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DATA FOR HEALTH INITIATIVE

CRVS analyses and evaluations

CRVS innovations: Assessing the performance of CRVS systems

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These resources outline the context, training approach, course content and course objectives for the suite of CRVS trainings delivered through the Bloomberg Philanthropies Data for Health Initiative. Each course focuses on a specific CRVS intervention or concept, and is designed to support countries to strengthen their CRVS systems and data.

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The CRVS Fellowship Program aims to build technical capacity in both individuals and institutions to enhance the quality, sustainability and health policy utility of CRVS systems in Fellows' home countries. *Fellowship reports* are written by Fellows as a component of the program, and document, in detail, the research outcomes of their Fellowship. *Fellowship profiles* provide a summary of Fellows' country context in relation to CRVS, an overview of the Fellowship experiences, the research topic and the projected impact of findings.

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These analytical and evaluative resources, generated through the Initiative, form a concise and accessible knowledge-base of outcomes and lessons learnt from CRVS initiatives and interventions. They report on works in progress, particularly for large or complex technical initiatives, and on specific components of projects that may be of more immediate relevance to stakeholders. These resources have a strong empirical focus, and are intended to provide evidence to assist planning and monitoring of in-country CRVS technical initiatives and other projects

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Generated through the Initiative, CRVS best-practice and advocacy resources are based on a combination of technical knowledge, country experiences and scientific literature. These resources are intended to stimulate debate and ideas for in-country CRVS policy, planning, and capacity building, and promote the adoption of best-practice to strengthen CRVS systems worldwide.

CRVS country reports
CRVS country reports describe the capacity-building experiences and successes of strengthening CRVS systems in partner countries. These resources describe the state of CRVS systems-improvement and lessons learnt, and provide a baseline for comparison over time and between countries.

CRVS technical guides
Specific, technical and instructive resources in the form of *quick reference guides, user guides* and *action guides*. These guides provide a succinct overview and/or instructions for the implementation or operation of a specific CRVS-related intervention or tool.

CRVS tools
Interactive and practical resources designed to influence and align CRVS processes with established international or best-practice standards. These resources, which are used extensively in the Initiative's training courses, aim to change practice and ensure countries benefit from such changes by developing critical CRVS capacity among technical officers and ministries.

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Contents

Acronyms

BPI	Business Process Improvement
BPM	Business Process Management
CDR	Crude Death Rate
COD	Cause of Death
CR	Civil Registration
CRO	Civil Registration Office
CRVS	Civil Registration and Vital Statistics
CSMR	Cause-Specific Mortality Rates
D4H	Data for Health Initiative
EA	Enterprise Architecture
FTE	Full-Time Equivalent
HMN	Health Metrics Network
ICD	International Classification of Diseases
ID	Identity
IT	Information and Technology
KPI	Key Performance Indicators
LMIC	Low and Middle-Income Countries
MCCD	Medical Certificate of Cause of Death
PI	Performance Indicator
PPT	PowerPoint
SDG	Sustainable Development Goals
SwissTPH	Swiss Tropical and Public Health Institute
UoM	University of Melbourne
VA	Verbal Autopsy
VE	Vital Event
VS	Vital Statistics
WG	Working Group

Assessing the performance of CRVS systems

This paper describes the CRVS performance assessment toolkit that has been developed as part of the Bloomberg Philanthropies Data for Health (D4H) Initiative by the Swiss Tropical and Public Health Institute and funded by the University of Melbourne. This innovation project provides an approach supported by a set of tools **to assess the performance of CRVS system processes in low- to middle-income countries**. Having a strong monitoring system is essential for any program to function. As CRVS system strengthening initiatives take shape, there is an increasing need for a robust methodology to measure and monitor progress in data quality improvements in vital statistics at the national and even subnational levels.

There are several factors to consider when developing monitoring tools and approaches for complex adaptive systems as CRVS systems. Firstly, the monitoring framework must be able to capture their complexity and identify appropriate metrics that can be used routinely to assess their performance. Secondly, the tools must be flexible enough to accommodate multiple operational arrangements in different settings (eg the framework must be useful in paper-based as well as digital systems). Finally, the framework must cover all the requirements for a robust monitoring framework including a clear design and rationale, data collection tools, approaches for the data analysis and visualizations.

