QUESTING THE MYCHILD SOLUTION IN AFGHANISTAN

An external evaluation of Data Quality, Operational Cost and Efficiency

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Executive Summary

From planning to evaluation and quality improvement, the data plays a pivotal role in the health systems, especially to expand the immunization coverage and mitigate the emergence of the preventable diseases, which is why it is crucial to have high-quality data from administrative/routine health information system. Considering the shortages of health workers and workload in Afghanistan, the paper-based system is often burdensome, time-consuming and prone to errors. To address the issue, MyChild Solution (MCS) was introduced in Mehterlam District, Afghanistan by the Shifo Foundation, in collaboration with The Ministry of Public Health of Afghanistan, The Swedish Committee for Afghanistan and IKEA Foundation in 2016. In order to evaluate the contribution of the pilot intervention and its potential from the national perspective, it was important to conduct the assessment, which was aimed to evaluate the solution from 3 different aspects of 1) Data quality, 2) Efficiency and 3) Operational Cost.

To evaluate the 3 components of this assessment, the data was obtained from the MCS, components of efficiency study and costs were identified and measured. In the study, the data quality assessment was guided by the WHO Data Quality Review Toolkit, a time-and-motion approach was incorporated to estimate the time-efficiency, and to compare the costs of MCS and current HMIS system, an incremental cost analysis was employed. Even though, only the MyChild Card system was applied in Afghanistan, the potentiality of the MyChild Form system was also included in the cost analysis to assess its feasibility in the specific context.

According to the dimensions of WHOs Data Quality Review (DQR) Toolkit, the metrics, namely: Completeness, Timeliness, Internal consistency and External consistency, were within the recommended thresholds. Moreover, the ratio of data recording error was also low in the study ranging from 0.05% to 1.7%. Secondly, regarding the Time-efficiency, around 64% to 96% time could be reduced in different stages of data administration during and after the immunization sessions with MCS in contrast to current Health Management Information System (HMIS).

However, the significance of time was also evident in the incremental cost analysis. When the value of time spent in data administration was considered, the current HMIS system subjected to the highest cost (0.63 USD per child) but in the contrary, excluding the value of time it exhibited the lowest cost (0.141 USD per child). Subsequently, MyChild Form was the cheapest when the value of time was included (0.228 USD per child). Additionally, a supplementary estimation was included for the cost-analysis of MyChild Cards where a discounting was adhered for mass production in national level and then, the cost was decreased by 0.14 USD per child. On the other hand, even when the value of time is not considered, the expenses in MyChild Form system is only 5% higher than the HMIS system.

Overall, MCS was apparent to be both cost and time-efficient with a standard quality of data where time saving played a key role in the comparisons. Although, the significance of the time-savings in pragmatic settings and resource allocation can be argued, if the saved time can be utilized to conduct awareness building activities like counselling and discussions, it can enhance awareness and facilitate community engagement to expand immunization coverage. Considering the quality of the data and findings of the efficiency study and cost

analysis, this intervention can be scaled up to provincial level and evaluated for a national implementation with proper planning of time utilization.

Acronyms

EPI – Expanded Program on Immunization

DQR – Data Quality Review

HMIS – Health Management Information System

MCS – MyChild Solution

WHO- World Health Organization

SCA- Swedish Committee of Afghanistan

USD- United States Dollars

MOH – Ministry of Health

Background

Health data is widely used in a number of purposes of planning, evaluation, quality improvement and reporting, which is why it is vital to have high quality administrative data. Since the inception of Expanded Program on Immunization (EPI) by the World Health Organization (WHO) in 1974, data collection and retrieval system in EPI remains the same in most parts of the low-income countries around the world. In usual scenario, EPI sessions are conducted by a vaccinator or health worker whereby data is collected and stored in paper-based system (2). Considering the shortages of health workers and workload in low and middle-income countries, the paper-based system is inefficient, time consuming and prone to human errors (3). Moreover, the intrinsic error in paper-based data collection system leads to unreliable and inaccurate data, which hampers the system enhancement plan of national and international stakeholders.

To improve the data collection system, several solutions have been proposed over the years and eHealth solution is one of them (4). At the same time, eHealth solutions are often challenging to maintain in a sustainable way as well as to implement in low-resource settings, considering the context of poor infrastructure, low computer literacy rate, network failure and insufficient electrification in rural areas (5).

To address this issue, Shifo Foundation, a non-profit organization based in Stockholm, developed a hybrid solution called MyChild Solution (MCS) based on Smart Paper Technology incorporating both paper-based form and information technology which enables health care workers to capture data in paper form and transfer it to electronic system using scanning and digitization technologies (6). The aim of the MCS is to utilize the information technology in low resource setting and minimize the data administration time and simplify the data collection procedure while retaining the quality data, which Shifo believes, enable health workers becoming the user of data from just being producer of data.

Afghanistan is one of the countries where MCS solution has been implemented as a pilot project in 2016 and then expanded in the whole Mehterlam District of Laghman Province (6). MCS covers 141 health service delivery points in Mehterlam, among which, there are 8 fixed health service delivery points, 105 outreach health service delivery points and 28 mobile health service delivery points.

Afghanistan is a South Asian country with a population of 34.5 million and 1,386,240 children under 1 year as of 2017 (7). There are total of 2,338 fixed health facilities in Afghanistan, which provide vaccination to children (7). Poor infrastructure, fragmented health system, political instability, and diverse geographical terrain of Afghanistan can be a potential proving ground for Shifo's MCS solution.

In the existing Health Management Information System (HMIS), the vaccinator has to fill out 5 different forms prior to vaccination, namely: the register of child immunization, child registration book, child registration card, daily vaccine administration and utilization sheet, and vaccination card. Then, they aggregate the collected data on a daily basis, use it to produce the monthly reports and submit them to the provincial health directorate to incorporate into national database (7). The parents are required to bring the child vaccination

card every time, as without the card, it is almost impossible to find out the name of the child during the sessions from the register containing around 200 pages and 3000 entries of children (7).

To ameliorate the circumstances, Shifo started operation in Mehterlam District in a collaboration with Swedish Committee for Afghanistan (SCA) and the Ministry of Public Health in Afghanistan, where the IKEA Foundation funded the project. In 2016, the project started in two health facilities and over time, it expanded to cover all health facilities in Mehterlam District operated by Swedish Committee for Afghanistan.

However, MCS claims to potentially shift the paradigm of immunization data. If this theoretical acclamation of the potentiality can also be narrated in the field of operation, it requires to be evaluated. Therefore, an independent evaluation was conducted to assess how far the intervention could reflect to its aim in the setting of Afghanistan. Motivation of the study was to assess quality of immunization data produced by MCS and efficiency of the system, in contrast to operational costs. Data quality was intended to be measured according to WHO Data Quality Review (DQR) toolkit whereas operational costs and efficiency parameters were compared with existing HMIS system. Results of this evaluation might help to determine scaling up the intervention nationally and further strategic development in a sustainable way. The study was divided into three sections:

i. Assessment of data quality
ii. Evaluation of efficiency
iii. Analysis of incremental cost

Assessment of Data Quality

Aim and objective

The aim of this section of the study was to assess the quality of the data collected by MCS according to the DQR guideline by WHO. The aim was executed in a set of five dimensions:

- Dimension 1 - Completeness and timeliness: What is the level of completeness and timeliness of facility reporting? What is the level of data completeness of immunization sessions captured in electronic reports? What is the level of completeness of indicator data?
- Dimension 2 - Internal consistency*:* What is the level of consistency between immunization indicators and between scanned smart paper forms & electronic data?
- Dimension 3 - External consistency*:* What is the level of consistency between data generated through MyChild Solution and external data sources?
- Dimension 4 - External comparisons of population data*:* What is the level of consistency of denominator between MyChild data and official government population statistics?
- Assessment of Data Recording Error: What is the incidence of data recording errors in immunization data collected with MyChild Solution?

