Advancing Data-Driven Decision-Making for School Improvement

Findings from the One Tablet Per School User Testing Programme in Sierra Leone

About this document

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Contents

Abbreviations and acronyms

CPSS   Council for Principals of Secondary Schools

DSTI   Directorate of Science, Technology and Innovation

MBSSE   Ministry of Basic and Senior Secondary Education

NaCoHT   National Council of Head Teachers

NGO   Non-governmental organisation

SLTU   Sierra Leone Teachers Union

TSC   Teaching Service Commission

1. Introduction

Since September 2020, EdTech Hub has supported Sierra Leone's Ministry of Basic and Senior Secondary Education (MBSSE) and Teaching Service Commission (TSC) to develop the One Tablet Per School programme. The programme aims to support school leaders to collect and use dynamic school-level data on teacher registration, student enrolment, teacher and student attendance, and Covid-19 cases. Notably, the programme feeds into the government's wider goal of promoting data-driven service delivery and evidence-based decision-making.

In the initial stages of this engagement, EdTech Hub, MBSSE and TSC collaborated to design a tablet-based data management model. This work involved activities such as assessing government needs, mapping existing education data systems, and identifying barriers to programme delivery.

Separately, *Leh Wi Lan* has worked with the MBSSE to support school-based data collection since 2018. The team used the Tangerine mobile platform to conduct lesson observations and gather data on several classroom indicators. In doing so, *Leh Wi Lan* has collaborated with school support officers, MBSSE supervisors and secondary school principals.

Over the past three months, EdTech Hub, *Leh Wi Lan,* the MBSSE and the TSC have come together to test the proposed data management model in two phases. The first phase focused on 40 schools in Freetown while the second phase focused on 40 schools in Port Loko. Notably, participating schools already had experience of using tablet-based data systems through the *Leh Wi Lan* programme. This process aimed to generate insights on how and why school leaders engage with tablet-based data management systems to inform the development of tools that better meet their needs.

This paper presents detailed analysis from the first phase of user testing for the MBSSE and TSC to use to refine the design of the programme. When conducting this analysis, we used a sequential mixed-methods approach to understand the experiences of participating school leaders. The paper begins with background information on data-driven decision-making and the One Tablet Per School programme. The subsequent sections outline the study's methodological approach and summarise our findings before ending with recommendations for the next iteration of programme delivery.

2. Background

2.1. Data-driven decision-making for school improvement

The systematic collection and use of data can enable education decision-makers to pinpoint gaps in service delivery, identify inequities to address, and show how different interventions impact learning (↑UNESCO IIEP, 2020). In Madhya Pradesh, India, for instance, decision-makers used student assessment data to target coaching support to underperforming schools (↑Tobin et al., 2015). Meanwhile, the publication of data on the relationship between learning gaps and social inequality in Chile precipitated an equity-oriented policy response (↑Meckes & Carrasco, 2010).

At a school level, the provision of education data and training on data use can strengthen school management. In Argentina, for instance, the dissemination of diagnostic reports on student performance led to a statistically significant increase in foundational learning outcomes (↑de Hoyos et al., 2017). School leaders who received these report cards proved more likely to use data to monitor teaching quality and support parental engagement (↑ibid.). In Brazil, training for school leaders on data-driven improvement planning generated a 30% increase in average test scores in numeracy and literacy (↑de Barros et al., 2019).

However, many education systems in low- and middle-income countries lack the technical expertise to translate evidence into effective and equitable decisions. Despite the need for capacity building, political pressure to make visible investments in education — constructing schools, procuring buses, and buying computers — can undermine support for long-term professional development initiatives (↑Kallon Kelly et al., 2020). In turn, a lack of technical expertise can result in decisions that are only superficially based on evidence (↑UNESCO IIEP, 2020).

Even where countries have the required expertise, the structure of education data systems may prevent decision-makers from accessing information. In particular, the design of data systems rarely meets the needs of school leaders in low- and middle-income countries (↑Crouch, 2019). In these contexts, data structures often follow an extractive model in which governments collect information from schools without providing any feedback (↑ibid.). These unidirectional data flows limit opportunities for bottom-up, evidence-based school improvement initiatives.

When school leaders can access education data, the provision of large volumes

of unfiltered information can discourage the use of evidence in decision-making. In practice, the setup of education data systems frequently assumes that all stakeholders need all data for all decisions (↑Custer et al., 2018). Yet, decision-makers will be less likely to act on evidence that is irrelevant to their priorities, their position within the education system, and their wider context (↑Raudonyte, 2019).

Investments in data systems may prove ineffective if these interventions do not account for the needs and motivations of education stakeholders. In Madhya Pradesh, India, for instance, the state government introduced a school improvement programme that featured comprehensive school ratings, regular school assessments, and customised action plans (↑Muralidharan & Singh, 2020). While the intervention increased school-level reporting, the programme had no impact on learning outcomes because of a lack of incentives such as performance-based pay or sanctions (↑ibid.).

Even though researchers have started to examine how and why education stakeholders use data in decision-making, this analysis has focused on senior officials in government, donor organisations and on-governmental organisations (NGOs) (↑Custer et al., 2018; ↑Freiermuth et al., 2020). This study will build on this growing literature to explore what drives school leaders to engage with tablet-based data management in the Sierra Leonean context.

2.2. Data-driven decision-making in the Sierra Leone education sector

In Sierra Leone, the latest Education Sector Plan prioritises the use of data to support service delivery and to inform programme design at all levels (↑Ministry of Education, Science and Technology, 2018). In particular, the plan highlights the need for a data-driven approach to managing the education workforce (↑ibid; ↑Teaching Service Commission, 2020). Previously, the TSC has struggled to combat teacher absenteeism and monitor teacher supply and demand (↑Education Workforce Initiative, 2020; ↑Graham et al., 2020). These issues stem in part from the presence of a significant number of 'volunteer' teachers, with 32% of schools having no paid staff (↑Wright, 2017).

Despite major resource constraints, the MBSSE has expanded and digitised the collection of education data. For example, the Annual School Census provides a yearly snapshot on the state of education in Sierra Leone (↑Ministry of Basic and Senior Secondary Education, 2019). Since 2018, the government has sent enumerators to collect school-level data on tablets as part of this exercise (↑Namit & Mai, 2019). Notably, school leaders have the responsibility of completing paper-based surveys with relevant school-level information prior to enumerator visits.

The Annual School Census preceded several pilot programmes that aimed to collect more dynamic data. In July–August 2020, the TSC trialled the Sierra Leone Education Attendance Monitoring System in 43 schools (↑Graham et al., 2020). Under this system, principals were responsible for submitting teacher attendance data and maintaining an up-to-date list of classroom teachers (↑Kawa et al., 2020). The latter task involved verifying a list of payroll teachers and adding or removing staff members as needed (↑ibid.). On a monthly basis, district-level officials conducted spot checks to validate the accuracy of the submitted data (↑ibid.).

Meanwhile, the UKAid-funded *Leh Wi Lan* programme has invested in data collection to advance its goal of improving secondary education in Sierra Leone. At first, *Leh Wi Lan* hired school support officers to use tablets to collect real-time school-level data at a national scale (↑Leh Wi Lan, 2018). More recently, the programme piloted the use of tablets for data collection with principals in 250 secondary schools (↑Leh Wi Lan, 2020). At these schools, principals submitted data from teacher and student attendance reports, lesson observations and performance reviews (↑ibid.). In 2021, *Leh Wi Lan* will expand elements of this pilot to all government and government-assisted secondary schools in Sierra Leone.

