-build a solution. [...] This can be an effective approach to [electronic system] implementation in public health organizations that have limited or no information technology skills. It also allows these organizations to benefit from the skills of outside consultants or companies who have experience implementing computerized systems for a number of clients in a variety of settings (DELIVER, 2006, pp. 37-38).



◀ *Dashboard chart showing the percent of schools that have submitted their request data, used by Cambodia's Ministry of Education, Youth, and Sport on their Requests Dashboard.*

## **Open source software**

There are many open-source software platforms that may be appropriate for a TnT system. The advantage of open source software platforms is that there are often local developers that have experience using them, which can be crucial after the initial rollout phase if system changes or bug fixes are needed later on.

Open source software can be subscription-based or free to use. However it is important to keep in mind that free-to-use software packages generally do not offer any development support, which either costs extra or must be done by the user themselves, meaning that the cost of local software developers must be taken into account.

## **DASHBOARDS, INDICATORS, AND REPORTS**

Up to now we have been talking about how your Track and Trace system will gather the data needed to monitor the performance of the TLM supply chain. But once all that data is in your system, who will need to use it, how will they need to use it, and how will they access it?

### **Who will have access - user types**

Users of the Track and Trace database will fall into two basic types: those who need to have root access to all the data to be able to make new reports and perhaps to change or transform the data, who we will call “administrators,” and those who simply need to be able to see premade reports and indicators, who we will call “users.”

### **Administrators**

There will typically be only a few administrators of a system, who will be the people that need to be able to go into the database and make changes to it. For example, an administrator may need to add a new school to the master list of schools in the system, or update the list of approved TLM titles that will be tracked by the system. Administrators will also have the ability to change the data that has been submitted to the system. For example, a user may accidentally report receiving the wrong package, and an administrator would need to change the status of the incorrectly reported package. Administrators will also have the ability to create or change any reports and dashboards that will be displayed by the system. In short, administrators are people who will be able to make changes to what everyone else sees when they access the system.

A key thing to keep in mind when deciding who will be an administrator of the system is that most software licenses that may be used as part of a TnT system will charge per administrator, while allowing any number of users to view the data.

### **Users**

Unlike administrators, users simply need access to be able to see the data in the system, usually through an online dashboard. Users will be able to view indicators, dashboards, and reports that are available in the system. Users can be anyone from a high-level Ministry of Education official that will use indicators tracked at the national level to assess the overall performance of the TLM distribution system, to sub-national level supervisors who wish to be able to track progress within their own administrative unit, to school directors or commu-

nity members that wish to compare the performance of their own location with that of their peers.

Users will usually be able to apply filters to reports and dashboards so that they only see the particular data that interest them, but these filters will only affect what the individual user sees, they will not affect what other users see.

## HOW WILL USERS ACCESS THE DATA

### Dashboards

An online dashboard, accessible by a web URL, is a natural choice for aggregating and viewing data, and is the centerpiece of most TnT systems. Containing easy-to-understand charts and graphics that enable users to understand at a glance what the overall state of performance of the distribution system currently is.

## REAL EXAMPLES

### Dashboards and Visualizations

Ideally, a TnT dashboard has the capability to show locations of orders - whether books or consignments of books, such as boxes, pallets, containers (ACR, 2015a; ACR, 2018). However, much depends on the complexity of the data that has been collected by the system.

The first iteration of the TnT developed by Creative Associates and the government in Afghanistan, when it used Geospago proprietary software and had users throughout the supply chain, was able to have 'high-end' dashboards with maps and the ability to visually map the location of specific boxes of books, in real time, at all stages of the supply chain. However, the scaled-up and streamlined version that was developed later on, using open-source software and with less functionality, did not have this capability (A. Kishore, personal communication, March 24, 2021).

In Rwanda, the system includes GPS coordinates for schools so that the ministry can easily map distribution nationally. The online dashboard and map provides administrators with a view of the status of any delivery, in near real time. (*Results for Development Institute (R4D) & International Education Partners (IEP), 2016; )*

### Reports

In addition to a dashboard displaying key information, most TnT systems also allow the users to view various reports that display the data in more detail, often with the option to filter by characteristics like administrative groupings or geographic locations.

### Dashboards and key performance indicators

Dashboards will generally show key performance indicators (KPIs), which are a key output of any Track and Trace system that enables managers to understand the performance of their TLM supply chain. KPIs define how supply chain managers will measure the success or failure of the distribution system, and should be among the first things that a user sees when they access a TnT dashboard. Good KPIs are easy to understand, while conveying rich information about how a system is performing.

## REAL EXAMPLE

### The Rwanda LTM MIS is accessed via a website URL.

Users are provided with a username and password so that, for example, every school can view its own inventory and place its own orders. Publishers and distributors can download consolidated national and regional orders, print completed delivery certificates for school signature and stamping as the basis for payment claims and view customised order, delivery and payment reports. (Read, N, 2017, p 530)

These indicators can be calculated in many different ways, depending on the granularity of data available. The indicators that you will be able to calculate will also depend on the decisions you have made up to this point in designing your system, such as whether you are pursuing a First and Last tracking model or a Full tracking model, and what technologies will be used to enter data at each level included.

### TLM delivery indicators

The most fundamental kind of indicator for a TnT system will track whether or not TLMs are reaching their intended beneficiaries. However, this can be calculated many different ways, at many different levels.

#### Delivery batch level

##### Example Indicators:

- Percentage of deliveries/packages that have been received (total number of deliveries confirmed received / total number of deliveries sent)

##### Requirements:

- Individually numbered/barcoded deliveries for each recipient, either as a bound package or box, or as a discrete delivery note
- Recipients must have SMS- or IVR-capable phones (at a minimum)

This indicator can be used in systems that track discrete batches of TLMs, such as an individual delivery of TLMs for a particular school, containing many titles but delivered together in one box or on one truck all at once. This generally requires that the delivery batch was packed all together as it entered the system, such as in one box or wrapped in plastic together, and labeled for its end destination/recipient, often with a barcode or delivery number. In this case, the recipient would collect the box or package and would report having received it, using its barcode or delivery number. This can also be accomplished where books have not been individually packaged by recipient if there are delivery notes accompanying the TLMs that indicate which titles and quantities each recipient should be receiving. In this case the receiver would report that they had received the TLMs titles and quantities according to the list indicated in their delivery note whose number they are reporting as delivered.

This is simplest for the receiving party, as they do not need to enter any information about precisely which titles they received and in what quantities, or even where they are receiving the delivery or on whose behalf they are receiving it, because the TnT system already “knows” what was in that particular delivery batch, and where it was supposed to go. Be-

cause the user only has to indicate what the batch's identifying number is and that it has been received, the data for this indicator is easily collected by simple phones through SMS messages or IVR. The TnT system may also include an option for the user to indicate that there is some problem with the delivery batch, such as that it arrived damaged or did not contain what it was expected to contain, which can then be investigated by higher-ups.

Although relatively simple, this is a very powerful KPI to use to assess TLM deliveries in real time, as it enables all stakeholders to see the overall state of deliveries down to the school level. It also enables stakeholders to identify when the deliveries in a particular region or district are lagging behind its peers, which can trigger higher level supervisors to investigate the situation to find a resolution.

The first main drawback to using a KPI for deliveries by delivery batch is that the quantities of books that should be delivered to each final location must be known at the outset when the books enter the supply chain, and this is not always the case. More decentralized systems, in which the central level does not receive orders for or allocate books to individual schools, are not compatible with this kind of indicator. This includes systems where the central level receives bulk orders from the lower levels that have done their own aggregation, as well as systems that allocate books without using school-level data.

The second main drawback is the flip side of its simplicity for the receiver: the information the receiver provides is minimal. In a system where the receiver simply indicates reception of a particular package, that package will be marked as received in the system, without any independent verification that it was received by the correct recipient. Even where the recipient is allowed to indicate a problem with the delivery, because the information they provide is only basic, it can be time-intensive for higher level supervisors to follow up with the recipient to determine the exact nature of the problem and whether or not it can be resolved.