Methods

To address the specific research questions regarding data quality, the methodology has been developed according to the toolkit for DQR by the World Health Organization (WHO).

The study was overall based on the data from 1st January to 31st December of 2017 (except for the metrics of data completeness and external consistency). Statistical software STATA 13 and Microsoft Excel were used to analyse the data in the study.

Dimension 1. Completeness and timeliness of data

(Evaluation of timeliness and completeness of reporting)

- Data completeness

In this dimension, the extent to which data are reported through system for future planning, evaluation, monitoring are adequate and available, was measured. Data completeness is a trusted indicator for the functionality of a system, to assess the ability and to collect the data in a continuous and efficient manner. Completeness of administrative unit reporting (e.g. district, regional or provincial reporting) is defined as the proportion between monthly reports from the administrative units and the expected number of monthly reports for a specific time period. Completeness of facility reporting was calculated by comparing the number of reports sent by the facilities to the district headquarters at the end of month against the number of reports expected to be reported by those facilities. In addition to this, session data completeness was calculated by measuring the entities inputted in contrast to the scheduled

number of immunization sessions both at static and outreach sites. Therefore, the number of scheduled sessions were estimated to the number of sessions that took place in the area.

Subsequently, a completeness rate of 100% indicates that all facilities have sent their reports. The WHO recommended threshold level for data completeness is 75%. To assess the completeness of specific data elements in the report, only the core indicators of immunization recommended by WHO DQR, such as DPT1, DPT2 and DPT3, were taken into consideration. Completeness of data elements was analysed by assessing if all the core indicators were reported/included in the monthly reports generated from MyChild Solution.

Thus, the completeness of the data quality was assessed according to facility reporting, session and indicator data completeness. However, the consistency of reporting completeness over time was not included in the study as to measure that at least three years of data would be needed, however MyChild Solution was implemented in Afghanistan less than two years ago. Hence, this indicator of completeness was not assessed in the study.

- Data timeliness

Timeliness of facility reporting is defined similarly: i.e. the proportion of reports received from health facilities by subnational administrative units before deadline. Timeliness of data was evaluated based on the facility reports generated and sent from MyChild Solution. In Afghanistan, timeliness of reporting was evaluated using Jalali calendar. The reports submitted by 5th of every month in Afghanistan were considered to be on time. The evaluation included the reports, which were sent between January 2017 and December 2017. In MCS, the date and time of the reports sent every month were tracked by the system. The system log was checked for reports sent in the timespan to identify on which dates they were sent.

Dimension 2. Internal consistency of reported data

(Coherence within the collected data)

This dimension examines the inherent coherence of the reported results based on the history of reporting of program indicators. Assessment of the reported indicators was done to find out if there was any unreasonable relation to other values. Within this dimension, the results of programme indicators were compared to other indicators with which they have a predictable relationship to determine whether the expected relationship exists between the two indicators.

In WHO toolkit, there are four metrics to determine internal consistency. Out of this four metrics, outliers and consistency over time were not included in the evaluation because timeframe of data was not enough to make the calculations (three-year data is required to check consistency over time). To check outliers, it is a requirement to have one-year data of all the facilities but MyChild solution was being implemented in whole Mehterlam District progressively over the year, hence the outliers were not included in the study. The remaining two metrics in this dimension were considered relevant for this assessment: Consistency between indicators and consistency between reported data and original records.

- Consistency between indicators is measured by looking at indicators with a predictable relationship, (e.g. DPT1 is always higher than DPT2 and DPT2 is always higher than DPT3), to determine if the anticipated relationship is held true.

- Consistency between reported data and original record was evaluated by comparing the information in the source documents from facilities (original document image) to the information in the electronic records. Thus, the source documents from the facilities which were reported by the health workers had been scanned and imported by the recognition software of MCS were compared to the digitalized data available in the electronic records. Only those records of the services that were administered during the visits, were included in the study.

To estimate the level of consistency between original document image of the smart paper forms and electronic data, 266 smart paper forms from Afghanistan were assessed and compared with the electronic data. Percentage of the mismatch was calculated to validate the consistency between them. Sample size was calculated with 5% margin of error and 90% confidence interval using online sample size calculator [1].

The documents were checked by comparing original images of scanned visit forms with the digitised health data captured in the system. Two of the researchers checked the original images of visit forms and compared them with the electronic data (Excel sheet). The number of children whose health data was not recognised correctly when compared to source documents from facilities were intended to be tracked. The number of children with correctly recognised health records were then compared to the total number of children included in the study to get the consistency rate.

Dimension 3. External consistency

(A contrast to other source of data such as surveys)

The purpose of this dimension is to evaluate the level of consistency between two sources of data measuring same health indicator. Usually the two sources of data are the data that are routinely collected and reported in HMIS system and the periodic surveys such as yearly Demographic Health Survey (DHS).

The level of consistency between the data generated through MyChild Solution and DHS report was evaluated by comparing MCS data on DPT coverage with provincial data from DHS report from 2015 in Afghanistan. The data collected between 22nd November 2017 to 19th February 2018, was set to be the time-frame of the segment of the study. During these three months all the district was covered by MCS. According to the WHO toolkit, the difference of coverage between two different data sources should not exceed 33% to be termed as consistent.

Dimension 4. External comparisons of population data

(Review of denominator data used to measure performance indicators)

To compare the results within or across geographical areas, over time, and between population subgroups, it is required to have a population census. This dimension could not be evaluated as there was no census in Afghanistan from the last 39 years. The last census conducted was in 1979 (1). Since the system was gradually implemented in the district, and some facilities only used the system for few months, the entire population of the district is not

[1] Raosot: http://www.raosoft.com/samplesize.html

yet registered into the system. Due to the aforementioned reasons, dimension 4 was not included in this assessment.

Assessment of data recording error

Even though data recording error was not included in the WHO data quality review toolkit, it was included in the study to estimate the data entry errors done by health workers using MCS. Rates of data recording errors could be used as an indicator of data accuracy to see resemblance of real world data with statistical data. Moreover, data entry errors rates can also be an indication how pragmatic the solution is for health workers to use in their everyday work. The incidence of data recording errors was defined as the proportion of data that was incorrectly entered on the visit forms in term of:

- *Same vaccine dose marked as administered more than one time to a child during two different visits*

The reason behind this error can be medical (a health worker administers a vaccine that was already administered before), or it can be due to a data entry error, where the vaccine is marked on the form but not administered. The incidences of single-dose Bacillus Calmette-Guérin (BCG) vaccine being marked as administered twice for the same child were investigated. As the vaccine leaves a visible scar on the arm, reducing the likelihood of it being administered twice. All children who received BCG between 1st January to 31st December 2017 were collected from MCS database, and vaccine information from all the visits during this time period was analysed to identify children who had been marked as having received BCG twice.