Following these pilots, the MBSSE and TSC developed the vision for the One Tablet Per School data management programme. The programme aims to build on past and present dynamic data management initiatives. Under this programme, school leaders in government and government-assisted primary schools will receive a tablet to gather, verify, and access the following data:

- registration details of individual teachers including payroll status, years of service, qualification and subject specialism;
- classroom-level student enrolment data disaggregated by gender, educational need, and pregnancy status;
- daily attendance records for teachers and students;
- daily reports on the presence of Covid-19 symptoms and Covid-19 cases.

The programme intends to adopt a similar model as the completed Sierra Leone Education Attendance Monitoring pilot in which district-level officials from the TSC visited participating schools each month. Moreover, *Leh Wi Lan* will support the MBSSE and TSC to collect the same data in secondary schools.

Before implementing the programme, the MBSSE and TSC wanted to better understand how school leaders engage with tablet-based data management systems. As such, EdTech Hub, *Leh Wi Lan*, the MBSSE and the TSC built on the Tangerine platform to create a prototype data management tool for rapid testing. At this point, school leaders received no summary information

although they will have access to a data dashboard from the start of the full programme pilot.

In February 2021, the government invited school leaders from 40 secondary schools in Freetown (Western Area) to trial the prototype tool over a five-week period. In May 2021, the government invited school leaders from a further 40 secondary schools in Port Loko (North Western region) to test the tool over a shorter two-week period. The remainder of this report presents in-depth analysis from the first phase of the user testing programme.

3. Methodology

In this study, we aimed to identify ways to iterate the One Tablet Per School programme to increase the collection and use of data in schools. In doing so, we focused on the following research questions:

RQ1. How do school leaders engage with tablet-based surveys to manage school-level data?

RQ2. What factors influence the engagement of school leaders with the One Tablet Per School programme?

To answer these questions, we adopted an explanatory, sequential mixed-methods approach (⬆Creswell & Plano Clark, 2018). This approach involved:

1. Real-time mixed-methods analysis of tablet-based data management.
2. Endline quantitative analysis of tablet-based data management.
3. Endline explanatory, qualitative analysis of tablet-based data management.

The overall research design is shown in Figure 1. Importantly, this research focused on the first phase of the user testing programme. We opted to focus on the first phase as it lasted for a longer duration and Covid-19 restrictions limited our capacity to conduct in-depth field work outside of Freetown.
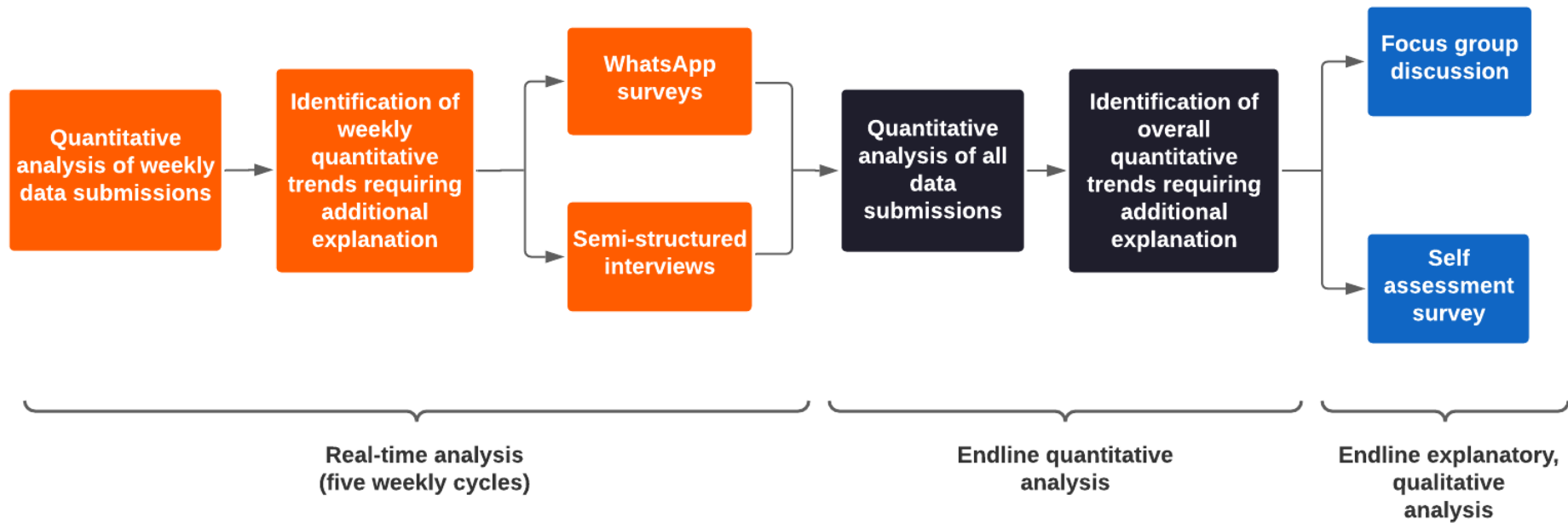
3.1. Real-time mixed-methods analysis of tablet-based data management

In the first stage of research, we collected and analysed data in five weekly cycles for the duration of the first phase of user testing. This cyclical process initially involved descriptive quantitative analysis of the data that school leaders submitted each week. This analysis examined variables such as time of form completion, the number of submissions and the volume of duplicates. After conducting this analysis, we used the following qualitative methods in parallel to explain the quantitative findings.

WhatsApp-based surveys

At the beginning of the first phase of user testing, we added participating school leaders to a WhatsApp group. Following our quantitative analysis, we sent weekly follow-up questions to better understand how this population engaged with the programme (RQ1) and why this population engaged with the programme in this way (RQ2). Separately, we encouraged school leaders to share any concerns or questions via the WhatsApp group.

Figure 1. *An overview of the study's overall research design.*

Semi-structured interviews

On a weekly basis, we randomly selected two school leaders for a semi-structured interview without replacement (↑Adams, 2015). In the interviews, we asked the school leaders to describe their experience of using tablets to manage data (RQ1) and to identify any enablers or barriers to programme engagement (RQ2).

This analysis provided an indicative sense of how school leaders used tablets to manage data over time as well as a real-time understanding of what did and did not work.

3.2. Endline quantitative analysis of tablet-based data management

In the second stage of research, we expanded the scope of our analysis to focus on the entire first phase of the user testing programme. Here, we conducted descriptive quantitative analysis of all of the data that school leaders submitted. In doing so, we studied trends such as the frequency of data submission, the proportion of data errors (e.g., a mismatch between disaggregated and aggregated student attendance data), and any variance in data submission by form and school. This analysis provided further detail on how school leaders engaged with specific forms at different times (RQ1).

Importantly, these results informed the study's endline explanatory, qualitative analysis (↑Creswell & Plano Clark, 2018). In particular, we used the results to design the structure of and questions for focus group discussions and to develop a self-assessment form for school leaders.

3.3. Endline explanatory, qualitative analysis of tablet-based data management

At the end of the first phase of user testing, we invited participating school leaders to a debrief session in Freetown. During the session, we divided participants into focus groups to discuss the study's two research questions (↑Krueger & Casey, 2015). In doing so, we could observe any convergence or divergence between the experiences of different school leaders. In the discussions, we also invited participants to write down their thoughts on note pads, which we collected at the end of the day.