Put more simply, this kind of indicator does a good job of conveying whether the TLMs were delivered, but it has a harder time conveying whether they were delivered correctly.

### **School or recipient level**

#### **Example indicators:**

- Percentage of deliveries/packages that have been confirmed as received correctly (total deliveries reported received by the correct recipient / total number of deliveries sent)
- Percentage of schools that have received their deliveries (total number of schools that have confirmed having received the correct delivery / total number of schools)

#### **Requirements:**

- Individually labeled deliveries for each recipient, either as a bound package or box, or as a discrete delivery note
- Recipients must have SMS- or IVR-capable phones (at a minimum)
- Recipient must have individual identification code to be able to compare intended recipient against actual recipient

A slightly more complex method of assessing TLM deliveries adds school information to the individual batch tracking outlined above. The simplest way to accomplish this is for each school to have a unique identifier code that is known to the person receiving the delivery. They could then use both the delivery number or barcode as well as their unique school identifier to indicate that the particular delivery batch was delivered to a particular location. Like using delivery batch only, this is also relatively simple to collect by SMS or IVR on a simple phone.

The main drawback to this indicator compared to the batch-only indicator above is that each school, and whoever receives the delivery, must know the unique identifier for that school. This may be simple in education systems where each school already has a unique code they use for reporting purposes. Absent that, each school will need to be provided with such a number in a way that ensures the number will be available for use when the delivery arrives, such as on a printed poster that is hung in the school office.

### **TLM title level**

#### **Example indicator:**

- Percentage of schools/recipients that have received all the TLMs that were allocated to them (total number of recipients that have received at least the quantity of each TLM title allocated to them / total number of recipients)

#### **Requirements:**

- Recipient must have smartphone and enough internet access to either access an online form or submit data through an application that they have already downloaded
- Allocations per recipient must be input into the system at the central level

The most complex way to assess TLM deliveries is by individual TLM title and the school to which it was delivered. Unlike the systems described above, this does not require that the destination of each individual TLM be known when it enters the supply chain. Instead, each recipient will need to record the quantities of each individual TLM title they receive, greatly increasing the data entry burden on the recipient. This is generally not suitable for entry on a simple phone, either by SMS or IVR, and instead will require that the data be entered on a smartphone or tablet, using either an online form or a dedicated application.

The main advantage of this kind of indicator is that because the user is entering rich data about exactly what they receive, the system can also track detailed data about any problems that arise, and more easily enable supervisors to understand the nature and scope of the problem without needing to perform an investigation.

The main disadvantage of this kind of indicator is that it places a larger burden on the recipient, both in terms of the technology that they must have available and in terms of the time it will require from them to enter data.

### **Delivery quality indicators**

#### **Example indicators:**

- Percent of shipments that arrive with damaged product (total number of shipments confirmed as arrived where damage was noted / total number of shipments confirmed as arrived)

- Percent of materials that arrived damaged (total quantity of TLMs confirmed delivered that were reported as damaged / total quantity of TLMs confirmed delivered)

**Requirements:**

- System is able to report when any part of a shipment has been received damaged (for percent of shipments); or
- System is able to report total quantity of TLMs that have been received damaged (for percent of materials)

This indicator measures the quality of transportation and storage within the supply chain and whether TLMs are being damaged before they arrive at their final destination. For SMS- or IVR-based systems that are able to capture a response from the receiver that some part of their delivery was damaged but that cannot directly capture detailed information about quantities, the first example indicator (percent of shipments) would be easy to calculate. For smartphone-based systems that can capture more detailed information about quantities, the second example indicator (percent of materials) provides a more detailed understanding of the scope of delivery quality problems.

**Additional delivery indicators for Full Tracking systems**

All of the above indicators can be calculated in a First-Last Mile tracking system. For countries that have chosen a Full Tracking system model, there are several additional delivery indicators possible for measuring what happens between levels of the system.

**On-time arrivals**

**Example indicator:**

- Number of shipments arriving on time, by level (number of shipments received within agreed delivery window / total number of shipments, disaggregated by level of the supply chain)

**Requirements:**

- Shipments must be able to be tracked as they progress from level to level through the supply chain
- Supply chain that has defined delivery windows between levels

Systems that include the ability to track shipments as they progress from level to level through the supply chain can include this indicator, which measures delays between each level of the supply chain. A dashboard could show the level of on-time arrivals for each level of the supply chain, which would give users an important understanding of the degree to which TLM deliveries are traveling through the supply chain as expected or are getting “stuck” at a particular level. It can be further disaggregated in a detailed report by administrative or geographic region, which would let users see whether any particular area is having more or less difficulty with ensuring on-time delivery than others. In the immediate term, this provides the opportunity for program managers to take action to get TLM deliveries moving when there are problems. Where performance within a level differs across administrative or geographic areas, it also provides an opportunity over the longer term to identify high-performing areas for study so that program managers can better understand what factors lead to higher performance and whether these factors can be replicated in lower-performing areas.

Shortcomings of this indicator are that it does not change as problems are resolved, and does not reveal the degree of the problem. That is, at any given time, a delivery has either arrived on time, has not arrived but is not yet over time, has arrived but was over time, or still has not arrived and is over time. This indicator does not distinguish between the last two, and does not distinguish between a delivery that arrived one day late and a delivery that arrived 100 days late. Put simply, this indicator signals that there is a problem with deliveries that merits attention, but does not allow program managers to see at a glance how big the problem is or when it has been resolved.

### **Delivery completeness**

#### **Example indicator:**

- Percentage of TLM materials that reached a pass-through level that were received by the next level (total quantity of TLMs that were confirmed delivered at the next level / total quantity of TLMs that were confirmed received at each level, calculated for each pass-through level)

#### **Requirements:**

- Shipments must be able to be tracked as they progress from level to level through the supply chain. Supply chain must be well mapped, with each pass-through entity (warehouse, subnational office) mapped to each destination that receives TLM deliveries from it

This indicator can be thought of as the progress of deliveries for each level of the system that acts as a pass-through for TLM deliveries on their way to their final destination. Calculated for each distinct pass-through level of the supply chain (for example national, then provincial, then district level warehouses), it allows program managers to see where the TLM materials currently are in their supply chain. It can be further disaggregated in a detailed report into administrative and geographic areas, and even to individual warehouses, to allow a more fine-grained understanding of where problems are.

Like on-time arrivals, this indicator allows program managers to identify when materials are getting “stuck” at a particular level, giving them an opportunity to take action to resolve the situation. However this indicator addresses the shortcomings of the on-time arrivals indicator, because it will continue to change as materials move through the system. That is, a program manager can see when deliveries are getting stuck, can take action to resolve the situation, and then can see the indicator change as materials get moving through the supply chain again.

### **Requesting/needs indicators**

It is worth noting that in systems that include a requesting component, in which the school must either submit requests or must submit other data that will be used to calculate its needs, there is a very strong incentive for the users to use the system to submit this data. That is, if a school does not submit its request/needs data, it may very well not receive books, and so we expect that the vast majority of schools that are able to submit this data will do so.

This is in contrast to delivery indicators, where the recipient has by definition already received their books, and the incentive to complete the required data to confirm the delivery

is weaker and may be seen as a mostly administrative requirement. Because of this, in all delivery indicators, where there is a difference between the total deliveries expected and the total deliveries confirmed, there must be some uncertainty about the degree to which the deliveries that were not confirmed were actually not received, or whether the recipient simply did not, or could not, use the system to confirm the delivery. To use an example, if a country completes a delivery cycle and finds that 92% of schools confirmed having received their deliveries, then there is some uncertainty about how many of the remaining 8% of schools in fact did not receive books, how many chose not to confirm the deliveries that they did receive, and how many were simply unable to use the system for some reason or other.

Requesting indicators therefore serve as a good gauge to assess not only how many schools have submitted requests, but also in a general sense how many schools are able to use the TnT system to submit data. This can add a layer of understanding to your other indicators.