- *Two different doses of the same vaccine marked as administered to a child during the same visit*

To evaluate this data entry error, following cases were assessed:

- if the same child was marked as administered with DPT1 and DPT2 at the same visit
- if the same child was marked as administered with DPT1 and DPT3 at the same visit
- if the same child was marked as administered with DPT2 and DPT3 at the same visit

All children who received DPT doses between 1st January to 31st December 2017 were collected from MCS database, and vaccine information from all the visits during this time period was analysed to identify children who had been marked as having received different doses of the DPT marked as administered during the same visit.

Result

Dimension 1. Completeness and timeliness of data

- *Data completeness and timeliness of facility reporting*

Results of the assessment indicate that all monthly reports from the health centres using MyChild Solution were sent to the district headquarters at the end of the month. Hence, completeness of health facility reporting was 100%.
Timeliness of the reports from the January 2017 to December 2017 was 91.66%. As the dates used in Afghan administration was according to the Jalali calendar, the months were in fraction compared to the standard calendar. There was one report delayed for 1 day in the study. The study tried to determine the validity of the delay and apparently, it was due to interference in local capacity that caused the delay, which was resolved and the report was sent a day later.

- *Data completeness at a session level*

To assess the completeness *at a session level*, the EPI performance dashboard, an online platform describing all sessions held at all facilities in Mehterlam District (Laghman Province) was reviewed. Data obtained from the dashboard showed that reports from all the facilities were complete *(*Illustrated in *Table 1)*. To check session completeness, vaccination sites were divided into 3 categories i.e. static, outreach and mobile sessions. Data completeness was examined separately for each of the sites and sessions. During the review process, the sessions which were missed or cancelled with appropriate explanation were not considered as incomplete data. Data completeness in session level was 100% for the three months. The explanations such as unavailability of the clients, government holidays, difficult climate situation, unstable political situation etc. for the missed or cancelled sessions could be availed on the dashboard and considered.

Table 1. Data completeness at the session level

Month	Sessions scheduled to be held	Sessions held	Cancelled session(s) with proper explanation	Missing report
Static sessions				
November	172	159	13	0
December	208	199	9	0
January	216	210	6	0
Outreach sessions				
November	44	44	0	0
December	41	41	0	0

January	52	52	0	0
Mobile session				
November	59	46	13	0
December	49	47	2	0
January	39	39	0	0

- *Data completeness of indicator data*

  Monthly reports of MCS are automatically generated and contain all data elements required in the reports. The core indicators DPT1, DPT2 and DPT3 were reported in the subsequent months. The completeness for indicator data was 100% as well.

Dimension 2: Internal consistency

- *Consistency between indicators*

  The data was found to be consistent within the DPT vaccines. Administration of DPT1 was the highest, followed by DPT2 and DPT3 respectively. During the time period of 1st January 2017 to the 31st December the percentage of DPT1, DPT2 and DPT3 are shown in the *Table 2* below. The result is consistent with WHO DQR toolkit requirements (DPT1>DPT2>DPT3)

Table 2. Consistency between indicators

Vaccines	Number of administrations	Percentage (%)
DPT1	5180	17.65
DPT2	4723	16.10
DPT3	4573	15.59

- *Consistency between source documents from facilities and electronic data*

  The visit information from immunization sessions available in the electronic record was compared to the original document image containing details of 266 visits. We found no inconsistency between electronic record and checked original document image from MyChild Card. This resulted in data consistency rate of 100%.

Dimension 3: External consistency between data sources

Consistency between data sources was examined by comparing DPT1 and DPT3 coverage reported by MyChild Solution to coverages reported in the most recent Demographic and

Health Survey conducted in Afghanistan in 2015. Out of all children eligible for vaccination during the study period, DPT3 coverage was 58.6% in Laghman Province. The most recent national population-based data from DHS showed that DPT3 coverage was 58% when considering information based on vaccination card (8). DPT3 coverage measured with MyChild Solution, was 0.6% higher compared to DHS 2015 report, which is below the 33% threshold defined in the Data Quality Review toolkit, suggesting good external consistency.

Incidence of data recording error

- *Data recording error I - Proportion of children with the same dose of the same vaccine marked as administered during two different visits*

  Among 5981 observations, there were 103 cases where BCG was reported to be administered twice to the same children, which is 1.7% of total number of children immunized with BCG. This indicates 1.7% data recording error.

- *Data recording error II - Reported cases of children with different doses of the same vaccine administered during the same visit*

  There were 5 cases reported to be administered with both DPT1 and DPT2 in the same visit amongst the 9,903 observations (0.05%). Similarly, DPT3 and DPT1 were reported to be administered together in 5 cases (0.05%), and 5 cases for DPT2 and DPT3 (0.05%). Amongst these three interactions, one single observation was common where three doses of the DPT vaccines were reported to be administered at the same visit out of 14,476 visits (0.01%).

Evaluating the Efficiency at facility level

Specific Objective

1. What is the time required to perform the data administration with MCS and HMIS system at the facility level?
2. Are the findings consistent with Shifo's internal evaluation?

Method

Firstly, the study compared time spent on data administration at facility level between the current HMIS system and MyChild Solution to estimate the time efficiency. The time consumption was assessed from a pre/post intervention evaluation from local observation report by Swedish Committee for Afghanistan, which is the health service provider in Laghman Province. According to the time-motion observation results, the administrative tasks were observed during and after care delivery and the time spent per vaccination/care delivery session was captured. Each of the activities such as data administration during vaccination, time spent after the session, time to develop monthly report, counselling time etc. were timed and recorded. All the times were measured using a stopwatch, where *Time-and-motion* method was applied to quantifying the steps to sequence tasks and distribute time by the professionals. The methodology consisted of breaking down a process into its constituent tasks and observing and recording time for each task repeatedly. The study employed direct on-site observation using manual timing techniques, and observations were conducted until a 'saturation point' was reached in the study area of Mehterlam District. The observation guidelines were based on the work of Taylor-Powell and Steele (9), who recommend direct observation-based methods for researchers looking to compare the relative efficacy of different programs or interventions. The observations for the HMIS system (pre-intervention) were conducted from August 2016 to October 2016 and the observations for MCS (post-intervention) were conducted from January 2017 to February 2017.

Secondly, the cost-efficiency was calculated comparing the monetary values of the spent time in data administration in the different systems considering the current salary scale of the employed human resources in the EPI, which was incorporated in the cost analysis as well.

Lastly, the result was compared to the existing evaluation report "Improving Child Healthcare in Low-Resource Settings: A Pilot Study of MyChild System in Afghanistan" by Andersson et al. (6).

Result

Considering the Time-Efficiency in general, the MCS system was more efficient dominating in all the different stages. The average observation times in different stages are depicted in *Table 3*. Among those stages, the highest efficiency was shown in the data administration in the end of the month and in the end of the session which were reduced by around 96% and 93% respectively in the MCS system, compared to the HMIS. Additionally, there was an exclusive component in the HMIS system to make a follow up list. Due to the digital data alignment process in MCS system, there was no extra time required to make follow up lists there. Hence there was a 100% reduction of 1 hour 8 minutes spent every month in every facility.

Moreover, regarding the monetary value of efficiency, the cost was five times higher in HMIS system compared to the MCS system. Where in HMIS system the value of time spent in data administration was around 0.5 USD per child, and in MCS System it was 0.1 USD per child. This result was coherent to the findings by Anderson et al, and therefore, the consistency between the availed data and the existing report could be confirmed.