Separately, we provided school leaders with a form to describe their level of engagement with tablet-based data management (RQ1), the rationale for this

assessment (RQ2), and ways to increase programme participation (see Appendix 1 for a copy of the self-assessment form).

After the debrief session, we thematically analysed all qualitative data using the following steps (↑Peel, 2020):

1. **Engaging with the qualitative data.** We read all qualitative feedback to familiarise ourselves with the data, noting any initial observations related to the research questions (↑Braun & Clarke, 2006; ↑Creswell, 2013).

2. **Generating a list of codes.** Based on our review of the data, we identified extracts that provided information with relevance to the research questions (↑Merriam, 2009). Subsequently, we adopted an inductive approach to create codes to represent the significance and meaning of each extract (↑Braun & Clarke, 2006; ↑Peel, 2020).

3. **Developing code categories from the initial list of codes.** We aggregated similar codes into code categories that highlighted important patterns in the data (↑Peel, 2020).

4. **Identifying consolidated themes from the code categories.** We compared patterns from the code categories and the literature to identify themes (↑Braun & Clarke, 2006; ↑Creswell, 2013; see Annex 2 for an overview of the study's code categories).

In the following section, we will provide an overview of the findings from this analysis.

4. Findings

4.1. How do school leaders engage with tablet-based surveys to manage school-level data?

This section provides an outline of the school-level data management cycle and identifies the pain points within this process (see Figure 2).

4.1.1. School-level data management cycle

Before participating in the One Tablet Per School programme, school leaders had limited access to usable data. In a focus group discussion, a participating school leader explained how

> *"Before this time, most of this [administrative] work was left to teachers and heads of department. There was little we knew about teachers and students. We only looked at registers on a termly basis."*

School leaders do not appear to have previously applied data to systematically inform decisions on school improvement. The lack of a formal school-level data management system ostensibly discouraged the collection and use of data. In a semi-structured interview, a school leader noted that they "just didn't care" about checking on teacher attendance in the absence of structured guidance. The motivation of school leaders to gather and apply data depends in part on the provision of external scaffolding.

Despite the limited use of evidence in the decision-making process, schools developed a range of data management tools prior to the intervention. For example, many participants described how teachers were expected to fill in time books when signing in and out of school and to complete paper-based attendance registers every day. Even though most of these systems focused on compliance and record-keeping, the tools provided a supporting backbone for tablet-based data collection.

During the user testing programme, school leaders established a dual data system — paper-based and tablet-based — to streamline the data collection process. The majority of school leaders used paper forms to gather data for input on tablets instead of immediately entering information in a digital format. In a focus group discussion, school leaders stated that "data collection is not hard unless you lack a record system". Outside of existing tools, school leaders designed new systems such as printed templates to monitor attendance and a book to track teacher absenteeism.

The establishment of a dual system enabled school leaders to delegate data collection responsibilities. In a focus group discussion, a participant noted that "if you take all of the load, you cannot do it [tablet-based data collection]". In this context, school leaders often required each member of staff to complete a hard copy of the teacher registration form. Moreover, school leaders frequently asked the vice principal to track teacher absenteeism and instructed teachers or prefects to monitor student attendance. The development of a dual system with the support of other staff underpinned the feasibility of tablet-based data management.

In some schools, principals created internal mechanisms to ensure the validity of data. For example, over 50 per cent of daily student attendance forms were submitted between 11 am and 2 pm. In a focus group discussion, participants recounted how they checked attendance in the last period of the day to limit opportunities for students to leave school when marked present. Separately, one school leader explained how they went further to design a system to cross-check data for input on tablet-based forms:

> "I task the vice-principal and class prefect to collect the same data on pupil attendance. I compare the results and match. If there is a discrepancy, I visit the classroom myself to rectify."

The commitment of school leaders to providing accurate data demonstrated nascent school ownership of the data management cycle.

Even though participating school leaders lacked access to summary data, some used tablet-based forms to inform management decisions. In the focus group discussions, school leaders identified the following four courses of action:

Warnings and sanctions
'We now give verbal or written warnings to teachers and students who are regularly absent.'

Guidance and counselling
'We engage teachers on absenteeism and [meet with students] discuss the benefits of coming to school regularly and punctually.'

Community engagement
'We share data with the community teacher association who helps monitor children and teachers.'

Departmental meetings
'We have meetings with heads of department two or three times a term. In these meetings, we plan how to accomplish our goals and how we can improve.'

Notably, school leaders applied data to inform a package of interventions — rather than a single course of action. In the focus group discussions, a participant outlined how

> *"[Based on this data], we can suspend students and take action if they miss multiple days. We [also] use this information to engage parents on these issues and to encourage children to come to school."*

Over the duration of the user testing programme, school leaders moved from a position with limited administrative information to a situation where they could mobilise data to shape incentives for school participation.

4.1.2. Pain points in the data management cycle

The user testing programme highlighted several pain points where school leaders either found the process unclear or required further support.
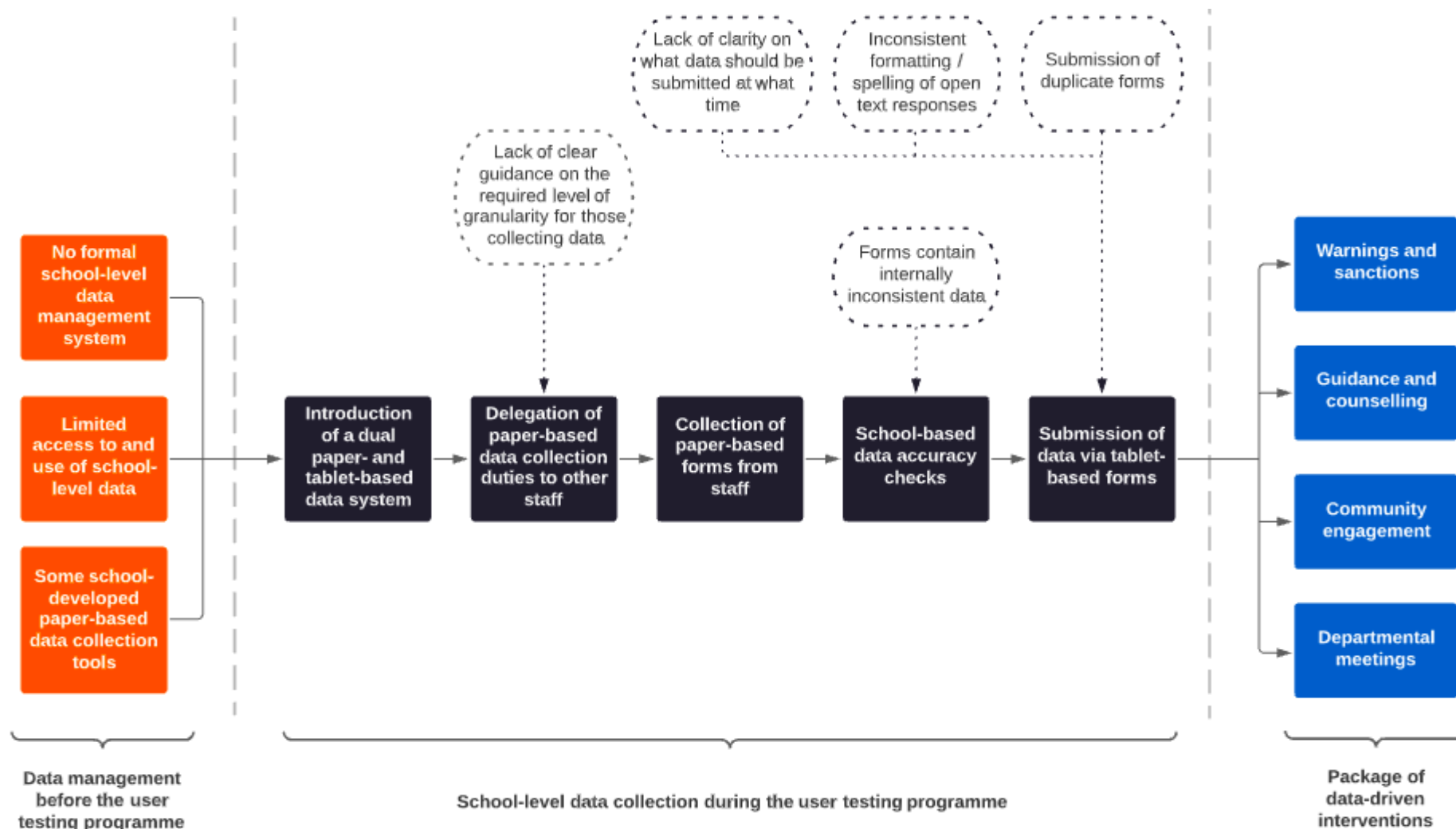
The submission of duplicate forms undermined the quality of school-level data throughout the programme. In the first week of user testing, school leaders submitted twelve duplicate teacher registration forms from a total of 486 entries. In the following week, school leaders submitted a further eight duplicate forms from an additional 110 entries. The duplication of teacher registration forms will prove problematic if the government uses this data to identify who actively works in school and who should — and should not — receive a salary.