### **School or recipient level**

#### **Example indicators:**

- Percentage of schools/recipients that have successfully submitted a book request or other needs data (number of schools that have submitted request or needs data / total number of schools)

#### **Requirements:**

- Recipients must have SMS- or IVR-capable phones (at a minimum)
- Recipient must have individual identification code to be able to link their request to their school

This indicator can be used in systems that include a method to collect data to establish needs, either at the individual TLM title level or at the school level (enrollment data), to assess how many schools have been able to successfully submit their request/need data. Because the indicator is calculated at the school level, it easily disaggregates into a report by administrative or geographic region. This report can then be used to identify which schools require follow-up to either assist them in using the system to submit their request data or else to collect the request data manually from them if they are unable to use the system.

### **Allocation indicators**

#### **Example indicators:**

- Percentage of requested books that were allocated (total number of books allocated / total number of books requested)

#### **Requirements:**

- TnT system that includes a system for collecting request data

In systems that collect request data from schools, an allocation indicator can help the central level assess how well they were able to meet the expressed needs in TLMs. Unlike the previous indicators, this indicator does not measure the performance of the TnT system or the TLM distribution system itself. Where TLM procurement is done centrally, this simply helps central planners understand the gap between what their budget was able to provide for the current year and what the expressed need for textbooks was. Where TLM procurement is done at a decentralized level, such as by province-level education offices, then this indicator can help everyone understand the degree to which different administrative sections of their

education system are able to meet the needs of their students, where additional budgetary support may be needed, and whether there are any imbalances that can be addressed.

## Reports

While dashboards showing KPIs do a good job of showing aggregate indicators that let users know how the distribution system is performing and signal when there might be a problem, for more detailed analysis it is often useful to be able to work with a more detailed report. That is, once a program manager has identified through a KPI that a problem exists that merits attention, a detailed report can help pinpoint exactly where the problem lies.

Different types of users may need different types of reports, and indeed some users may not need reports at all - they simply want to use the dashboard. For example, high-level program managers may simply want to be able to view KPIs, and can delegate further analysis when problems arise. At the other end of the spectrum, a school director might have no interest in the overall state of an indicator at national scale, instead simply wanting to see what is going on in their specific area.

Apart from being more detailed than KPIs that might be shown on a dashboard, reports will generally also allow users to choose different levels at which they want to see the data aggregated, and will allow users to use filters to narrow down the results displayed in the report to just what the individual user is interested in. For example, a program manager at the province level might wish to see data aggregated to the level of the districts that they serve, while filtering to only show the districts within their province. A district level manager might wish to see the same report, but with data aggregated to the level of the schools they serve, and only within their district. This ability to slice and dice the data in many different ways for different audiences makes reports powerful tools for doing deeper analysis to understand what is happening in a supply chain.

The report examples discussed below present a few possible reports that system designers may want to make available to all users, including possible use-cases. This list is far from exhaustive, but will give system designers some ideas and insight into how to think about what reports they might want, who would use those reports, and how they would use them.

## REPORT EXAMPLES

### Quantity requested, by TLM title and by school

This report would display request data at a very fine-grained level, down to the quantities of individual titles requested by individual schools. A school director might wish to consult this report, filtered for only their school, to ensure that the request data they intended to submit is correctly captured in the system. A district level manager might wish to view this report, filtered for only the schools within their district, to review the requests submitted by the different schools they oversee. Users at higher levels of the system would generally not need to see the data at this level of detail, as it is simply too much data to understand for a large group, but may instead wish to see the request data aggregated not by school but by administrative or geographical region, or for the whole country, in order to understand the overall quantities of each TLM titles that will be needed.

### **Quantity allocated, by TLM title and by school**

Similar to the previous report, this report would display the individual quantities of TLM titles allocated to each school (that is, the quantity that the procuring entity has committed to deliver to each school, after taking into account request data and available budgets). Here again, subnational managers may wish to view this report filtered for their administrative area to see the overall number of TLMs that they should expect to receive, or to compare a received delivery against what was expected to be delivered. School directors might wish to view this report, filtered for only their school, to see what has been allocated to them without having to wait until the delivery shows up. Higher-level users might want to aggregate this information at different levels to see the TLM materials that are expected at each level, but are unlikely to wish to use the report in its fully disaggregated form.

### **Delivery status, by school**

This report would show the delivery status for each school. Possible delivery statuses will differ depending on the design of the system. They might simply include delivered/not yet delivered, or they might include delivered/delivered (unconfirmed)/delivered (confirmed), or they might contain additional information such as not yet delivered/delivered (complete)/delivered (incomplete)/delivered (damaged).

This report is most useful for managers at the subnational levels. Managers at the level right above schools, such as districts, could use this report to keep track of which of the schools they oversee have not received books (or come to collect them in systems that rely on schools to collect). This could give them an opportunity to take a number of actions for schools that have not received their delivery yet: they might encourage that school to come collect their delivery; they might try alternate means to get the delivery to the schools; or they might follow-up with the school to ensure that a successful delivery that was not confirmed can be confirmed in the system.

Higher up subnational levels might use this report, filtered for their own area such as a province, to check on the performance of the next level that they supervise. For example, a provincial manager might check on the status of the deliveries in all the districts they oversee, and if they notice that a particular district is lagging behind they would have the opportunity to follow-up with that district manager to see if performance can be improved.

### **Delivery discrepancies and problems, by school**

This report would show all the schools that have reported a problem with their delivery. Depending on how the system is configured, it might also show additional information such as the nature of the problem reported, such as a delivery marked received damaged or incomplete.

This report can act as a checklist for program managers, who can look up all the schools within their area of responsibility that have reported a problem, and begin investigating those problems for possible resolution.

### **Non-reporting schools; non-requesting schools**

These two reports, which are distinct but serve a very similar function, allow program managers to identify schools (or other recipients) that either have not reported their delivery as received, or have not submitted their book request data. Much like the delivery discrepancies report, these reports can act as a checklist for program managers, allowing them to identify which schools need follow-up, either because they have not confirmed a delivery or because they have not submitted their requesting data.

One notable thing about these reports is that unlike the reports mentioned above that include data submitted by schools and warehouses, these reports include schools that have not reported something. This requires that the master list of schools in the system is kept as up to date as possible, as otherwise these reports will contain errors. For example, these reports would include a school that has *not* reported even if that school was not expected to report, for example because it has closed. On the other hand these reports would not contain a new school that is expected to report, if that school has not been added to the master list of schools.

## **REAL EXAMPLE**

### **Afghanistan OTIMS reports**

The OTIMS manual describes the reporting functionality in this way:

OTIMS provides a one-click report generation module for all the reporting and planning needs of the Ministry at all levels of textbooks distribution process. One of the many important reporting features is that of the lost or missing textbooks, which provides an accurate list of books that are missing at any level in the process. This, along with other features, helps assure transparency, accountability, and timely access to the books by the students.

OTIMS is currently hosted at and can be accessed at <http://74.208.121.179> (Afghan Children Read, n.d., p. 4).

## **HOW WILL USERS RECEIVE TRAINING?**

The costs and feasibility of training users at national scale are very important criteria to keep in mind when designing a TnT system. Very often, the simpler the system, the less complex are the training requirements.

## **REAL EXAMPLES**

### **TRAINING CONSIDERATIONS GLEANED FROM CAMBODIA**

Train on a just-in-time basis: In most TnTs, there are usually long gaps where users are not engaged with the system. For instance, school level book confirmations may occur 6 months after book requests are entered on the system. Training should be broken down into modules/chunks based on immediate tasks, and delivered either virtually or in-person as close as possible to the time of use. 30 second videos or 1 pagers with screenshots demonstrating one or two steps are ideal.

