

**Smart Paper Technology for EPI data
quality and data use evaluation
Mukono district, Uganda.**

Evaluation report 2021

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List of abbreviations

DQR	Data Quality Review
HMIS	Health Management Information System
KPI	Key Performance Indicator
MAD	Median Absolute Deviation
SPF	Smart Paper Forms
SPT	Smart Paper Technology

Introduction

Shifo Foundation, a non-profit organisation based in Stockholm, Sweden, has developed a hybrid solution with both digital and paper-based components. This solution can be deployed in resourceful and resource-constrained settings to capture and digitise beneficiaries' information and health services provided [1]. The system utilises Smart Paper Technology (SPT), which uses locally printed Smart Paper Forms (SPF) to capture biodata of individuals and the services they received at a health facility. These forms are then transported to a central location for scanning. The scanned forms are uploaded for processing and digitisation to generate electronic records.

In 2015, Shifo Foundation, in partnership with IKEA Foundation, and with the support of the Ugandan Ministry of Health, Mukono District Local Government and Mukono Municipality Office, agreed to implement the SPT Solution for immunisation services in Mukono district, Uganda. During immunisation sessions, health workers used the SPF to register beneficiaries' information and vaccine doses administered, as well as to capture vaccine balances after physical counts are conducted at the end of each month. The SPT Solution automates data aggregation and reporting processes and ensures that each beneficiary is assigned a unique ID that can be used to trace their details easily. It also generates a defaulters' list which health workers can use to trace beneficiaries who have not returned for due services.

Scope of the evaluation

Following the successful implementation of the project, in line with the partnership Memorandum of Understanding, this evaluation was commissioned. The evaluation sought to 1) assess the quality of vaccination data generated through SPT using the WHO Data Quality Review (DQR) Toolkit [2] and 2) assess the implementation of a Data for Action intervention that was geared towards improving data use among health workers.

Part 1 – DATA QUALITY

Introduction

Good quality data is crucial for monitoring and improving programme performance. Policy makers and officers at the service delivery level require data which is complete, timely, and consistent to track the progress of programs and inform potential interventions to be undertaken. A scoping review found that vaccination data in low and middle-income countries is mostly poor when evaluated and encouraged investment in health information systems and health worker capacity building to improve data quality and data use culture [3].

Methodology

The WHO DQR Toolkit was used as a framework for the data quality assessment [2]. It was developed by a consortium of partners with the goal to provide a generic framework and suggested metrics that can be applied to evaluate the quality of data across several health programs. This framework has been used to assess the quality of data produced through the conventional paper-based Health Management Information System (HMIS) [4] and through SPT [5]. This part of the assessment examined the quality of vaccination data collected from health facilities using SPT Solution in Mukono district, Uganda. Three dimensions of data quality – data completeness, timeliness and internal consistency – were evaluated. The data from February to June 2021 were extracted from 22 Mukono district health facilities, which implemented the SPT Solution.

Dimension 1: Data Completeness

Two data completeness indicators were analysed: Health facility reporting completeness and Indicator completeness. The acceptable threshold for completeness based on the DQR toolkit is at least 75% [2]

- 1. Health facility reporting completeness:** It is expected that monthly reports are submitted by all functioning health facilities each month. Completeness of facility reporting refers to the proportion of expected health facility reports actually received. Confirmation of health facility reporting was done by reviewing timestamps in SPT report submission logs.
- 2. Penta 3 completeness:** This metric was measured as the proportion of monthly returns without missing or empty spaces for the 3rd dose of Pentavalent Vaccine (Penta 3). Penta 3 is a crucial indicator to measure the utilisation of immunisation services. Therefore, it is not expected to be missing/left blank in monthly reports.

Dimension 2: Timeliness

Reporting timeliness measures the proportion of received monthly reports submitted on or before an agreed deadline. The agreed deadline for submitting timely reports in Mukono is the 6th of the subsequent month. Timestamps of report submission email logs generated by the SPT Solution were obtained and reviewed to determine the timeliness of reporting. At least 75% of reports should be submitted on time per the DQR [2].

Dimension 3: Internal consistency

Internal consistency of reported data refers to the level of agreement of data from different sources expressed as a percentage or ratio. It was assessed in this evaluation in three ways: 1) Penta 1 – Penta 3 consistency, 2) presence of outliers and 3) consistency of data between SPF and electronic records.