Similarly, school leaders submitted termly student enrolment data on multiple occasions. In the first week of user testing, a participant completed the termly enrolment form five times including two instances on the same day. Notably, the enrolment figures varied across each entry. In this case, the frequency of form submission and variance in enrolment figures suggests that the school leader used the form to collect daily attendance data. The combination of duplicate entries and data submitted on incorrect forms indicates that school leaders lacked clarity on what form to complete at what time.

Despite the presence of some school-based accuracy checks, participants often entered internally inconsistent data. On the daily student attendance form, for example, the total attendance figure did not match the sum of the classroom attendance figures on 35% of form submissions despite some automated verification checks. Here, the level of variance ranged from 1 to 1,153. Importantly, two schools were responsible for 56% of discrepancies. The volume of invalid entries highlights a need to standardise and strengthen data verification procedures across the system.
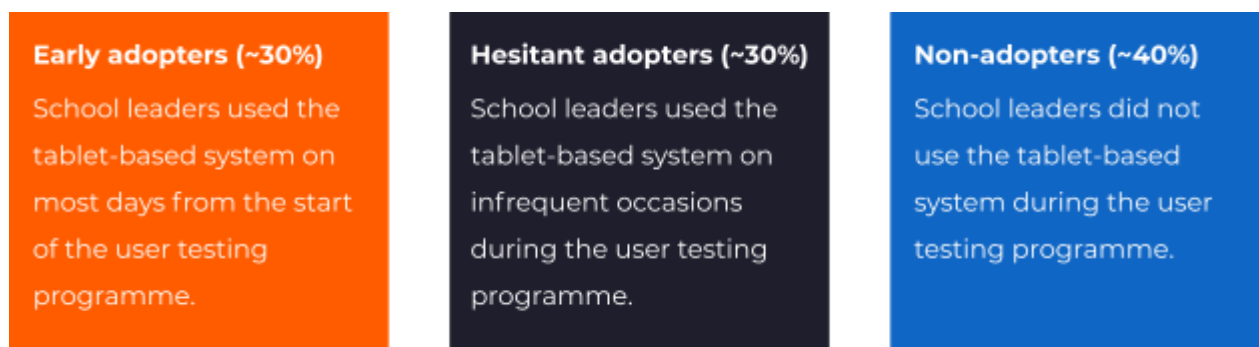
Outside of providing internally inconsistent data, school leaders formatted entries in open text fields differently across submissions. On the teacher registration form, for example, school leaders provided a range of responses — blank entries, all zeros, "no", "non", "not avail" — when they did not know the identity number of teachers. On the same form, participants used inconsistent spellings to list the academic institutions that staff members attended. The Institute of Public Administration and Management was referred to as "ipam", "IPAM", "Institute of Public Administration and Management, Freetown" and "University of Sierra Leone IPAM". The lack of uniform formatting signals that those responsible for collecting and submitting data required further direction on how to enter freeform responses.

Figure 2. *A diagram of the school-level data management cycle and the pain points within the process.*

4.2. What factors influence the engagement of school leaders with the One Tablet Per School programme?

The above framework reflects the feedback of school leaders who used the tablet-based data management system. Yet, school leaders showed varying levels of engagement with the programme. In practice, participants fell into one of three categories:

Early adopters (~30%)	Hesitant adopters (~30%)	Non-adopters (~40%)
School leaders used the tablet-based system on most days from the start of the user testing programme.	School leaders used the tablet-based system on infrequent occasions during the user testing programme.	School leaders did not use the tablet-based system during the user testing programme.

Separately, school leaders exhibited different levels of engagement with each of the forms. During the user testing process, 60% of participants submitted teacher registration forms and 63% of participants shared teacher attendance data. In contrast, only 48% of participants completed student enrolment forms and 43% of participants provided student attendance information.

In the remainder of this section, we will explore the factors that influenced if and how school leaders engaged with the programme (see Figure 3).

4.2.1. Issues with system set-up

The inconsistent provision of mobile data prevented some school leaders from submitting forms. In the focus group discussions, a school leader reported

> *"The supply of data is a major issue. I have been without data for 2 or 3 weeks and I'm not able to synchronise."*

Even where participants collected data, issues with airtime sometimes delayed the relaying information for further analysis and use.[1] During the user testing programme, the challenge of providing timely data stemmed in part from a system in which a central officer was responsible for distributing airtime to school leaders. This process involved regular communication with school leaders, monitoring mobile data use, procuring airtime and allocating credit as

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[1] The challenge of providing timely mobile data will likely impact the categorisation of school leaders. In particular, the categorisation may underestimate the proportion of school leaders who submitted forms and actively engaged with the programme.

needed. This approach will prove more demanding when the programme operates at scale. An additional challenge was that some school leaders replaced the provided SIM card with their personal SIM cards, meaning they could not access the provided data and further delays to data submission subsequently occurred.

Meanwhile, hardware issues prevented other school leaders from engaging with the tablet-based system. At the debrief session, for instance, a school leader self-identified as a non-adopter as "the tablet ceased to function well" during the user testing process. Similarly, another non-adopter emphasised the need to "automatically address the issue of tablet[s] malfunctioning". In other words, the absence of a system to quickly identify and respond to device problems hindered the collection and use of school-level data.

Where school leaders had access to a working device, low levels of integration with existing data systems reduced the usability of forms. In a focus group discussion, a school leader described how

> "Every time you log in, it is time-consuming to enter your ward and region. Can the tablet automatically fill this information [in] for each school?"

The inefficiency of repeatedly submitting school administrative data frustrated participants at a time when the school census collects this information. Weak linkages with other education datasets led to the duplication of effort rather than the optimisation of school management processes.