Developing digital training materials for nation-wide training reach: The TnT platform in Cambodia includes users at school and community level. To accomplish scale, trainings and support could only be provided virtually as face-to-face trainings nationwide were prohibitively expensive for the government. Short videos, short instant messages/emails with GIF graphics, digital one-page PDFs or JPGs, and an online noticeboard/repository of digital training tools all work well.

Dissemination of digital training assets: Using the ‘just-in-time’ approach, relevant actors within the MoE can schedule dissemination of the specific digital training tools through closed instant messaging groups (such as What’s App, Messenger etc), social media, email, SMS, or chatbot at the relevant stages within the supply chain timeline. Dissemination of training tools can even be integrated into the TnT system itself- sent out as a reminder or notification.

Accommodating annual training needs: If the system includes community level users, it will be important to remember that parents, PTA or SMC members change. Digital training tools will need to be distributed each year. For in-person training/support, there will need to be someone permanently at the school or local level who is responsible for training/passing on training tools to new community members. Also, if those involved with picking and packing books in warehouses are expected to use TnT, it is likely that these personnel will change annually or for each delivery, and would need training each time.

Create local resource persons for in-person training support: There will always be school/community level users for whom remote training through digital training tools is not a viable option, and in-person help is needed. Identifying local resource person is a low cost alternative to organising more formal face-to-face training workshops. District officers, for instance, can receive additional levels of training (virtually, if needed), that enables them to offer a strong network of support to school directors or community-level users. Alternatively, district officers can be asked to identify ‘early adopters’ or champions at school/community level who can provide peer support to others, and be recognised as ‘Track and Trace Experts’.

### **Full training vs. just-in-time training**

Experience has shown that a traditional full user training, where users are brought together and trained on an entire process from start to finish, is ill-suited for a TnT system for TLMs. Firstly because there are often so many actors involved that it can be prohibitively expensive and time consuming to try to gather everyone together for a central training. More importantly, because the distribution of TLMs often happens only once each year, and sometimes even less often, there is often a long time lag between such a centralized training and the time that the actors are actually asked to perform the tasks they have been trained on. This leads to problems with those actors being able to correctly recall what they have been trained on, often necessitating further on-the-job training and negating the benefits of the original training. For example, in many systems school directors may be asked to use TnT to request TLMs at the end of one school year and then again to confirm TLM deliveries as they are delivered months later. If they are trained in both of these tasks at once then it may be many months between the training and the time they are asked to confirm deliveries, and at that time they may only have used TnT once (to request books), and not for the task that they

## BEST PRACTICE

### PROMOTING LONG-TERM USE OF TNT AND ADOPTION OF NEW BEHAVIORS

While Ministries of Education are busy focusing on building the new TnT system, attention is needed at the same time on approaches for getting people to use the system over the long term. A number of countries have seen their new TnT platforms fall into disuse after a few years, or have struggled to get its widespread adoption at a national scale. There are some key approaches to consider to avoid this.

Ideally, the Track and Trace system would be designed so that it is fully integrated with existing supply chain practices, and is simply digitising the process that is already in place (All Children Reading, 2015a)

However, very often, the Track and Trace design is incorporating new elements or tasks into the supply chain process to improve its efficiency - such as doing classroom spotchecks, or bar-code scanning in provincial/regional depots or warehouses during re-packing, for instance. For such new tasks, attention must be paid to how to permanently change behaviors and adopt new practices. This is particularly crucial at the level of school directors or district officials where there may be many thousands of users of TnT. If decisions are made to keep the paper-based system at the same time as the new digital system during a trialling period, the MoE will need to take measures to encourage or formally mandate users to use both paper and digital methods during the trialling, and then to permanently shift to digital.

There must be strong support from leadership at all levels to get people to continue to use the new Tn after the initial excitement has worn off. At community or school level, people might be reluctant to use their own phone data/minutes. Incentives - including non-monetary ones - can play a role.

In Cambodia, for instance, research into the motivations and aspirations of School Support Committees (SSCs) suggested that simply giving the committees a concrete task and new role in textbook monitoring would be sufficient incentive for their use of the new TnT. Data from the pilot testing suggested this to be the case, with 70% using TnT for confirming the second round of book deliveries and 92% conducting spot checks. The MoE decided to award a certificate of recognition to committees who fulfilled all three of these criteria: i. registered on TnT, ii. used TnT

are then performing. Finally, by the time it becomes time to request books again it will have been a full year since they last performed this task, and they still will only have used TnT a handful of times over that year; experience shows they are not likely to remember how to use the system after such a gap.

By contrast, just-in-time training, in which actors are trained only on what they need to know to perform specific tasks and the training occurs shortly before they are asked to perform those tasks, is best practice among TLM supply chains. Since these trainings are small, they are also more easily adaptable to decentralized, local-level training, which greatly reduces the cost of training such a large number of people, and even allows repeated training each year. There are generally two ways to perform these small, decentralized trainings: in person by local master trainers, or remotely using electronically distributed training materials.

### **In-person training**

In-person training can be done through a cascading training model, in which a central master trainer holds a training-of-trainers for a limited number of actors that will in-turn themselves become master trainers for those below them. For example, a central master trainer may hold a training-of-trainers for administrators at the regional or provincial level, who will themselves then hold training-of-trainers for district administrators, who will finally provide training to school directors within their districts. These final school level trainings might be held at the district level, bringing together school directors in one district for a short training; or they might be held during normally scheduled supervision activities at the schools themselves. The key is that master trainers should become experts in the processes for which they will train others below them, and each level of master trainers can turn to the level above them for refresher training as needed.

### **Remote training**

Remote training is becoming feasible in ever more countries, as internet and cellular data access improves and the use of smartphones continues to spread. Remote training allows truly just-in-time training, as actors can be provided with the relevant training materials for discrete tasks at the same time that they are asked to perform those tasks.

Remote training materials can take many forms, such as a one-page document in PDF format or as an image such as a JPEG; or a moving GIF file or series of files; or a video that is either

## REAL EXAMPLES

### Use of TnT for Performance Based Payment

With a TnT system, commercial distribution firms can be paid for delivery based on data generated and displayed on dashboards and reports. This has been a game changer for places such as **Rwanda**. Under the Learning and Teaching Material (LTM) Management Information System (MIS) in the late 2000's, publishers/distributors could not be paid until they had demonstrated successful delivery. Distributors were required to deliver to schools and upon delivery, paper-based Confirmed Delivery Certificates were sent to the central level where the data was entered into the MIS and compared with book order data to assess the completeness of delivery. Distributors were paid on a whole district basis whereby they were paid upon successful delivery to all schools in a district (as opposed to nationally, which would have required a long wait time until all data was complete). Fines of 10% were also imposed for late delivery. At least three publishers/distributors were barred for five years as a result of poor performance and their books were removed from the government approved books list.

This system removed the issue of distributors neglecting the harder to reach schools, and proved most successful. Distributors accepted the system and agreed to deliver to schools as they were given a guarantee income of 5 years' delivery, had bulk orders and a guaranteed timeline of both book ordering and delivery (N. Read, personal communication, April 19, 2021; Read, 2016, 2017).

## BEST PRACTICE

### Performance-based financing: Cross-departmental engagement in design and decision making

Having the full engagement of the officials responsible for procurement and contracting in the design and initial testing of your TnT could be important to ensure that the use of TnT is included in the distributors' contracts, and that TnT is generating the data they need to determine payment. To accomplish this, the relevant procurement officials should be involved in all major discussions and decision making in the early stages of the TnT design and development. They should also be invited to observe its initial use during testing and piloting at school level to build their confidence in the reliability of the data generated by the system.

Further, if it is expected that the digital receipts/delivery confirmation slips generated through the TnT platform (on which digital signatures, geo-location and time stamps are all enabled) will replace the existing paper-based receipts/delivery confirmation slips, thorough engagement with the related ministry/department is crucial from the outset. This is often a government ministry entirely separate from the Ministry of Education, such as the Ministry of Economy or Finance.