Table 3.The result from the collected observational study

Processes	Average time spent in existing HMIS system (Pre-intervention observation result)	Average time spent in MyChild Card system (Post-intervention Observation Result)	Potential time saved	Potential time saved %
Vaccinations for newborns/first visits	00:08:11	00:01:50	00:06:21 per child	77.6% reduction in time
Follow-up vaccinations	00:00:56	00:00:20	00:00:36 per child	64.3% reduction in time
Administration at the end of the day	00:12:49	00:00:52	00:11:57 per day	93.2% reduction in time
Creating follow-up list from Register of Child Immunisation	01:08:04	N/A (Automated)*	01:08:04 per month	
Reporting at the end of the month	08:16:23	00:21:13	07:55:10 per month	95.7% reduction in time

Analysis of Incremental Cost

Specific Objective

1. What is the variance in operational cost of MCS compared to the existing HMIS system?

Methods

MyChild Solution was found to be implemented by two separate methods in different countries. First one was MyChild Card, which relied on a home-based record, designed to be kept by families and used by health workers during child health service delivery, it is used to capture data about a child's health at the point of care using only one tool - MyChild Card - thus circumventing the need to record children's information in multiple forms such as registers, tally sheets etc.

The second one is MyChild Form, which is a facility-based record that is kept in the health facility and used by health workers during child health service delivery. MyChild Forms are used at the point of health service delivery to register individual clients, assign unique ID and record delivery of immunisation services.

An incremental cost analysis of the operational costs was carried out considering the My Child Card (intervention focusing on the home-based record), MyChild Form (intervention focusing on the facility-based records) and the existing HMIS system. Even though, MyChild Form system is not implemented in Afghanistan, the operational cost was assessed in the study to present the financial feasibility of both alternatives of MyChild Solution. The study adhered an 'ingredient' approach, where the total quantity of specific inputs was multiplied by the unit costs and presented separately to be represented in a transparent manner. The guideline suggested by Drummond et. al., 2005 was followed in the study (13). An average conversion rate between Afghani and United States Dollar (USD) in the year of 2017 obtained from OANDA was considered in the study[2].

The steps followed in the analysis are:

I. Determination of all relevant costs for the three alternatives: HMIS, MyChild Card and MyChild Form
II. Identification of relevant data sources
III. Measurement of unit costs with cumulative amount in relevant fields
IV. Valuation of costs
V. Sensitivity analysis

The analysis was from a healthcare perspective where only the mutually exclusive components of the cost among the solutions were included in the analysis. The incremental cost analysis was of the operational cost only, none of the initial instalment costs were

[2] www.oanda.com

considered in the evaluation. Operating costs for MyChild Solution were estimated based on data gathered from health facilities in Mehterlam District where MyChild Solution is used as primary data collection and reporting tool.

Considering the equipment cost, scanners were only needed in both of MyChild solutions (Cards and Forms), hence the maintenance and depreciation cost of scanners were included. The estimated useful life of seven years is applied for each scanner and the depreciation cost was calculated using the straight-line method over the estimated useful life of the equipment, where the expected value at the end of the useful life of the equipment was assumed to be zero. Moreover, at the facility level, health workers receive monthly SMS with performance indicators on their personal mobile phones; therefore, SMS charges were added.

Considering the printing cost, the cost of the existing HMIS system was assessed from the Ministry of Health (MoH) - provided purchase order, which was prepared by UNICEF at a national level. As MyChild Card (intervention focusing on the home-based record) is implemented in Afghanistan, the cost of MyChild Card was analysed in two different methods: according to the given quotation and estimation for mass production at a national level. As the quotation provided for MyChild Card was for a smaller amount in Mehterlam District and cost data for production at a national level could not be availed, an estimation of price reduction in mass production was adopted from the MCS intervention in Uganda and calculated separately to provide a bilinear angle of the context.

On the other hand, as the MyChild Form solution is not implemented in Afghanistan and a quotation could not be obtained, the cost estimation of MyChild Form solution was taken from the intervention in Uganda.

Regarding the value of the time spent in data administration, there was a monetary valuation conducted on the analysis of the efficiency gain section of the study. In the study, the analysis was presented from both of viewpoints: with and without considering the value of the time spent on data administration. Moreover, the salary of the vaccinator engaged in the immunization data administration was incorporated from the report of *National Salary Policy in BPHS programme 2016-2020 by the Ministry of Public Health of Afghanistan*. In the study, the monthly salary of the vaccinator was divided by monthly working hours of 208 (considering 6 working days per week and 8 working hours per day) to calculate the salary per hour and then deducted to calculate salary per minute to use in monetary valuation of time spent in the process of data administration at facility level.

The verification time was an exclusive component in both of MCS systems and hence included, where the system detects and sends unrecognizable data to a Verification Officer for review and correction. The time spent on verification was calculated by the system based on Verification Officer's login and logout time. The salary of the verification officer (Administrator) was obtained from the report of *National Salary Policy* in B*PHS programme 2016-2020* by the *Ministry of Public Health of Afghanistan.* In the study, the monthly salary of the administrator was divided by monthly working hours of 208 (considering 6 working days per week and 8 working hours per day) to calculate the salary per hour and then deducted to calculate the salary per minute to use in monetary valuation of time spent in the process of verification.

Regarding the units, a total number of children under 1 year was estimated by UNICEF provided rule of thumb (under 1year population is 4% of total population in a given year). The data regarding total population was taken from the most recent UN statistics and the number of health facilities was provided by national expanded program on immunization (EPI) team by the Ministry of Public Health. Most of Afghanistan-based cost data were availed from the The Swedish Committee for Afghanistan. The yearly growth of the national population was taken into consideration to estimate the cost saved in next 5 years which was based on the national growth rate of Afghanistan. Financial costs of MyChild Solution were extracted from the project accounts.

Sensitivity analysis

Finally, there was a sensitivity analysis conducted with annual discounting rates of 3% and 5%. As the report of National Salary Policy in BPHS programme 2016-2020 by the Ministry of Public Health of Afghanistan considered an inflation rate of 5%, an annual discounting rate of 5% was set as one of the ranges for sensitivity analysis. On the other hand, as project costs, number of operational costs derived from Sweden (e.g.: Maintenance and replacement of scanners) 3% discounting rate was set as another benchmark which is suggested by the guideline for health economic evaluation by The Dental and Pharmaceutical Benefits Agency, TLV, the central government agency of Sweden. The sensitivity analysis included in the table was done for an annual discounting of 3% and 5%.

Assumptions

The analysis adhered an assumption that the following specific aspects were following the same way in the different systems of HMIS and MCS:

- Delivering Smart Paper Forms from facility to district
- Storing paper Smart Paper Forms in district and facility
- Procurement and distribution processes of the paper forms
- Electricity, computer/laptop and internet access at provincial level
- Data storage and maintenance costs
- In the existing HMIS System, time spent on manually validating and entering aggregated monthly reports into national database were considered insignificant; therefore, those costs are not included in the calculations

Result

In total, annual incremental cost of the current HMIS, MyChild Card and MyChild Forms are respectively USD 873 253, USD 611 974 and USD 316 436 at a national level. Compared to the current HMIS system, these amounts are subjected to a potential 30% cost saving with MyChild Card and 64% with MyChild Form. In the contrary, excluding the value of time spent in data administration, the annual incremental cost of current HMIS is USD 195 581 where the cost with MyChild Card and MyChild Forms are respectively USD 501 622 and USD 206126. The annual incremental cost of operation with the 3 systems is depicted in *Table 4.* The shift from current HMIS to the MyChild Card amounts to a potential 156% increase in cost without considering the value of time spent in data administration. On the other hand, when moving from current HMIS to MyChild Form potential increase in cost is 5% without considering the value of time spent in data administration. The shifts within the systems are illustrated in Figure 1.