Similarly, the limited selection of options in drop-down menus decreased the efficiency of the system. For example, school leaders manually entered "other" subject specialisms on 36% of teacher registration forms.[2] In the focus group discussions, school leaders explained that this problem arose as "the [current] subject list is for JSS [junior secondary schools] and it needs to be updated for SSS [senior secondary schools]". The lack of tailored responses increased the workload of school leaders looking to integrate the system into their daily routine. At the same time, this issue underlined the importance of involving users in the development process to resolve basic errors before deploying systems at scale.

4.2.2. Enablers and barriers to school-level data management

This subsection outlines the non-technical factors that facilitated or impeded the collection and use of school-level data during the user testing programme.

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[2] A list of proposed form upgrades (including the addition of qualifications and subject specialisms) can be found in Annex 3.

Workload and time management

The workload associated with data collection had a significant impact on the level of observed programme engagement. At the start of the programme, for instance, a school leader completed 13 teacher registration forms in 2 hours and 56 minutes and therefore spent an average of nearly 14 minutes on each submission. Notably, this school leader went on to register 27 more teachers in the following days. In this context, focus group participants commented that "data collection [and the termly teacher registration process in particular] is like carrying an extra load". The required time commitment appeared to hinder the data collection process. Importantly, the timing of the data management cycle can influence the capacity of school leaders to manage this workload. A focus group participant described how "we should start teacher registration before term" when school leaders have more availability.

Similarly, the need to manage competing school priorities led to varying levels of programme engagement. On a self-assessment form, a hesitant adopter attributed their sporadic use of the system to "unavoidable undertakings" such as teaching, general administrative work, and exam invigilation. Here, the delegation of responsibilities for data collection emerged as a critical enabler. In a focus group discussion, for example, another hesitant adopter identified the need for "an assistant to help carry out some of the other school functions". The involvement of other staff in the daily running of the programme can provide school leaders with the flexibility to balance data management duties with other demands.

Yet, the support of other staff members requires a concurrent investment in capacity building. For example, a focus group participant noted that "training needs to filter into schools so others can help with the data collection". Notably, training for school leaders and support staff should be scheduled on a regular basis. On a self-assessment form, a non-adopter highlighted a "need [for] help and continuous practice to use the tablet" for data management. Importantly, ongoing capacity building does not require the input of external facilitators. At the debrief session, a school leader described how they "learned how to use Tangerine [the tablet-based data management tool] from the vice principal". In this context, school- or cluster-based learning circles could allow school leaders to share knowledge and jointly troubleshoot data management issues.

Teacher cooperation

In some schools, a lack of cooperation from classroom teachers impeded data collection. In a focus group discussion, a participant described how they faced

a "problem in collecting daily attendance [as] some teachers do not disclose the register". Similarly, another participant reported that only a few members of staff shared information for the teacher registration form. At times, school-level resistance limited the capacity of principals to provide the required data as well as the possibility of delegating data collection responsibilities.

This lack of cooperation stemmed in part from the perception that the data management system could have negative consequences for teachers. During the debrief session, a participant recalled how teachers interpreted a question on their planned retirement date as a suggestion to retire from the workforce. Meanwhile, several school leaders noted that teachers viewed the exercise as a "witch hunt" as only a small number of schools participated in the user testing programme. In this context, briefing sessions on the purpose of the system constituted an important measure for alleviating staff concerns. During a focus group discussion, a school leader explained that

> *"We encouraged cooperation from teachers by holding a meeting to manage their expectations. Inspectors need to support the school [to set these expectations]."*

Teacher buy-in depended on the provision of information on how government- and school-level decision-makers intend to use the collected data.

Systemic workforce-related issues exacerbated the challenge of securing the cooperation of teachers. In a focus group discussion, a school leader described their perception that "data collection is impacted if teachers are not on the payroll". Meanwhile, another school leader noted that "if I am a volunteer [teacher], I will try to do what I can and I may not like threats". The precarious employment status of non-payroll teachers reduced the ability of participants to involve staff in the data collection process and to enforce data-driven decisions.

Government follow-up and action

During the user testing programme, the lack of summary data limited the use of evidence in the school decision-making process. In a focus group discussion, a participant identified the "need for [summary] information to motivate and reward teachers". Meanwhile, another participant requested a dashboard to "support informed planning" after engaging in a separate *Leh Wi Lan* project that provided summary data. Even though some school leaders applied data from tablet-based forms, the absence of summary information impeded the integration of evidence into the design of school improvement initiatives.

In this context, the government should share analysis on key performance indicators to support school leaders to make data-driven decisions. During the debrief session, for instance, a school leader noted that "we don't just want to send information to the ministry, we want to use information in schools". Even though school leaders recognised the utility of the data management system, the lack of government feedback prevented participants from using the tool as they wished. The provision of summary data will serve as an important foundation for bottom-up, evidence-based interventions.

Importantly, decision-making structures need to align across the sector to sustain a culture of evidence use. In particular, principals will require external support to promote school-level change in a system where the government controls the payroll. In a focus group discussion, a participant detailed how

> *"We need ministry action. If attendance drops and there is no [financial] punishment then there is no impact, just empty words."*

Moreover, another school leader suggested that the government should use teacher attendance data to identify active "volunteers" to add to the payroll. Data-driven, school-level actions such as warnings and counselling will have a limited impact without concurrent and coordinated government action.

Increased leadership capacity

Despite the required workload, resulting gains in administrative efficiency incentivised the collection and use of school-level data. At the debrief session, for example, a school leader explained how the automated system "reduces lots of paperwork". Meanwhile, another school leader noted that "the operation of the[ir] school [had become] easier, faster and more accurate" since they began to use the tablet for data management. The simplification of school reporting processes encouraged sustained programme engagement.

An associated increase in school leadership capacity reinforced the value of collecting and applying school-level data. In a focus group discussion, for instance, a participant outlined how

> *"We are forced to learn and this is a very rewarding process. A clear picture emerges and allows us to improve performance. Implementation has improved daily student attendance. Before we ignored student attendance and now I can sit in my office and know the attendance of boys and girls."*