Their involvement in the design of the digital receipts and their field testing will be essential for garnering their full trust in the new system if the digital versions are to ultimately be recognized by all relevant authorities.

sent directly or linked to on a website or social media platform; or simply an email or series of SMS messages with instructions. These materials are relatively easy to create, and once they have been created they can be disseminated and reused each cycle at minimal cost. The Cambodian Ministry of Education, for instance, achieved full nation-wide adoption of their TnT by school directors (100% of schools nationally) simply through disseminating short videos and one pager for various TnT functions in closed Telegram messaging groups, on a dedicated Telegram Channel, YouTube and Facebook.

## PERFORMANCE-BASED FINANCING

Track and Trace systems can enable or enhance performance-based financing systems wherever private parties have been contracted to provide a service. For example, where a country contracts with third-party logistics providers to deliver school books, data from a TnT system can be used to assess the performance of the contractor in real or near-real time, and the contractor's payments tied to this performance. Similarly, where book publishers are contracted to deliver books to a particular warehouse, those publishers' contracts can be tied to the data from a TnT system.

When implemented thoughtfully, performance-based financing contracts can bolster the performance of a TnT system. For example, when it is in the contractor's interest that data be recorded confirming deliveries, the contractor is incentivized to become a steward of that data, and can assist in ensuring that the appropriate data is entered into the system, in effect turning the contractor into an agent of the TnT system that ensures that all data is entered as expected.

However, careful consideration must be given to what data your TnT system is collecting, what that data actually tells you, and who enters it. For example, in a TnT system that relies on SMS for school directors to confirm that a particular shipment has arrived, with a recipient at the last mile simply entering the shipment code and confirming that it was received, there may not be any way to verify that the shipment was delivered specifically at the place it was intended to be delivered. Such a system could be exploited by the contractor to report a shipment correctly delivered when in fact it was not, unless there is some way to independently verify where exactly the shipment was delivered. Collecting GPS coordinates at the delivery location and comparing to a database of delivery sites could provide this verification, but requires a GPS-enabled device be used at the last mile, which is not possible in many places, requires that the GPS-enabled device be able to receive an accurate signal, which is not always possible, and requires an up-to-date database of all delivery locations with their GPS coordinates. Alternatively, including a location code in the delivery confirmation that is known only to the recipient could provide this verification, but this requires that each delivery location have a specific code, that those codes be communicated to key staff at those locations, and that key staff that know those codes be available when the delivery arrives. All this greatly complicates the system and requires more training and planning, which adds to the cost of the system overall.



# Appendices

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## APPENDIX I: MASTER DATASHEET EXAMPLES

The backbone of a system is its master datasheets. These keep track of all the different categories of things that a system must track, and how they relate to each other.

### Schools/locations Master Datasheet

This sheet should contain all the information that is needed to identify and define a school or recipient. Data fields could include the following:

- School name
- School ID
- School type (primary, secondary, university, etc.)
- School address
- Province
- District
- GPS coordinates
- Contact person name
- Phone number
- Email
- Supplying facility
- Grade levels
- Active/inactive

### Warehouses Master Datasheet

This sheet should contain all the information about the warehouses within the supply chain.

Data fields could include the following:

- Location name
- Location ID
- Address
- Province
- District
- GPS coordinates
- Contact person
- Phone number
- Email
- Supplying facility
- Distribution level
- Number of each product title and type in stock
- Active/inactive

### **National TLM List Master Datasheet**

This sheet should contain all the information about the individual TLM titles that are used within the education system. Data fields could include the following:

- Title
- Identification number
- Author
- Publisher
- Edition number
- Publication year
- Language
- Product year/grade
- Subject
- Category (student edition, teacher edition, etc.)
- Active/inactive

### **Requests and Allocations Master Datasheet**

This sheet should contain the information that will be used to define the expressed need of each school, whether that is requests submitted by the schools or other information that is used to calculate need. Data fields could include the following:

- School ID
- Number of students by grade level
- Number of teachers
- Number of students with special education needs, by type
- TLM identification number
  - Quantity in stock
  - Condition
  - Quantity requested
  - Quantity allocated

### **Distribution Master Datasheet**

This sheet should contain the information that is used to identify each individual shipment that will be tracked by the system. Data fields could include the following:

- Shipment ID
- Origin ID
- Destination ID
- TLM identification number
  - Quantity
- Shipment status
  - Date and time of last update



## APPENDIX II: EXAMPLE INDICATOR REFERENCE SHEETS

An Indicator Reference Sheet is a tool that assists all those who conduct or review monitoring and evaluation data in having a clear understanding of how an indicator is defined, how it is displayed, what it is used for, and exactly how it is calculated. It is useful to provide these to the developer of your TnT system to ensure that they understand the expectations you have for how the data in the system will be used. A generic indicator reference sheet is provided below.

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### METHOD OF CALCULATION:

**Numerator:** *describe what to include in the numerator*

**Denominator:** *describe what to include in the denominator*

**Disaggregated by:** *describe at what levels of disaggregation the indicator will be calculated*

### Justification:

*Describe why you are collecting this indicator, including what it tells you and what you can do with that information*

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## APPENDIX III: ADDITIONAL TECHNOLOGY CONSIDERATIONS

### BLOCKCHAIN

#### What you need to know about blockchain

In a few words, “blockchain” refers to a technology that essentially makes sure that all the people that have access to a dataset can trust that the data they are seeing has not been changed or tampered with. We will dive deeper into how a blockchain actually works below, though this is a very complex topic and we are only going to scratch the surface here. The thing to know is that the use case for Track and Trace applications is ensuring that everyone can trust the data where there might be worries about someone changing it. For example, a multilateral donor may fear that a country might change their data either to please the donor or to try to elicit more funding. Within a country, the central government may fear that province or district level staff are changing their data, either making things look better than they are to make their own performance look good, or making things look worse than they are to try to turn more resources and help their way. Staff at the lower levels of the TLM supply chain may fear that the central level staff are changing the data they report to make the situation look better than it is in order to hide poor governance. Blockchain ensures that all the data within the system remains as it was originally entered, and any changes to the data are recorded and visible by all users.

Blockchain does not itself enable any part of the data collection, communication, or analysis that a Track and Trace system may be built to do, but it does ensure that all users can trust that the data in the system is as it was originally entered and has not been tampered with. However, blockchain is a complicated technology, and using it adds complexity and expense to a Track and Trace system without adding additional functionality. Although some countries have tried it, notably with OTIMS in Afghanistan (described below), to date no country is using blockchain in a track and trace system for TLMs at scale.

### REAL EXAMPLE

#### BLOCKCHAIN IN TNT SYSTEMS

Creative Associates International have developed a proof of concept using blockchain in TLM supply chains. With an end goal of more rigorous performance-based payments of TLM distributors, Creative Associates want to investigate whether using the blockchain ledger would provide the confidence to be able to tie distributor payments, perhaps even automatic payments, to TLM distribution data. Creative have put the architecture in place, and are inviting global players in the TLM supply chain field to connect to the system. More information can be found at <https://vimeo.com/user18516416/review/298939561/d32f74b8fb> (Creative Associates International, n.d.).

#### More about blockchain

Blockchain works as a chain of blocks that contains information in self-contained blocks. This chain is distributed across the internet through peer to peer networking. When a new user joins a blockchain system, he/she gets their own copy of the blockchain.

Each block contains data about a unit of transaction, a unique hash created from this data, which acts as a fingerprint. Each block also stores the hash of the previous block. This uniquely chained block, linked through cryptographically generated hash, prevents



attempts to tamper with any block since any change will lead to subsequent change to auto generated hash, which will invalidate the whole chain. Since blockchain is distributed, others will also notice this tempering attempt. Blockchain uses a technologically enforced consensus system that validates the integrity of the blockchain distributed across the peer-to-peer network.

Bitcoin is one of the most popular blockchain. Each bitcoin block contains info – value received from user, value to user and the value amount. Bitcoins act as digital crypto-currency, eliminating the middle-man (e.g., banks) and its self-contained user-to-user transaction mechanism makes it difficult to regulate (e.g., by central bank and tax authorities).