A summary of the finding from the incremental cost analysis is illustrated in *Table 5*, in addition to the detailed analysis of the cost components in the tables 6, 7, 8 and 9 where the basis of the estimations is mentioned accordingly. The incremental operational cost was the highest in the existing HMIS system cumulatively when the value of time was considered (0.63 USD per child), but in the contrary, excluding the valuation of time, HMIS system was subjected to the lowest expense amongst the three systems (0.141 USD per child). On the other hand, including the value of time, the lowest incremental cost was observed in the MyChild Form system (0.228 USD per child), depicted in table 6.

However, considering the value of time and discounting for mass production, MyChild Card system was in the second position. When the discounted rate for mass production was considered the incremental operating cost was decreased by 0.14 USD per child (Table 6).

Figure 1. Incremental cost of operations within different systems

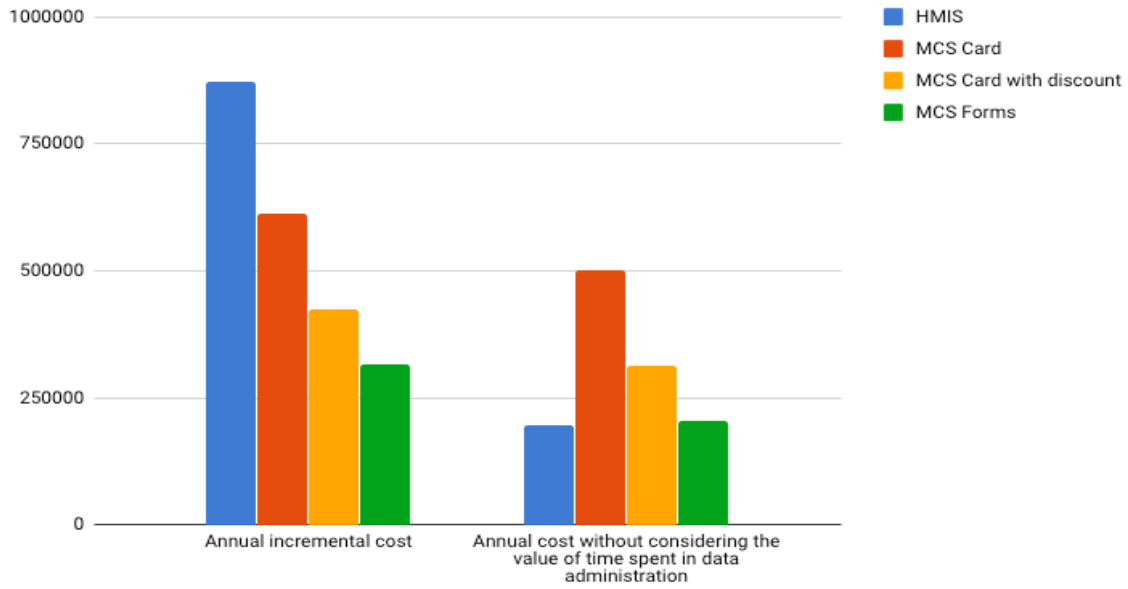

Table 5 Annual incremental cost of operation

	HMIS (USD)	MyChild Card (USD)	MyChild Card with discount (USD)	MyChild Forms (USD)
Annual incremental cost	873 253	611 974	423 968	316 436
Annual cost without considering the value of time spent in data administration	195 581	501 622	313 617	206 126
Annual Value of time spent in data administration per child	677 672	110 351	110 351	110 309

Table 6. Costs per beneficiary

	HMIS (USD)	MyChild Card (USD)	MyChild Card with discount (USD)	MyChild Forms (USD)
Total cost per child	0.630	0.441	0.306	0.228
Cost Per child without considering the value of time spent in data administration	0.141	0.362	0.226	0.149
Value of time spent in data administration per child	0.489	0.080	0.080	0.080

Table 7 Annual incremental cost of operations with HMIS system.

Expenses	Quantity	Unit Price in Afghani	Total cost in Afghani	Total cost in USD	Remarks
1. Birth Registration cards	415 872	1.5	6 238 080	93 721	The price for this form was not available, therefore it was estimated from the price of vaccination cards, as the paper qualities are homogeneous. Regarding the quantity, three copies of the card are needed to be filled per child: one copy is provided to the family, one copy is kept in the health facility, and another one is sent to the Bureau of Statistics.
2. Monthly vaccination report	2 338	300	701 400	10 538	There are 2338 health facilities that provide vaccination services and each facility needs one of these books annually. (Source: SCA)
3.Expanded Program on Immunization (EPI) register of child immunization	9 352	150	1 402 800	21 076	Four registers are required per facility per annum.
4. Vaccination and other supply request form	2 338	14	32 732	492	Required annual quantity per health facility is one. There are 2338 health facilities that provide vaccination services
5.Vaccination card	1 386240	2	2 772 480	41 654	Prices and quantity is provided by UNICEF, delivered to the authors by SCA. Nationally, 1 card is required for each child.
6. Daily tally sheet	9 352	200	1 870 400	28 101	Prices and quantity is provided by UNICEF, delivered to the authors by SCA. Quantity required during one year per health facility is four. There are 2 338 health facilities that provide vaccination services.
Value of time spent on administrative tasks during service delivery					
New born	1 386240	9.4	12 987 660	195 127	Salary of the vaccinator was based on the National Salary Policy Afghanistan, 2016-2020. Time spent by the vaccinator was obtained from efficiency study.
Follow up	5 544960	1.1	5 906 369	88 738	
Value of time spent on administrative tasks after service delivery					
Administrative tasks at the end of the day	549 889	14.7	8 072 175	121 277	Salary of the vaccinator was based on the National Salary Policy Afghanistan, 2016-2020. Time spent by the

Value of time spent on creating follow up list at the end of the month	28 056	78	2 188 326	32 877	vaccinator was obtained from efficiency study
Value of time spent on reporting at the end of month	28 056	568.6	15 951 323	239 653	
Total cost			58 123 746	873 253	
Cost per child			41.93	0.630	
Cost per child Without considering the value of time spent in data administration			9.391	0.141	
Value of time spent in data administration			32.538	0.489	

Table 8: Incremental operational Cost with MyChild cards

Expenses	Quantity	Unit Price in Afghani	Total cost in Afghani	Unit Price in USD	Total cost in USD	Remarks
1.MyChild Card	1386240	16	22 179 840	0.24	333 231	Population under one year is 1 386 240 children. Price quotes extracted from project cost, invoice paid by SCA.
2. Smart paper technology Engine operation and continuous development	1386240	6.66	9 226 813	0.1	138 624	Based on costs of operations in Uganda, Gambia and Afghanistan provided by Shifo.
3. Replacement of scanners	34	8 078.8	274 680	121.38	4 127	Depreciation cost calculated for 7 years period in Straight-line method