Once school leaders had accepted the short-term costs of a higher workload, programme engagement led to a virtuous cycle of learning and improvement:
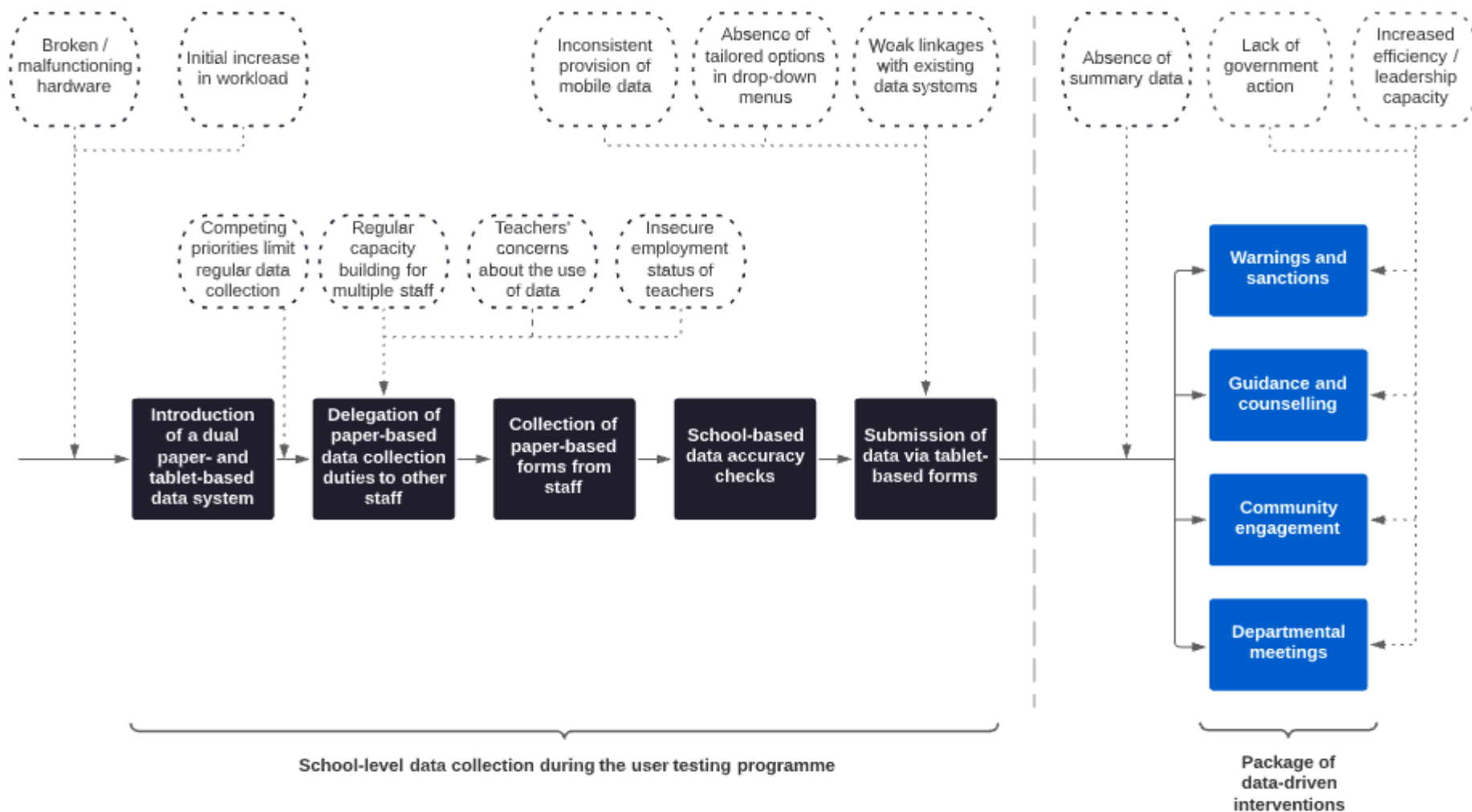
school leaders collect data, learn from this information, take evidence-based action and gather more data to assess progress.

Participation in this learning cycle stimulated demand for more school-level data. In the focus group discussions, for example, a participant described how

> *"Data collection can help us know what activities improve. Tangerine can help us learn more. I want to know more about learning materials."*

Similarly, other school leaders requested information on student performance, infrastructural provisions, individual medical conditions, and the availability of resources. Even though data collection entailed an extra time commitment, an increased capacity to monitor school activities motivated school leaders to promote the expansion of the data management system.

Figure 3. *A diagram of the school-level data management cycle and enablers and barriers to programme engagement.*

School-level data collection during the user testing programme

Package of data-driven interventions

5. Recommendations

Based on these findings, we developed a set of recommendations to refine each stage of the data management process (see Figure 4).

Introduction of a dual paper- and tablet-based data system

1. The pilot programme should encompass a dual paper- and tablet-based data management system. The implementer should provide templates for paper-based data collection — teacher registration forms, enrolment documents, attendance registers — to support the development of school record-keeping systems. During training sessions, facilitators should encourage school leaders to build on current administrative tools and repurpose the given templates to supplement existing routines.

2. The pilot programme should establish a clear structure to report device issues. For example, school leaders should notify district officials of breakages and system problems (e.g., via text message or short code). District officials should then follow up with schools, requesting either further technical support or a replacement from the central government if the device cannot be easily fixed. Separately, district officials should verify the functionality of devices on each school visit.

3. School leaders should have the option to collect teacher registration data at least one week before the start of term.

4. The implementer should work with the TSC and MBSSE to identify data that needs to be collected or verified on a daily, termly, and annual basis. At present, the tablet-based data collection forms and the Annual School Census ask similar questions on teacher registration. Even though school leaders may need to validate this information, greater system alignment could reduce the length of forms and the workload of school leaders.

Delegation of paper-based data collection duties to other staff

1. The implementer should provide a suggested approach to delegating responsibilities based on examples from the user testing programme. For instance, school leaders could ask teachers to complete registration forms, the vice-principal to report on teacher absenteeism, and teachers and prefects to track student attendance.

2. The implementer should ask school leaders to nominate another staff member to join central training sessions. Meanwhile, the implementer

should collaborate with the TSC and MBSSE to explore the possibility of regular, cluster-based knowledge-sharing sessions for school leaders and supporting staff.

3. The implementer should prepare a short how-to guide for those with delegated responsibilities. For example, the guide should outline the required level of detail to input in fields such as institutional name (e.g., university name *and* city) and address (e.g., chiefdom-level).

4. The implementer should engage the Sierra Leone Teachers Union (SLTU), the National Council of Head Teachers (NaCHoT) and the Council for Principals of Secondary Schools (CPSS) before launching the pilot. This platform will provide an opportunity to clarify any concerns with the programme and share information with school leaders and teachers.

5. District officials should hold school-based meetings on the purpose of the programme and the planned use of collected data during their first school visit. In this meeting, district officials should present the system as part of a wider school improvement package that includes a school-based continuous professional development programme.

School-based data accuracy checks

1. The implementer should share examples of how school leaders have taken measures to ensure the accuracy of data through training sessions and communications materials. At this stage, the implementer should not make internal accuracy checks compulsory given the challenge of workload management.

2. The tablet-based forms should perform automated validation checks to prevent school leaders from submitting inconsistent data (e.g., total attendance does not equal the sum of disaggregated attendance). Alternatively, the forms for disaggregated attendance and enrolment data should include a call-out box that displays the total aggregated value alongside the cumulative disaggregated value. This approach would encourage school leaders to enter consistent data and limit the risk that automated checks create barriers to form completion.

3. District officials from the MBSSE and TSC should conduct spot checks to validate the quality of submitted data. Officials should conduct checks at a sample of schools within their district on a monthly basis.