The appeal of blockchain is that it is virtually unhackable, anonymous and trustworthy because of the elegance of its technical architecture. Typical use cases of blockchains are smart contract, distributed ledger of medical records, e-notary and many others. Ethereum is one of the biggest blockchain that supports smart contracts. It uses Solidity programming language to create the smart contracts.

Crowdfunding is another user case. If the target amount for fund raising is reached, the fund is made available to the product team that campaigned for crowdfunding. If the target is not reached, the individual contributor's funder gets back their money without any middleman in the system (e.g., escrow company). Also, if the product team failed to deliver on their "contracted goal", money automatically goes back to the original contributors.

Blockchain led to a technology-generated trust system between parties, that in many situations brings more efficiency through eliminating the need for middle men.

However blockchains generated a relatively new ecosystem. Many pioneers and early adopters are building new systems to take advantage of blockchain's unique properties – tamper proof, decentralized, encrypted, distributed ledgers, technology-enforced consensus-based decision making, and faster settlement for monetary transactions.

### **Server-based vs cloud-based system**

Traditionally web-based applications used to be on-prem (within one's own premises), meaning that an organization's own data centers or server rooms are used to host those applications. In most cases for backup/restore and power outage-related troubleshooting, physical access to servers was needed.

However, in recent days, with maturation of Amazon Web service (AWS), Microsoft Azure, Google Cloud platforms and many other low cost cloud providers, the cost benefit of on-prem vs. cloud hosting has tilted towards cloud hosting.

Amazon AWS cloud has the most market share with a complete set of development, deployment and management tools accessible through browser and remote access command line interface (CLI) tools.

Cloud interface also makes it easier to maintain separate development, testing, training and production instances. Continuous integration and continuous deployment (CI/CD) tool set allows best practices for agile development.

In many situations, host countries require the data within their own control. In such scenarios,

development, testing and training can be performed through cloud-based instances. For final production, a container image can be generated using the CI/CD pipeline for plug and play deployment of production instances at government-controlled on-prem data centers. Alternatively, to meet the ownership control requirements, the production instance can be deployed to a government-controlled cloud account, by simply sharing the container image link to that account.

### Recommended database functions

The table below lists key database functions that a Track and Trace database will need to be able to perform:

<b>FUNCTION</b>	<b>DESCRIPTION</b>
<b>Manage facilities/schools</b>	Enables users to add, edit, and inactivate facilities/schools in the logistics system
<b>Manage TLM titles</b>	Enables users to add, edit, and inactivate entries for TLM titles in the logistics system
<b>Manage other descriptive data</b>	Enables users to add, edit, and inactivate other descriptive data used by the TnT system
<b>Manage logistics data reported by each facility/school on a scheduled basis</b>	Enables users to add, edit and delete individual reports submitted by facilities/schools.
<b>Manage TLM allocation list</b>	Enables users to add, edit, and delete entries from a final allocation list
<b>Print reports and graphs</b>	Enables users to print reports and graphs both to the screen and a printer
<b>Export data</b>	Enables users to export data in at least some fixed formats for analysis outside of the computerized TnT.
<b>Backup and restore system data</b>	Enables users to back up and restore data from the computerized TnT.
<b>Archive system data</b>	Enables users to back up data for a period and then delete that data from the computerized TnT.
<b>Manage users permissions</b>	Enables an administrator to create, update, and inactivate users and assign permissions to and revoke permissions from those users.
<b>Interface with mobile component</b>	REST protocol based Application Programming Interface (API) for exchanging data securely with mobile component
<b>Potential interfaces with 3PL logistics service providers</b>	Potential API based interfaces so send data and to consume data from 3PL service providers (e.g., shipper, freight-forwarder, transport carrier)

### Platform Options

New software platforms are being developed and updated every day. The TnT system owner should work with their software development team, be they internal or external, to determine the most appropriate platform for their particular use case. However, this section will discuss some popular current options that you might consider.

### **JotForm**

Jotform is a data collection tool that can be used through browsers or mobile devices. Data collection forms can be designed through the Jotform website using pre-built templates.

Jotform has built-in offline mode which allows collection of data when the user does not have internet access. Jotform can automatically detect online connectivity and can transparently sync data with the Jotform website.

Jotform has a Kiosk mode which allows a mobile device, such as a tablet, to act as a service station. In the Kiosk mode multiple users can use the data collection/survey tool to submit their responses.

Jotform has strong encryption built-in so that privacy protected sensitive user data can be collected through Jotform. Jotform is [HIPAA](#) compliant.

Jotform can allow setting up an approval workflow through which supervisor and managers can review, approve and take actions for each data submission. Approval workflows can send email notifications.

To report on collected data, Jotform's report builder can be used. It can report on collected data using graphs, charts, tables and images. Reports can be embedded on other websites or shared on social media. Reports can be printed to PDF.

Jotform has capability to integrate with other platforms such as Google sheets, Mailchimp, Salesforce, online payment systems, and connector to popular database systems. SMS notifications for submitted forms can be added to Jotform through integration with Zapier.

Jotform is a commercial application with a free tier for limited usage. Integration tools are commercial add-on.

### **GraphLI (formerly Geospago, on which Afghanistan's OTIMS is built)**

GraphLI is a commercial business to business (B2B) delivery workflow automation platform. It has mobile and web-based interfaces, with real-time geo-location tracking capability.

GraphLI was called Geospago before and since its reorganization, it is mostly targeted for delivery fleet systems to provide real-time monitoring of delivery vehicles, estimated arrival time to destination and to send proof of delivery to online delivery tracking systems.

### **GEMS**

Geo-Enabling initiative for Monitoring and Supervision ([GEMS](#)) is a set of tools that enables remote supervision. GEMS is supported by the Korea Trust Fund for Economic and Peace-Building Transitions (KTF); it gathers digital data from the field using open-source tools, which then automatically feeds into a centralized MIS.

Data from the field is collected using KoboToolBox, which is an open source, freely available

set of tools that allows quick development of data collection forms through mobile devices such as smartphones or tablets and sends the data into a back-end system for aggregation, analysis and sharing with other systems. In addition to capturing user-submitted responses to the form data, KoboToolBox has the capability to upload pictures, scan barcodes, send SMS, and capture users' geo-location.

GEMS has a back-end central MIS system that leverages the data sent by the KoboToolBox and uses GEMS geo-tagging system to pinpoint the user on a map. The map can overlay other data such as an overview of the user's organization/involvement with the project, and display uploaded pictures.

GEMS can enable real-time monitoring, through its ability to process large volumes of data received from anywhere in the world over the internet through the KoBo mobile app and visualize the data on a map with geo-tags and allowing drill down to view the information sent by individual users.

### **Odoo**

Odoo is a popular enterprise resource planning (ERP) application with many suites of modules covering aspects of procurement, product catalog, order management, inventory and warehouse management, distribution and transportation.

Odoo is primarily a cloud-based commercial ERP system. However, Odoo also has a community edition, which is open source and free to use. Basic procurement, production catalog, and inventory modules are available within the community edition. Community edition also comes with a website to act as a landing page.

Odoo has a reseller network and many freelance programmers are available for customization.

Odoo marketplace also has many third-party relatively inexpensive apps which can be added to community editions. For example, a transportation and distribution module can be added to Odoo.

### **KoboToolbox**

KoboToolbox is a set of tools freely available as an open source application. Kobo website can be used to design data collection forms from a ready-to-use template of sample survey questions. Questions support most of the popular types of survey questions such as text box, drop downs, yes/no and multiple choice questions. Barcode scanning, picture taking, geo-location capturing and file uploads are also supported. Kobo forms also allow data validation and skip logic (jumping to different sections/questions based on user response).

At the back-end Kobo website aggregates the submitted data which can be viewed online. Basic reports such as number of submissions, reporting rate etc., indicators are available on the website. Data can be exported for use in other applications for further analysis. In fact, the GEMS tool listed above utilizes KoboToolBox to provide the geo-location tracking system, with an additional central level application system that leverages the data submitted through Kobo apps running on user mobile devices.