4. Maintenance of scanners	34	3 328	113 152	50	1 700	There are thirty-four provinces in Afghanistan (OCHA 2015); one scanning station is needed in every province. Scanner rollers are replaced on a yearly basis based on recommendations from the manufacturer.
5.Session Voucher	1010016	1	1 010 016	0.015	1 5175	Quantity per year considers that on average 36 vouchers are used per month per health facility, based on data from facilities in Mehterlam District.
6.Extra registration voucher	392 784	1	392 784	0.015	5 901	Quantity per year considers that on average 14 vouchers are used per month per health facility, based on data from facilities in Mehterlam District.
7.Extra visit voucher	28 056	1	28 056	0.015	422	Quantity per year considers that on average 1 voucher are used per month per health facility, based on data from facilities in Mehterlam District.
8.Key Performance Indicators sent by SMS to health workers	28 056	5.8	162 651	0.087	2 444	Key Performance Indicators are sent by SMS to health workers on monthly basis. Quantity of SMS is calculated based total number of facilities (2338 Health Facilities that provide vaccination services) and SMS is sent to 1 health workers from each facility (2338*12).
Value of time spent on administrative tasks during service delivery						
Newborn visit	1386240	2.10	2 905 552	0.031	43 653	The valuation of spent time in data administration during the session was based on the required time obtained from the efficiency study and salary of the vaccinator according to the salary scale for 2018, National Salary Policy Afghanistan, 2016-2020.
Follow up visit	5544960	0.38	2 095 808	0.006	31 488	
Value of time spent on administrative tasks during service delivery						
Administrative tasks at the end of the day	549889	0.99	541 643	0.015	8 138	Firstly, the valuation of spent time in data administrative task after the sessions at the facilities (both end of the session and end

Creating follow up list at the end of the month	0 (automated)		0		0	of the month) was based on the required time from the efficiency study and the salary of the vaccinators according to the salary scale for 2018, National Salary Policy Afghanistan, 2016-2020. Secondly, the valuation of spent time for verification was based on the verification time captured in the system and the salary of the Administrator according to the salary scale for 2018, National Salary Policy Afghanistan, 2016-2020.
Reporting at the end of month	28056.0	24.30	681 778	0.365	10 243	
Verification at the district level	6931200	0.16	1 120 195	0.002	16 830	
Total cost			40 732 969		611 974	
Cost per child			29.384		0.441	
Cost per child Without considering the value of time spent in data administration			24.085		0.362	
Value of spent time spent in data administration			5.298		0.080	

Table 9 Incremental operational cost of MyChild Card -with discounting for mass production

Expenses	Quantity	Unit Price in Afghani	Total cost in Afghani	Unit Price in USD	Total cost in USD	Remarks
1. MyChild card	1386240	7.52	10424525	0.113	156618	Population under one year is 1 386240 children. Price quotes extracted from project cost, invoice paid by SCA
2. Smart paper technology Engine operation and continuous development	1386240	6.66	9226813	0.100	138624	Based on costs of operations in Uganda, Gambia and Afghanistan provided by Shifo.

3. Replacement of scanners	34	8078.83	274680	121.38	4127	Depreciation cost calculated for 7year period in Straight-line method
4. Maintenance of scanners	34	3328.00	113152	50	1700	There are thirty-four provinces in Afghanistan (OCHA 2015); one scanning station is needed in every province. Scanner rollers are replaced on a yearly basis based on recommendations from the manufacturer.
5. Session Voucher	1010016	0.47	474708	0.007	7132	Quantity per year considers that on average 36 vouchers are used per month per health facility, based on data from facilities in Mehterlam District.
6. Extra registration voucher	392784	0.47	184608	0.007	2774	Quantity per year considers that on average 14 vouchers are used per month per health facility, based on data from facilities in Mehterlam District.
7. Extra visit voucher	28056	0.47	13186	0.007	198	Quantity per year considers that on average 1 voucher is used per month per health facility, based on data from facilities in Mehterlam District.
8. Key Performance Indicators sent by SMS to health workers	28056	5.80	162651	0.087	2444	Key Performance Indicators are sent by SMS to health workers on monthly basis. Quantity of SMS is calculated based total number of facilities (2338 Health Facilities that provide vaccination services) and SMS is sent to 1 health workers from each facility (2338*12).
Value of time spent on administrative tasks during service delivery						
Newborn visit	1386240	2.10	2905552	0.031	43653	The valuation of spent time in data administration during the session was based on the required time obtained from the efficiency study and salary of the vaccinator according to the salary scale for 2018, National Salary Policy Afghanistan, 2016-2020.
Follow up visit	5544960	0.38	2095808	0.006	31488	
Value of time spent on administrative tasks after service delivery						

Value of time spent on administrative tasks at the end of the day	549889.2	0.99	541643	0.015	8138	Firstly, the valuation off spent time in data administrative task at the facilities after the session (both end of the session and end of the month) was based on the required time from the efficiency study and the salary of the vaccinators according to the salary scale for 2018, National Salary Policy Afghanistan, 2016-2020. Secondly, the valuation of spent time for verification was based on the verification time captured in the system and the salary of the Administrator according to the salary scale for 2018, National Salary Policy Afghanistan, 2016-2020.
Value of time spent on creating follow up list at the end of the month (automated)	0		0		0	
Reporting at the end of month	28056	24.30	681778	0.365	10243	
Value of time spent on verification at the district/provincial level	6931200	0.16	1120195	0.002	16830	
Total			28 219 300		423 968	
Cost per child			20.357		0.306	
Cost per child Without considering the value of time spent in data administration			15.058		0.226	
value of time spent in data administration			5.298		0.080	

Table 10 Incremental operational Cost with MyChild Forms

Expenses	Quantity	Unit Price in Afghani	Total cost in Afghani	Unit Price in USD	Total cost in USD	Remarks
1. Shifo Child Health Form	659867	1.0	659867	0.016	10558	The required amount was calculated from the MyChild dashboard data, where 20% of the sessions in Mehterlam required 2 sheets and 80% of the session, given that one form can accommodate 50 visits. The price was taken from the quotation from Ugandan study as there was no quotation available from Afghanistan.
2. Shifo Birth Records	231040	1.8	406630	0.028	6469	On average, six observations can fit into one form and then, it was calculated in national level. The price was taken from the quotation from Ugandan study as there was no quotation available from Afghanistan.
3. Replacement of the scanners	34	8078.8	274680	121.4	4127	Depreciation cost calculated for 7year period in Straight-line method.
4. Maintenance of scanners	34	3510.0	119340	50	1700	There are thirty-four provinces in Afghanistan (OCHA 2015); one scanning station is needed in every province. Scanner rollers are replaced on a yearly basis based on recommendations from the manufacturer.
5. Shifo Birth Record Updates	30862	1.0	30862	0.016	494	On average 1. 1 MyChild Birth Records Update forms (one form includes 15 children per sheet) are used per month per health facility, based on data from facilities in Mehterlam District.
6. Vaccination card	1386240	2.0	2772480	0.030	41296	Prices and quantity is provided by UNICEF, delivered to the authors by SCA. Nationally, 1 card is required for each child.