- 1. Penta 1 – Penta 3 consistency:** This metric was assessed as the proportion of health facilities in which the total Penta 3 doses administered over the reviewed period is greater than the total Penta 1 doses administered. Since Penta 1 is given before Penta 3, it is logically expected that total Penta 3 doses administered should not be more than total Penta 1 doses administered (provided that all other conditions remain the same).
- 2. Presence of outliers:** Outliers are values extraordinarily high or low from the mean value. The presence of outliers may be due to errors in data inputs or catch-up doses administered to children or due to seasonality. The frequency of moderate and extreme outliers was estimated using the Median Absolute Deviation (MAD) method. Health facilities with MAD values 2 - 3.5 were considered to have moderate outliers, and those with values greater than 3.5 were classified as having extreme outliers [2].
- 3. Consistency of data between SPF and electronic records:** This indicator was defined as the percentage agreement between data in scanned SPF and data in electronic records. Based on the parameters confidence level = 95%, response distribution = 50% (very conservative), and margin of error = 5%, the recommended sample size is 377 [6]. A random sample of 9 scanned documents containing the information of 555 visits was extracted, and the number of tick marks in them was compared with the number of ticks captured in the electronic records. This metric provides information on the ability of the SPT Solution to correctly digitise manually recorded data. The acceptable threshold for this indicator is $\pm 10\%$ [2].

Results

Data Completeness and Timeliness

Table 1 summarises the completeness and timeliness of vaccination data over the five months reviewed (February - June 2021). All of the expected reports were submitted, resulting in 100% reporting completeness. Of the submitted reports, 80% (n = 88) were submitted on time, which is acceptable based on the DQR toolkit data timeliness threshold. The 12% (n = 22) of monthly summaries not submitted on time were submitted a day after the deadline. Penta 3 data was 100% complete during the period reviewed.

Table 1. Data completeness and timeliness in Mukono District, Uganda (February – June 2021)

System	Expected # reports	Submitted # (%)	Submitted on time # (%)	Penta 3 data complete # (%)
SPT Solution	110	110 (100%)	88 (80%)	110 (100%)

Data consistency

Table 2 presents the three measures of data consistency. The results indicate that consistency between Penta 1 and Penta 3 is observed as expected i.e., the number of Penta 1 doses administered is greater than Penta 3 doses administered in each of 22 health facilities evaluated. The data captured in the SPF is 100% consistent with the electronic records.

Table 2: Data consistency in Mukono District, Uganda (February – June 2021)

Data consistency measures	Frequency
Number of health facilities with total Penta 1 doses > total Penta 3 doses	22/22 (100%)
Number of health facilities with moderate or extreme outliers	1/22 (4.5%)
Consistency of data between SPF and electronic records	555/555 (100%)

Part 2 – DATA USE INTERVENTION

Introduction

High quality data is undoubtedly essential for making effective health interventions. However, gaps in data quality may also not be noticed if data is not used. Therefore, data quality and data use culture are bidirectionally related. The SPT Solution was implemented with add-on processes and tools to encourage data use at health facilities. Key among the tools and processes are 1) monthly SMS Key Performance Indicators (KPIs) sent to health workers, 2) SMS reminders sent to beneficiaries to remind them of due services, 3) installation of notice boards for KPI charts in health facilities, and 4) reporting action taken to improve KPIs using a dedicated form. This section of the evaluation focused on the availability and adoption of those tools and processes in selected SPT implementing health facilities in Mukono district, Uganda.

Methodology

Study design and data collection

A mixed-methods study design was used. Quantitative data was collected for indicators related to background characteristics of the respondents, the availability of data use tools, and adherence to data use processes, while adoption and perception related data were collected qualitatively. Data collectors used an observation checklist and interview guide for data collection. Key informant interviews and observations were conducted in six of the SPT implementing health facilities in Mukono district, Uganda. A two-stage sampling procedure was used to select the sample of representative health facilities. All 22 health facilities were stratified based on distance from the scanning station (far and near), ownership (government and private), and size (big and small). A total of 11 health facilities were sampled. However, due to the unprecedented situation and Covid-19 restrictions, only 6 health facilities completed the data collection.

Analysis

Quantitative data was analysed using simple frequencies. Key informant interviews were transcribed verbatim, coded, and then used to write the results.

Results

Respondent characteristics

Two males and four females were interviewed in 6 health facilities. The average age of the respondents is 37 years and ranges from 32 to 44. All the respondents were trained on SPT Solution. Except for one person who started using the solution four months at the time of data collection, all others have worked with the solution for three years.

Availability of Data for Action tools and utilisation at health facilities

The interviewed health workers confirmed that they all receive KPIs on the 10th of each month. All six health facilities visited have appropriately set up notice boards with KPI charts pinned on them. However, it was found that the charts in one of the health facilities were not up to date. In assessing whether health workers use other charts to plot immunisation indicators, data collectors observed that health workers were using only the charts provided by the SPT team for plotting KPIs.