KoboToolBox was originally developed by the Harvard Humanitarian Initiative. It is open



source and free to use. It can be downloaded from [github](#)  
This article described how GEMS used the KoboToolBox based system in Bangladesh.

## ODK

Open Data Kit (ODK) is a commercial survey design and data collection tool. However it also has a free community edition that can be downloaded from [github](#).

In many aspects KoboToolBox has replaced the original version of ODK. The commercial version of ODK has added additional features.

## OpenEMIS Logistics

OpenEMIS Logistics, developed by Community Systems Foundation (CSF), is an open-source software that tracks the delivery of textbooks to schools, based on SMS and email communications. This tool is part of the open source OpenEMIS suite which is an initiative

led by UNESCO and backed by CSF to assist countries with implementation and support. While OpenEMIS software is made freely available by UNESCO to member states, the costs associated with the technical assistance provided by CSF to adapt the system to meet the specific needs of each country must be paid for.

The OpenEMIS platform contains a range of interoperable products which can work independently or as part of the entire OpenEMIS architecture. This allows ministries of education to choose whichever of the OpenEMIS products meet their needs. OpenEMIS Logistics is one of these products (All Children Reading, 2015b).

Key features of OpenEMIS Logistics include:

- Local system administrators manage users, subscriptions and system configurations
- Ministry of Education officials enter package and shipment details, including preferred routing
- OpenEMIS Logistics uses SMS and email alerts to send out and respond to queries from school personnel and parents
- Supply chain actors confirm deliveries via web, mobile or SMS interface
- It uses mapping technologies through geo-coordinates to track shipments
- It generates reports, dashboards, shipments labels, packing lists and maps
- OpenEMIS Logistics is fully customizable, has multiple language support and options to track any school supplies

## REAL EXAMPLE

### OPENEMIS LOGISTICS ALPHA TEST IN MALAWI

In 2016, one of the winning submissions for the All Children Reading: A Grand Challenge for Development Tracking and Tracing Books prize competition was OpenEMIS Logistics developed by Community Systems Foundation. The open source platform was trialed in four schools and tracked the delivery of books to schools using a web interface, a mobile app and SMS technologies. Packages of books were tracked from point-of-entry to each school using individualized codes. MoE users could receive delivery status reports and were able to pinpoint problems. Community level users were also able to submit queries and confirm deliveries through SMS on feature phones (All Children Reading, 2015b; Lacey, 2016).



## SalesForce

SalesForce is a commercial platform as a service offering. It has many ready-to-use built-in constructs such as – accounts, products, contacts, case, asset, users. Additional objects can be quickly created through online design tools. Objects can have relationships with each other such as parent/child as found in relational databases.

Salesforce can auto generate the CRUD (create, read, update and delete) forms for each of the objects. Basic data validations can also be applied. Salesforce can be configured with approval workflows and notifications through email and SMS.

Salesforce is a complete application development platform. It has its own AppsExchange marketplace where additional third party apps can be purchased as add-ons.

For complex programming, Salesforce’s own Apex programming language can be used. Salesforce has integration modules with many other platforms such as Tableau, Zapier, Google, Microsoft SharePoint, JIRA, and other commercial ERP and online payment systems.

Salesforce uses per user, per month pricing model. Salesforce has discounted pricing for non-profit organizations.

## REAL EXAMPLES

### TYPE OF TECHNOLOGIES USED BY VARIOUS TNTS

In Nigeria, the Book Track and Trace component of the Northern Education Initiative Plus, implemented by Creative Associates in collaboration with Education Development Center and partners, used the following combination of technologies:

- Microsoft Excel based data sources (easy offline access) at last mile Microsoft Excel Templates for Book Distribution Lists
- Microsoft Word Mail Merge for Printing Shipment Notes
- Offline Tablet data collection at delivery
- Database using Microsoft SQL Power BI for dashboards and reports (Global Reading Network, 2018).

In Afghanistan, Working with the Ministry of Education, Creative Associates International’s [Development Lab](#) custom developed the OTIMS application system based on a [MySQL](#) database and [Laravel](#) [Php programming language](#) for the back-end, and [JavaScript Vue.JS framework](#) for web-based front-end. For mobile components, OTIMS uses [Cordova framework](#). More details can be found at [github](#). The OTIMS application login screen and user guide is here ([Afghan Children Read, n.d.](#)).

## APPENDIX IV: CASE STUDIES: RWANDA

### RWANDA LEARNING AND TEACHING MATERIALS, MANAGEMENT INFORMATION SYSTEM

The following is an excerpt from Read N. (2017). Measures of learning and teaching material availability and use in sub-Saharan Africa and other low-income countries. *European Journal of Education*. 2017;52:523–532. Retrieved from <https://doi.org/10.1111/ejed.12242> page 529-531

In 2009, the Rwandan Education Board (REB), with assistance from DFID, BTC and UNICEF, developed a computerized Management Information System (MIS) to look after national LTM provision for all schools in Rwanda. Due to the success of the system after implementation in 2009/2010 three further versions of the MIS were developed. The Rwanda MIS manages national publisher orders, school deliveries, management of stock (lost and damaged, LTM life, student/teacher/subject ratios) as well as providing MoE and donors with financial and other indicators for future budget allocations.

The Rwanda LTM MIS contains comprehensive data on every public, state aided and private school, including all pre-schools, primary, secondary, combined schools (primary and secondary), VTC (vocational technical schools) and TSS (technical secondary schools). The database also holds all GPS location data on almost every school entered and is provided to publishers on their school delivery forms to facilitate smooth delivery of materials. Individual school enrolment data (boys and girls) are collected and updated annually to the database which enables MoE budgets to be as accurate as possible. The LTM MIS also holds information on teacher employment data by subject; student enrolment data by subject for those grades where elective subjects were specified; procurement budgets; Special Educational Needs (SEN) enrolment data by grade and subject; the LTM Approved catalogue; approved publishers; annual school orders; annual deliveries to schools; LTM technical specification data; target supply assumptions; late deliveries and publisher payment schedules.

The LTM MIS can provide REB with information on individual school LTM stock levels; loss and damage rates per school, sector, cell, district and nationally; book Life projected vs book life achieved; LTM to Student ratios by subject per school, sector, cell, district and nationally; LTM to teacher ratios by subject per school, sector, cell, district and nationally; LTM to subject ratios by subject per school, sector, cell, district and nationally; financial projection system— forecasting future budgets based on projected ratios and successful/unsuccessful deliveries.

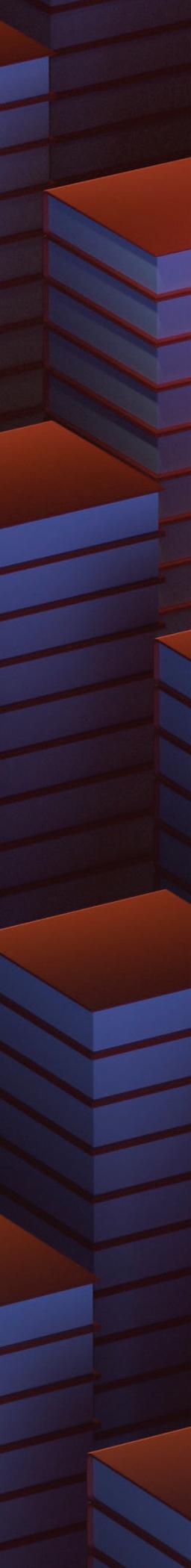
From 2009 to 2017, additional tools were developed on the MIS to provide the MoE with the ability to manage a school demand-based supply system and plan and manage the system cost effectively and efficiently. The tools also helped strengthen the links between schools, districts and the MoE and provided the inspectorate with reliable information to undertake school stock inspections. Feedback from these inspections provided the basis for assessing school levels of usage, stock management, loss and damage rates, management practices, levels of conservation which are a key factor in bringing the loss and damage rates in schools under control and thus reducing costs and improving supplies. The MoE is now able to generate reports to provide detailed and customized data split into national, regional, circuit and school's sections.