7. Monthly Vaccine Management form	28056	1.0	28056	0.015	418	Quantity required during one year per health facility is one. There are 2338 health facilities that provide vaccination services.
8. Smart paper technology Engine and continuous operation	1386240	7.0	9717542	0.1	138624	Based on costs of operations in Uganda, Gambia and Afghanistan provided by Shifo.
9. Key Performance Indicators sent by SMS to health workers	28056	5.7974	162651	0.087	2441	Key Performance Indicators are sent by SMS to health workers on monthly basis. Quantity of SMS is calculated based total number of facilities (2338 Health Facilities that provide vaccination services) and SMS is sent to 1 health workers from each facility (2338*12).
Value of time spent on administrative tasks during service delivery						
Newborn visit	1386240.0	2.10	2905552	0.031	43653	The valuation of spent time in data administration during the session was based on the required time obtained from the efficiency study for MyChild Card solution and salary of the vaccinator according to the salary scale for 2018, National Salary Policy Afghanistan, 2016-2020.
Follow up visit	5544960.0	0.38	2095808	0.006	31488	
Value of time spent on administrative tasks after service delivery						
Value of time spent on administrative tasks at the end of the day	549889.2	0.99	541643	0.015	8138	Firstly, the valuation off spent time in data administrative task at the facilities after the session (both end of the session and end of the month) was based on the required time from the efficiency study and salary of the vaccinators according to the salary scale for 2018, National Salary Policy Afghanistan, 2016-2020. Secondly, the valuation of spent
Value of time spent on creating follow up list at the end of the month (automated)	0		-			

Value of time spent on reporting at the end of month	28056	24.20	678992	0.364	10201	time for verification was based on the verification time captured in the system and the salary of the Administrator, according to the salary- scale for 2018, National Salary Policy Afghanistan, 2016-2020.
Value of time spent on verification at the district/provincial level	6931200	0.16	1120195	0.002	16830	
Total			21 514 299		316 436	
Cost per child			15.044		0.228	
Cost per child Without considering the value of time spent in data administration			10.223		0.149	
Value of time spent in data administration			4.820		0.080	

Coherent to the findings, the study calculated the cost savings in 5 years. Like the previous segments, the estimated cost saving was from the two perspectives; with and without value of time spent in data administration. An annual growth of 2.7% was incorporated to the study (10). The detailed calculation of cost saving in 5 years with both MyChild Cards and MyChild Form system are depicted in *Table 11.* The comparisons were made in contrast to the existing HMIS system.

Considering the value of time spent in data administration in the calculation, around 2 938 543 USD was predicted to be saved with the MyChild Form system in 5 years. But when the value of time was not considered, HMIS system was subjected to save 55 650 USD compared to MyChild Form system in 5 years.

However, with the MyChild Card system, estimation of saving was around 1 378 875 USD compared to the HMIS system when the value of time was included. Additionally when discounting for mass production was considered, the saving increased by around 75% in that span of time and thus, subjected to 2 397 163 USD. On the other hand, excluding the valuation of time, around 1 615 098 USD was predicted to be lost compared to the HMIS system.

Finally, the additional sensitivity analysis depicts the saved amount in 5 years within the range of 3% to 5% rate of annual discounting. To exemplify the interpretation, the saving

with MCS form can be considered where present value of saving 2 938 543 USD in 5 years would range from 2 302 425 USD to 2 534 813 USD considering annual discounting.

Table 11 Cost saving in 5 years and sensitivity analysis

		Cost saving in MyChild Card system		Cost saving in MyChild Form system	
	Expected number of children aged below one	With the value of time spent in data administration	Without considering the value of time spent in data administration	With the value of time spent in data administration	Without considering the value of time spent in data administration
Cost saved in 1st year	1 368 240	261 280	- 306 041	556 818	- 10 545
Cost saved in 2nd Year	1 423 668	268 334	- 314 304	571 852	- 10 830
Cost saved in 3rd Year	1 462 108	275 579	- 322 791	587 292	- 11 122
Cost saved in 4th Year	1 501 584	283 019	- 331 506	603 149	- 11 423
Cost saved in 5th year	1 542 127	290 661	- 340 457	619 434	- 11 731
Total		1 378 875	- 1 615 098	2 938 543	- 55 650
Sensitivity analysis on the basis of annual discounting	**5%**	1 080 384	- 1 265 471	2 302 425	- 43 603
	3%	1 189 429	-1 393 197	2 534 813	- 48 004

Discussion

Reliable and quality data plays a key role to develop and maintain a sustainable immunization plan at the national level. The implementation and acceptance of immunization data depend on its quality and the cost to operate the data management method, which is facilitated by the efficiency of the system. Hence the study estimated and illustrated the findings from the three different perspectives of data quality, time-efficiency, and incremental cost.

In the study, it was observed that the data was collected, analyzed, stored and distributed in a systematic procedure, and the overall quality of data was high. Within the time frame of the evaluation, both metrics of data completeness and timeliness were high. In the second dimension, two metrics, namely: consistency between indicators i.e. relationship between DPT1, DPT2, DPT3 coverage and consistency between electronic data and scanned paper were evaluated. DPT1 coverage was higher than DPT2 and DPT2 coverage was higher than DPT3, which was consistent with WHO recommendation. Consistency between the electronic data and the scanned paper was 100%, which is remarkable, considering that the system is working in 141 health service delivery points, and almost all work processes are being handled by the existing health system structure. In case of external consistency, DPT3 coverage from the system data was 0.6% higher than DHS data, which was much lower than WHO prescribed acceptable limit (33%). Data recording error was minimal while evaluating; the two types of error are multiple doses of the same vaccine in same visit and the same dose of the same vaccine in two different visits.

From the overall result of cost-analysis, it could be ruled out that the value of time played a key role in the cost-analysis. Depending on its inclusion and exclusion, the whole status of the incremental cost of operations was altered. For instance, when the value of time spent in data administration was included, MyChild Form system was the most cost-efficient one where the HMIS system was found to be the most expensive. On the contrary, when the value of time was discarded, the HMIS system turned out to be the most cost-efficient. Even though, theoretically the value of time appeared to be the major contrast among the three system, what can be the added value of saving time, can be argued. It can be anticipated that, with a proper planning to utilize the saved time, the quality of the data can be improved and minimize different errors. Potentially, the saved time can give a room to the vaccinators to conduct effective counselling and group discussions to avert missed cases. Additionally, even without the value of time, the difference of cost between the MyChild Form and HMIS system was only 5%, compared to which, an efficient data management system resulting in quality data can be anticipated to worth more.

Strength and Limitation

1. *Triangulation of perspectives:* The evaluation design is comprised of three different perspectives of data quality, cost, and efficiency, is a strength of the study as it gives room to the stakeholders and readers to take an insight from different viewpoints. The significance of data quality, operational cost and efficiency complement one another and facilitates the validity of the study.

2. *Following the standard guidelines:* The data quality was assessed according to the WHO toolkit including an additional dimension; Health economic evaluation was guided by Drummond et.al. and the efficiency study was based on the observation conducted following the guideline by Taylor-Powell and Steele to represent the standard benchmark or threshold to the stakeholders.

3. "Reality-check" in cost analysis: Regarding the cost analysis, the study tried to include all the non-mutual operational cost, which were reassessed with the local correspondent of SCA to enhance the rationality of the findings.