Adoption of the Data for Action intervention by health facilities

The Data for Action intervention is well adopted by the health workers. The majority of the health workers, 83% (n = 5), interviewed were able to show documented evidence of having reported taking action to improve poor indicators in the Vaccine Management and Data for Action form in the previous month. Sixty-seven percent (n = 4) of health facilities visited showed evidence of conducting performance review meetings following the receipt of SMS KPIs. All five health workers who took steps to improve indicators could name the indicators they took steps to improve. The finding that almost all health workers take practical steps to improve their performance is not surprising considering that the interviewees view the SPT Solution as enhancing performance monitoring and improvement by encouraging performance visualisation. For example, one health said, *"When it comes to discussion of interventions, we can discuss while looking at the charts and how the work is moving according to those graphs unlike before when we used to discuss without any reference"*. Another health worker said, *"... helped us to assess ourselves and find a solution, for example, after sending us performance indicators, we can see where we did not perform well and discuss the way forward on how to improve..."*.

Health workers appreciate the SMS reminders sent to caregivers when their children are due for vaccination and the defaulters' list produced by the system. About these two interventions, one respondent said, *"... in antenatal whoever comes, you are able to identify ... And in immunisation, the SPT Solution helps us send SMS reminders to our clients"*. Another respondent indicated that the SMS reminders are helpful as can be seen in quote *"the introduction of SPT is good and many clients have liked it because they receive messages [SMS reminders]. When you tell them to come on an exact date and in case you forget and write a*

wrong date [on their home-based records], it is still okay ... we tell them [the beneficiaries] that the SPT Solution will send them a message [when they are due to return for services].

Health workers perception of SPT Solution in comparison to the conventional HMIS

When comparing the SPT Solution to the conventional HMIS that was previously used, health workers depict the SPT Solution as easing their work and as more advanced over the conventional HMIS. The benefits they mentioned could be grouped into the ability of the solution to capture all the data it is designed to capture, automated calculation of KPIs, enhanced performance monitoring, vaccine needs estimation, and optimisation of the SPT form such that one form can be used to capture a lot of information. The users consider these aspects of the SPT Solution as great improvements that should be extended to other service areas of the health system. The health workers stated that they are not willing to return to the HMIS earlier in place and recommended that SPT Solution be rolled out to more health facilities and other departments in health facilities. One of the health workers also suggested that more staff in the health facilities should be included in the list of staff receiving KPIs.

Discussion

This evaluation assessed the quality of vaccination data produced through SPT and examined the availability and adoption of SPT based data use tools and processes in Mukono District, Uganda. The results showed that the SPT Solution produces complete, timely, and internally consistent vaccination data when reference to the WHO DQR Toolkit threshold values. The results also indicated that tools to enable the visualisation of KPI charts are available, and the health workers generally update the charts following the receipt of monthly SMS KPIs. Health workers are found to use and appreciate the Data for Action intervention.

The finding that SPT Solution produces high-quality data in Mukono, Uganda, is in conformity with the evaluations of the same solution in Afghanistan [7] and The Gambia [8], where findings suggested the solution produces high-quality vaccination data. Overall, the SPT Solution had higher quality data than the conventional HMIS in The Gambia, where the quality of data produced by the two systems was compared [5].

The observation that the health workers adopt the Data for Action intervention is very encouraging and depicts the willingness of healthcare workers to improve service delivery. It is not surprising that the health workers prefer the SPT Solution over the conventional HMIS, considering the very positive views they have about it and the many advantages, including administrative time savings.

Limitation

Field data collection could not proceed as planned due to a sharp rise in Covid-19 cases, warranting restrictions on movement, thereby halting data collection. It was decided that available data be analysed, resulting in data collected from 6 health facilities instead of the originally planned eleven. Therefore, although repetitive patterns could be observed in qualitative responses obtained, it is possible that we did not achieve theoretical saturation.

Conclusions

This assessment contributes to the growing evidence that the SPT Solution produces high-quality vaccination data. Healthcare workers have adopted the data for action intervention. The presence of the tools and regular sending of SMS KPIs and possibly the automation of some administrative processes, thereby saving health workers time they can spend on service improvement, facilitated the adoption of the intervention.

Recommendations

Based on the findings of this evaluation, the evaluation team recommends the following:

1. Shifo Foundation and partners to scale up the implementation of SPT in Uganda to cover more health facilities and service areas.
2. Considering the adoption of the Data for Action intervention and positive views of the health care workers towards the solution, we suggest that impact of the SPT Solution and Data for Action intervention on vaccination coverage, equity, and utilisation be assessed.

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