From 2016, REB has decided to change the model for a school demand- and order-based system to a government supply-based system, which will require enrolment data collection (independent of EMIS, which is not scheduled to provide the information required by the MoE at the time required for LTM allocations), a system to enable REB to allocate LTMs equitably direct to individual schools and monitoring of deliveries—Completed, Incomplete or incorrect deliveries.

The Rwanda LTM MIS is accessed via a website URL. Users are provided with a username and password so that, for example, every school can view its own inventory and place its own orders. Publishers and distributors can download consolidated national and regional orders, print completed delivery certificates for school signature and stamping as the basis for payment claims and view customised order, delivery and payment reports. The MOE can view and monitor the progress of every aspect of the supply cycle. Thus, the MOE is now able to monitor the process of LTM provision from collection of enrolment data, to school ordering/REB allocations, publisher deliveries to distributors and regional distributor deliveries direct to schools.

From 2010 to 2017, USD \$47,000,000 (18,000,000 units) have been allocated to schools via a capitation grant and central allocation by government for the procurement of textbooks and supplementary materials in Rwanda. The LTM MIS has firstly been able to track if the money allocated to classroom materials procurement has been spent by schools. In the 4-year period USD1,620,414 of this budget remained unused. Looking closely at the figures it can be noted that of this USD1.6 million underspend USD1,435,628 was not spent in the first year of operation of the LTM MIS. The subsequent 3 years' underspend amounts to only USD184,786. The reason for the large underspend in 2010 resulted from schools and REB not being familiar





with the ordering process. When schools received their 2010 order form they did not order up to the budget allocation provided by REB. In subsequent years, a threshold setting was applied within the LTM MIS during ordering that flagged any schools not ordering up to within 10% of their budget allocation. REB could see which schools were not ordering correctly, contacted the schools and provided additional support in operating the ordering process to the affected schools.

Not only was the LTM MIS able to guide and support REB in the allocation and ordering of classroom materials, but the MIS tracked deliveries of ordered books to the schools. Publishers were only paid on schools providing a 'Confirmed Delivery Certificate' (CDC) to REB which was signed and stamped by both publisher and school.

With the delivery data entered on the MIS, the calculation of the success of publisher deliveries to schools was made possible. In 2010, an excess of materials were delivered by publishers to schools and in each of the following 3 years the LTM MIS achieved delivery success rates exceeding 99% of materials ordered. Even more importantly, the REB knew every year the status of its own progress towards meeting its own learning and teaching materials supply targets.

The Rwandan Education Board (REB), having successfully used the LTM MIS since 2009, decided in 2017 to upgrade the LTM MIS for a fourth revision. It is currently being developed to include a 'Supply Based Distribution Model'. The MIS will be able to centrally allocate materials to schools using enrolment data and LTM:student class ratios when required.

## APPENDIX V: CASE STUDY: FINAL COSTS FOR CAMBODIA TRACK AND TRACE

Annual running costs of the final version of TnT that is used at scale in Cambodia After a successful pilot phase, the final design of the TnT was revised to enable national scale up at an affordable cost for the MoE, which is paying for the annual running costs of the system. Functionality of the system was pared down to reduce costs: it no longer tracks individual deliveries with bar codes at all. The final system functionality includes:

- Schools can enter book needs data on an online form
- Creation of a national allocation list based on these book needs
- Allocation list cutting/editing tool to enable the MoE to adjust the national allocation list according to budget, additional titles, application of estimated damage rates, etc.
- Schools can use a form to enter data on what books are received each time there is a delivery
- Community members can fill out a spotcheck form to audit book availability in the classroom.

School and community users access all forms through a chatbot which also has other functions, including reporting a problem, accessing training materials and finding out how many books have been approved for their school. The chatbot now sends only 1 notification directly to each school director, to tell them their final book request data based on the available books and student number information they submitted.

Other notifications about the start of the requesting period, or delivery period etc. are now sent generically to a Telegram channel and users who have subscribed to that channel will receive a notification. The MoE can use the dashboard to track what problems have been reported by schools. The dashboard has a number of visuals to track requests and deliveries, and a whole range of reports can be generated and downloaded.

The total annual running cost for use at all 9,100 schools in the country is \$7,163.92. There are three separate elements of TnT that use proprietary software which must be paid for. These are described below and the costs are provided in the table.

### SALESFORCE

This underpins the entire system and is where all data is stored, managed and viewed. The administrator licenses are more expensive (\$93/month) so there are only 4. Standard licenses, that enable users to view the Salesforce dashboard and export data, are cheaper (\$8.35/month) and there are 12 of these. Each one has its own username and password.



## FORMASSEMBLY

This software is for the web-based forms used by school directors and community members through the chatbots. This is a flat fee. The MoE was able to get a significantly discounted annual rate of \$665.28.

## FLOWXO

This is a service for managing the chatbot messages and connecting to Salesforce. Charges are based on the number of interactions. For low use periods in the book cycle, it is possible to pay only the standard plan (\$19/month). During periods where users are more active and the system has to deal with more interactions (submission of book data forms, book confirmations, etc.) the monthly fee is increased in \$25 increments for additional packages of 25,000 interactions per package. In a few months, the system may require up to 9 packages of 25k interactions, costing \$254 for that month.

PLATFORM	SERVICE	DESCRIPTION	QUANTITY	# OF MONTHS	DISCOUNTED/PRICE/USER/MONTH (USD)	TOTAL
SALESFORCE	Sales Cloud Enterprise	Access & edit rights for the Salesforce dashboard	4	12	\$93.00	\$4,464.00
	Lightening Platform Starter	Viewing rights to limited view of Salesforce dashboard- allows exporting of data	12	12	\$8.35	\$1,202.40
FORM ASSEMBLY	Form Tool	Forms for book requests, book, confirmations, spotcheks				\$665.28
FLOWXO	Chatbot	Chatbot Interaction		12	Depends on level of activity, ranges from \$19/mo to \$244/mo	\$832.24
<b>TOTAL</b>						<b>\$7,163.92</b>

### How did the MoE manage to get these annual costs so cheap?

- Cut out users: the pilot version of TnT had users at multiple levels, including warehouse managers and district education officers; the final version includes only MoE officials.
- Cut out functionality: the pilot version enabled scanning, tracking and confirming specific district and school shipments; the final version does not track specific shipments, it simply allows schools to confirm what they received.
- Cut out number of interactions: by interactions, we are referring to the occasions where there is data “flowing” through the system. For Cambodia, there are multiple deliveries by different companies each year. This means that school directors are frequently entering data on the books they receive. We could not reduce this. Therefore to reduce other types of interactions, we cut the number of alerts and notifications that the system sends out to each school director.
- Cut out expensive software requiring licenses: the pilot version had district-level officials using a mobile application to scan book deliveries and enter data on a form. Each user had to have their own license. This was too costly for use at national scale, and was removed from the final system.
- Reduced number of people who would have the more expensive licenses: Salesforce has a more expensive type of license with administrator rights. We limited this to 4 licenses. The other licenses that just allowed viewing rights were far cheaper and are fine for other members of the MoE who just wanted to access the dashboard and data on book cycle progress, without needing to manage the data at all. However, even the cheaper ‘viewing only’ licenses proved too expensive to give them to all district level officials. This meant that district users are no longer able to access dashboards or reports at all. Instead, central MoE export district specific reports to excel and email them/send by Telegram.
- Built the system around smartphones: users at school and community level were willing to cover the costs of data for accessing TnT out of their own pocket as the costs were minimal and TnT is only used a few times a year.
- Heavily discounted rates for the software that do require licenses: after lengthy negotiation and submission of written justifications of why discount was appropriate, the MoE was able to get discounted rates for software used in the system.



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