4. Depreciation cost: The depreciation cost of the scanners was included, so the estimation could be applied beyond the timeframe of the study without adding any bulk amount for the replacement. According to the incorporated depreciation process, there will be enough amounts secured from the yearly expenses for the replacement of the scanners by the seventh year.

5. Yearly average conversion rate: To reduce the uncertainty of the conversion rate between Afghani rupees and USDs, an average yearly conversion rate (1st Jan 2017- 31st December 2017) was used.

However, due to lack of time and resources, there were a number of limitations of the study as well:

1. Inconsistency of time frame: Data completeness was checked for 3 months and there is a possibility that the result could be different if it was checked for a longer time. For external consistency, indicators were compared with DHS 2015, which is two years older than the research data.

2. Unevaluated metrics*:* Few metrics included in the WHO data quality review toolkit were not possible to include in this evaluation as described earlier (presence of outliers and external consistency in population data).

3. Recording error versus medical error: Incidence of data recording errors in the data can be due to recording errors on the part of the health worker (data entry errors) but they can also be due to medical errors, where an inappropriate vaccine was administered and accurately recorded in the forms. We defined 2 data errors that are most likely due to an error in entering the data rather than a medical error.

4. Considering the cost analysis, some of the estimations were made from different contexts (e.g.: the cost of MyChild forms from Uganda). Even more, there was a proportionate discounting on basis of quotations from Uganda included in the study while estimating the incremental cost of operation in MyChild Card systems where the price gets lower for printing in a larger amount. Theoretical background could not be found to address this issue hence the pattern of the quotation adhered. The legitimacy of the discounting for larger production can also be argued, as the larger production is associated with larger cost of transportation and logistics. But the authors presented the costs with and without discounting for mass production to show the perspectives.

5. Monetary value of data quality could not be included in the study due to lack of existing scientific work on it. If a value of utility of the immunization data could be validated like the other utilities in health economic studies, such as: QALY (Quality adjusted life years), DALY (Disability adjusted life years), disease burden or life satisfaction scales, a more directional recommendation could have been provided.

Recommendations

- In the study, it was evident that the MyChild Solution could minimize the time spent in every step of data administration. Moreover, with a verification process comprising of both digital and manual assessment, it has the potential to reduce the workload from the engaged professional and thus reflect in mitigating errors. A further qualitative study can be conducted in order to illustrate the experience of the professionals engaged in immunization process and explore the contrast in both systems. From the perspectives of the vaccinator, mothers, and stakeholders, a social pathway can be explored for the highest utilization of the time and result in expanding the coverage in an efficient way.

- Due to the fact that MCS is operating in Mehterlam District for less than 2 years, the current study could not capture a number of metrics, such as consistency over time, outliers for internal consistency and the external consistency in population data. Once it would be possible to avail this data, further study should be conducted.
- Additionally, a health economic evaluation can be conducted with a probabilistic Markov model to estimate the cost-effectiveness among the three systems and predict the cost saving in a meticulous way where the uncertainties can be addressed as well. The evaluation can then predict the cost per case averted in the different systems and can estimate the savings in the long run. Furthermore, the contribution of counselling in the saved time can be also incorporated there.
- Quotations for the required amount of printing should be availed from the local settings to increase the validity of the further study.

To sum up, MyChild Forms were subjected to the highest cost savings with inclusion of value of time; even without considering the value of time, the difference of the prices between the forms and the HMIS system is 0.008 USD per child (around 5%), Significantly, the saved time in the intervention is also an asset to the settings as the number of the health workers is scarce. Hence, there is a possibility that the health workers would be able to serve more children in the given time with the MyChild Forms. Overall, considering the data quality, incremental cost and efficiency in MyChild solution, mitigating the data administration time and hurdles during service delivery with sustained standard quality of data from WHO parameters, MyChild Form system can be recommended to be scaled up in provincial level with proper planning of utilizing the time saved to increase coverage.

Since a number of studies determined the lack of knowledge and community engagement as a hindrance to immunization coverage and narrated the importance to address this with target interventions and counselling, the saved time in MyChild Form can be utilized with a target intervention to engage the communities more, it can facilitate the immunization coverage in Afghanistan (11) (12).

Followed by the implication, a further evaluation can be conducted to assess the pragmatics in the regional/sub-national level and evaluate the possibility to scale up at a national level.

Reference

1. Afghanistan Population 2018 (Demographics, Maps, Graphs) [Internet]. [cited 2018 May 20]. Available from: http://worldpopulationreview.com/countries/afghanistan-population/

2. Grevendonk J & Wilson K (2013). A case for better immunization information systems http://bit.ly/ 2d78HrN

3. O'Connor Y et al. (2016). Stakeholders perspectives on paper-based and electronic clinical decision support systems in Malawi Africa. June http://www.tandfonline.com/doi/pdf/10.1080/12460125.2016.1187400

4. Frøen JF et al. (2016). eRegistries: electronic registries for maternal and child health. BMC Pregnancy and Childbirth 16:11 Jan 2016 http://www.ncbi.nlm.nih.gov/pmc/articles/PMC4721069/

5. Cline GB & Luiz JM (2013). Information technology systems in public sector health facilities in developing countries: the case of South Africa. Jan http://bmcmedinformdecismak.biomedcentral.com/articles/ 10.1186/1472-6947-13-13

6. Anderson T et.al , Improving Child Healthcare in Low Resource Settings: A Pilot Study of MyChild Solution in Afghanistan Glance [Internet]. [cited 2018 May 20]. Available from: https://shifo.org/doc/MyChildEfficiencyEvaluationAfghanistan.pdf/

7. Ministry of Public Health Afghanistan, Health in a Glance [Internet]. [cited 2018 May 20]. Available from: http:// moph.gov.af/Content/Media/Documents Healthinaglance96201716121427553325325.pdf

8. Central Statistics Organization/Afghanistan, Ministry of Public Health/Afghanistan, and ICF. 2017. Afghanistan Demographic and Health Survey 2015. Kabul, Afghanistan: Central Statistics Organization. Available FROM http://dhsprogram.com/pubs/pdf/FR323/FR323.pdf.

9. Ellen Taylor-Powell, Collecting Evaluation Data: Direct Observation [Internet]. [cited 2018 May 20]. Available from : http://learningstore.uwex.edu/assets/pdfs/g3658-5.pdf

10. Afghanistan Population growth rate, 1960-2017 - knoema.com [Internet]. Knoema. [cited 2018 Jun 14]. Available from: https://knoema.com//atlas/Afghanistan/Population-growth-rate

11. International Initiative for Impact Evaluation (3ie), Sabarwal S, Bhatia R, Dhody B, et al. Engaging communities for increasing immunisation coverage: what do we know? [Internet]. International Initiative for Impact Evaluation (3ie); 2016 Dec [cited 2018 Jun 11]. Available from: http://www.3ieimpact.org/en/publications/3ie-scoping-paper-series/3ie-scoping-paper-3/

12. Gupta P, Prakash D, Srivastava JP. Determinants of immunization coverage in lucknow district. North Am J Med Sci. 2015 Feb;7(2):36–40.

13. Drummond, M., Sculpher, M., Claxton, K., Stoddart, G., & Torrance, G. (2015). *Methods for the economic evaluation of health care programmes* (Fourth edition / Michael F. Drummond, Mark J. Sculpher, Karl Claxton, Greg Stoddart, George W. Torrance. ed.). Oxford: Oxford University Press.