Submission of data via tablet-based forms

1. The implementer should systematise the distribution of mobile data to school leaders. The implementer can look to build on the government's
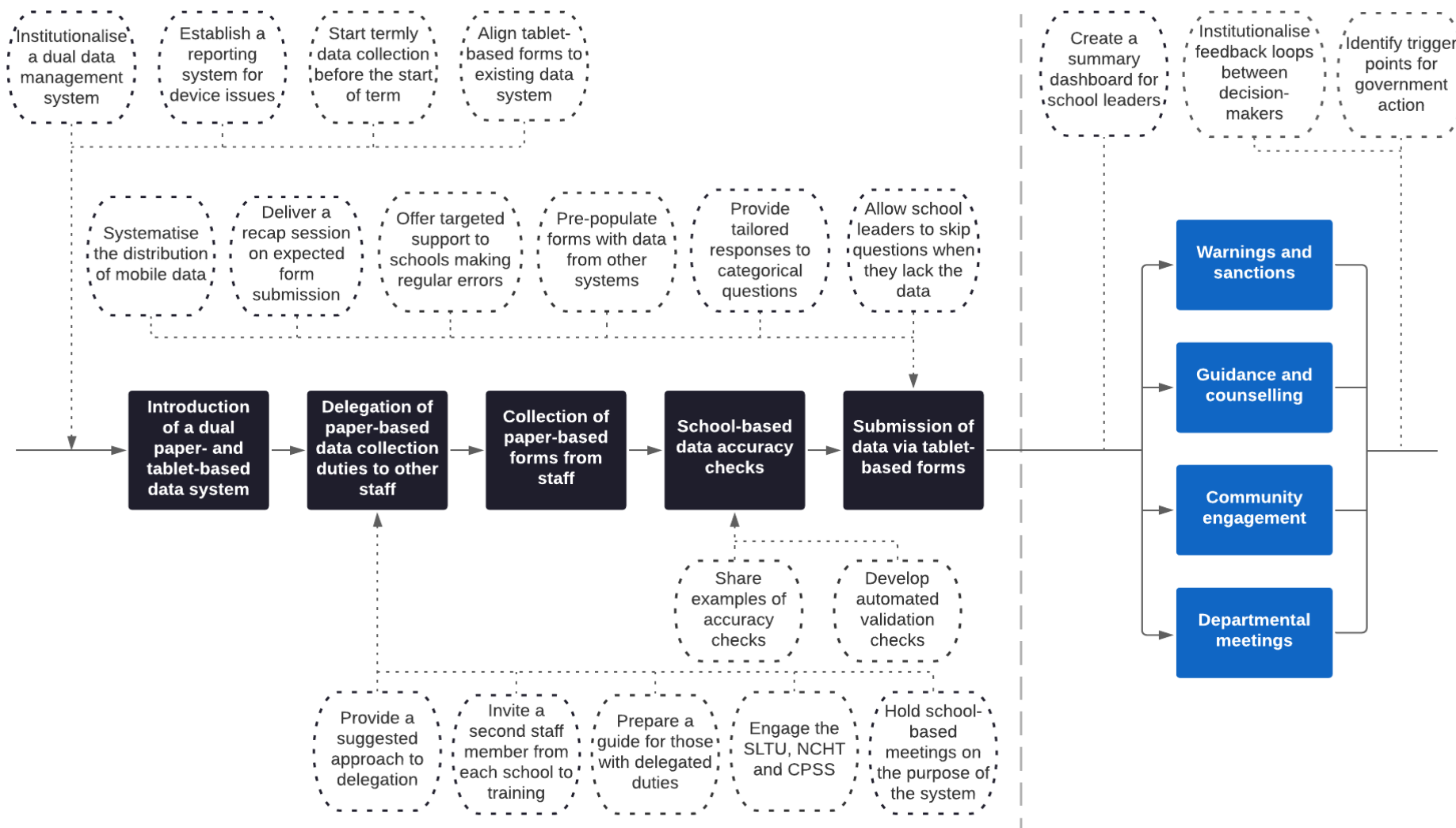
existing agreements with mobile network operators to remove network charges for access to the data management system. Alternatively, the implementer can set up a standing order to pay for mobile data at set intervals. However, this approach will require district officials to continue to check whether school leaders have used their data allowance before the end of the allotted period.

2. Training facilitators should provide a recap session on what form to complete at what time. The training for the user testing programme focused on the specific requirements for each form without reviewing general expectations for data submission. At the same time, the implementer should develop communications materials to promote timely data entry. For example, the implementer could design a sticker with pictographic instructions for the back of each tablet: submit one teacher registration form for each staff member at the start of term, submit one student enrolment form for each class at the start of term, submit one teacher attendance form every day, and submit one student attendance form every day.

3. The implementer should set the system up to only allow school leaders to submit one student enrolment form per term. District officials should have the permission to enable school leaders to submit a replacement form in the event of erroneous entries.

4. District officials should proactively provide targeted technical support to school leaders who repeatedly submit internally inconsistent data or duplicate forms as well as those who do not submit data. The implementer should set up high-frequency data checks and work with district officials to quickly identify school leaders in need of this support.

5. The data system should pre-populate forms with information from other education data sources for school leaders to verify. For instance, teacher registration forms could extract information from the Teacher Records Management system to allow school leaders to confirm the registration and attendance of payroll staff. Importantly, the purpose of the data management system — whether to reduce absenteeism or to better manage workforce supply — should determine how different systems link up. This approach can strengthen the quality of existing datasets and lower the workload associated with data collection.

6. The options for categorical questions should be adjusted to reflect the context in which schools operate. For example, school leaders at senior secondary level should see a list of senior-secondary-level subjects.

7. The implementer should add a skip option to questions where school leaders frequently lack the required information to submit valid answers (e.g., national identification number).

Package of data-driven interventions to support a performance-focused approach to school improvement

1. The implementer should develop a dashboard for school leaders to view summary data. The tablet should auto-generate analysis on a selection of key performance indicators that school leaders identify as critical for data-driven decision-making. Importantly, the dashboard should be accessible offline and in areas with low connectivity.

2. The TSC and MBSSE should institutionalise feedback loops between decision-makers at different levels of the system. For example, school leaders could use the data to identify school improvement actions at performance review meetings. District officials could then review the data and the proposed action points, following up with school leaders and requesting decision-makers within the central government to intervene as required.

3. The TSC and MBSSE should identify trigger points for actions such as sanctioning teacher absenteeism. The implementer should work with the government to communicate these trigger points to school leaders and teachers.

4. The TSC and MBSSE should test if and how other school improvement tools — lesson observations, monthly review forms, school-based teacher professional development content — can reinforce data-driven decision-making. In doing so, the government should investigate how teachers respond to different combinations of tablet- and non-tablet-based tools.

Figure 4. *A diagram of the school-level data management cycle and recommended steps for programme iteration.*

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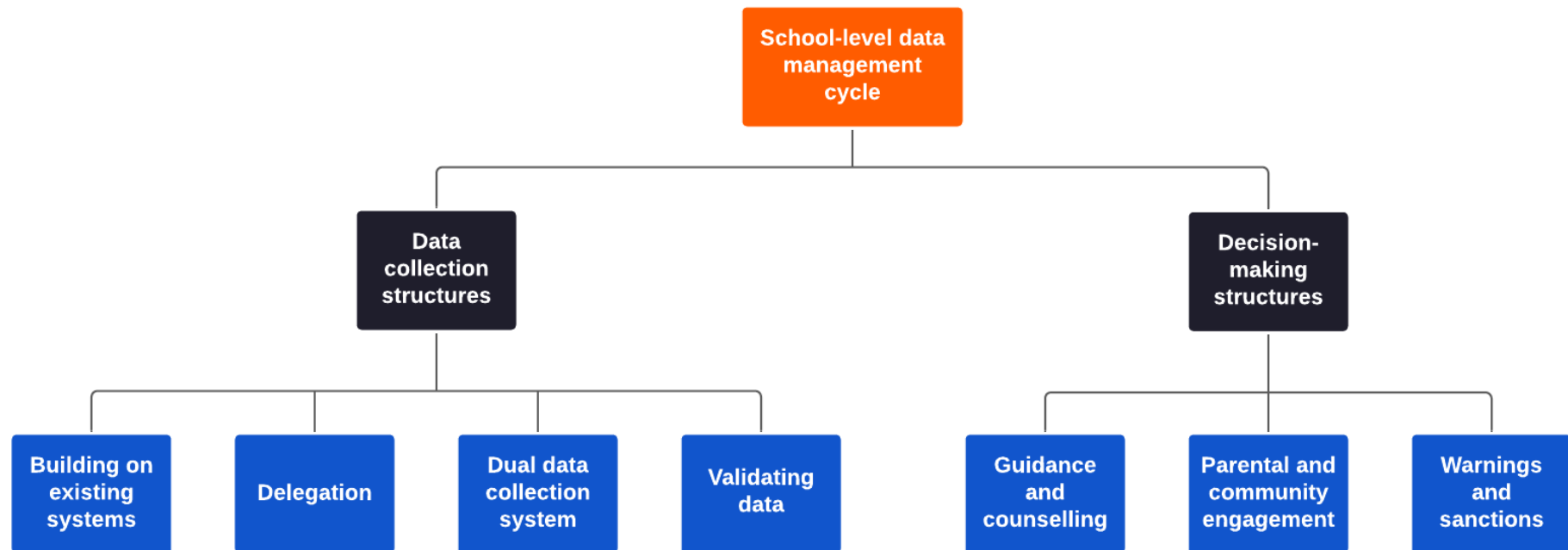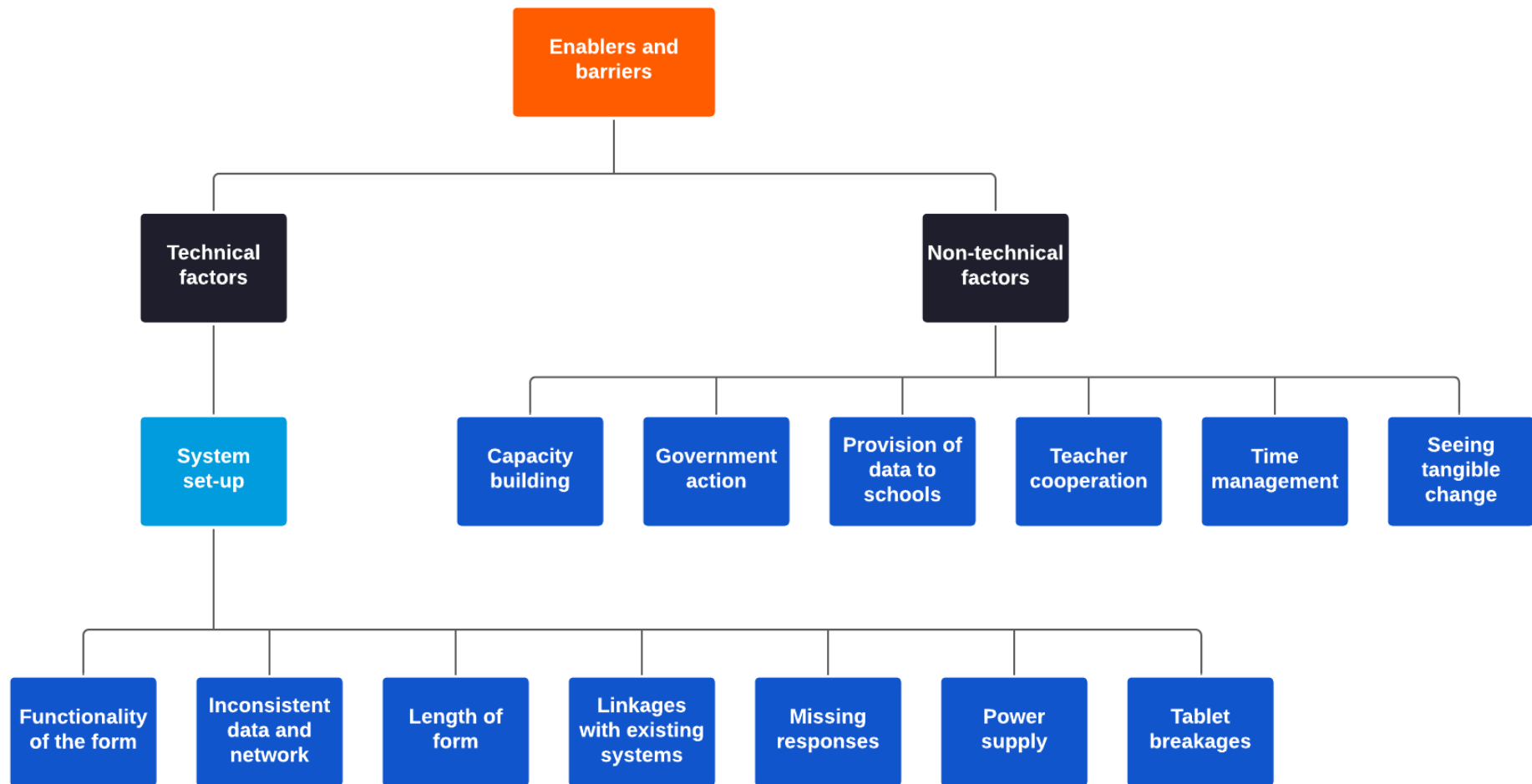
Annex 1. Self-assessment form

In the third stage of research, we asked all participating principals to complete the following form to assess their level of engagement with tablet-based data collection.

School name:	Principal name:
Self-assessment of level of engagement with tablet-based data collection (circle one option) ● **Early adopter.** I used the tablet to collect and upload data most days ● **Hesitant adopter**. I used the tablet to collect and upload data now and then ● **Non-adopter.** I haven't used the tablet to collect and upload data at all	
What are the main reasons for your self-assessed level of engagement?	**What would need to change for you to move into the next category of user (or stay there if you are an early adopter)?**

Annex 2. An overview of the study's code categories

This annex provides an outline of the study's top-level code categories and the associated codes.

Annex 3. A proposed list of form updates

Proposed update	Details of proposed update
Divide the termly teacher registration form into multiple modules	The registration form should be divided into bite-size chunks to enable school leaders to quickly identify and resolve any input errors.
Update the list of languages on the teacher registration form	During the user testing programme, the most common "other" languages included Kono, Fullah, Loko, and Madingo.
Update the list of tertiary education institutions on the teacher registration form	During the user testing programme, the most common "other" tertiary education institutions included the Institute of Public Administration and Management and the Port Loko Teacher's College.
Provide a tailored list of subjects for senior secondary schools on the teacher registration form	Principals should have access to subject lists that reflect their school level.
Add an option to register teachers on practicum	On the teacher registration form, the "teacher status" field should include an option for teachers on practicum.
Add a subsidy option to the "source of salary" field on the teacher registration form	In practice, many schools pay teachers using government subsidies. In this context, school leaders should have the option to identify these cases.
Add a skip option to the "national identify number" field on the teacher registration form	During the user testing programme, school leaders entered a range of responses — blank entries, all zeros, "no", "non", "not avail" — when they did not know the identity number of teachers.
Provide the functionality for school leaders to write dates on all forms using drop down menus for day, month and year	School leaders noted that the current system of scrolling through a calendar to find a date was unnecessarily time-consuming.
Amend the system's validation logic to prevent school leaders from making invalid entries in the "teacher start date" field	On the teacher registration form, school leaders often entered the date of form submission or future dates in the "teacher start date" field. In this context, the implementer should consider adding a skip option.

Amend the system's validation logic for all enrolment and attendance data	During the user testing process, school leaders often entered internally inconsistent data (e.g., total aggregated figures did not match the sum of disaggregated figures).
Pre-populate forms with information from other data sources	The system should extract pre-existing data from other sources where possible.
Start the phone number field on the teacher registration form with +232	During the user testing process, school leaders submitted phone numbers in inconsistent formats.
Link the profiles of registered teachers to their school	When filling in the teacher attendance form, if you select a different school, teachers from other schools show up on the profile.