With this in mind, the **CRVS Performance Metrics Toolkit** was developed. It covers the essential requirements for any monitoring framework (essential performance indicators, data collection tools, approaches to data analysis and visualizations) as well as supporting documents to help users with usage of the different tools. It has been developed in a way that can be used by countries with paper-based, electronic or mixed systems. The tools can be used to routinely review their operations and adjust them to improve their results or increase their efficiency. Countries may also be able to model the results of different interventions or implementation scenarios without having to pilot them in real life.

Elements of current systems that pose a challenge to measure the performance of CRVS processes were identified during the application of these tools in three pilot countries. First, the fact that in all three countries there was no method to uniquely identify each vital event (birth or death) across different systems, made it impossible to follow vital events through the 10 CRVS milestones from notification to dissemination of vital statistics. Another difficulty faced during the pilot was the coexistence of several sub-systems collecting information about vital events (usually as a result of donor-driven projects). Finally, the process of gathering information using the process maps to understand where the information was supposed to be recorded exposed several bottlenecks and problems in the design of the countries' information systems. The level of detail required to construct the CRVS performance indicators described in this package also enabled a greater understanding of the current processes in the system.

Introduction

The benefits of a robust and reliable CRVS system are well documented.[1,2] In addition to providing the best feeder document to establish unique identity at birth (birth certificate),[3] CRVS systems are the best source of vital statistics in a country.[4,5] CRVS systems provide a reliable, continuous and universal flow of information about vital events that can be disaggregated to produce estimates at the local level. Indeed, 67 of the 232 indicators to monitor Sustainable Development Goals (SDG) can be effectively measured with a functioning CRVS system.[6]

Despite the fact that all CRVS systems have the same output objectives, each country's system has moved along different paths with differing approaches to governance and policies, and differing accountability to multiple ministries such as justice, security, local government and health. Countries also vary in their CRVS organization, implementation, processes, scale, partners, and capacities. All CRVS systems are part of larger political, economic, social, health, and information systems, but nested within these larger systems are sub-systems concerned with, for example, legal identity, civil registries, vital statistics, information technologies, etc. As a consequence of this organizational structure, the overall performance of the CRVS system depends on the smooth integration and coordination of the activities in different sub-systems and requires all of them to perform adequately.

During the first phase of the Bloomberg Data for Health (D4H) Initiative, there have been substantial efforts to understand how CRVS systems operate, the stakeholders involved and how they are connected (or not) to each other. By using an adaptation of enterprise architecture methodology (business process management [BPM]), CRVS stakeholders in countries included in the D4H initiative have been able to understand and intervene in their CRVS processes with a systems approach.[7]

The application of these tools and approaches have led to a radical redesign of CRVS processes in some countries (e.g.redesign of the notification sub-process in Ghana) and to better coordination among national and local CRVS stakeholders.

At the global level, developing and analysing CRVS process maps has led to informed and structured discussions of the activities and operational procedures required for the system to function effectively. This brought about the concept of Ten CRVS Process Milestones. Each milestone represents the output or product of a number of activities that are logically grouped together and encapsulate a set of requirements that every CRVS system should fulfil (**Figure 1**).[8]

Currently, most D4H countries have covered the first phase of their CRVS system analysis. Each country developed a visual description of their core CRVS processes using business process mapping notation (BPMN) 2.0 and partially captured information flows within those processes. The next step in the business process improvement (BPI) cycle would be to analyse the current CRVS processes and find ways to improve them.

As CRVS system strengthening initiatives take shape, there is an increasing need for robust methodology to measure and monitor progress in data quality improvements in vital statistics at national and even subnational levels. Having a strong monitoring system is essential for any program to function. Although indicators and monitoring tools to assess the performance of CRVS have been partially described elsewhere,[5,8,9] to our knowledge this is the first attempt to develop a process monitoring framework for CRVS systems that would capture the progress towards achieving the goals of the system. **We thus aimed with this innovation project to develop tools to analyse and model the performance of CRVS system processes (performance metrics)**.

1 AbouZahr C, de Savigny D, Mikkelsen L, Setel PW, Lozano R, Lopez AD: Towards universal civil registration and vital statistics systems: the time is now. The Lancet 2015, 386(10001):1407-1418.

2 Schmider A: Advocating for civil registration: guide to developing a business case for civil registration. In. Herston: The University of Queensland; 2010.

3 Dunning C, Gelb A, Raghavan S: Birth Registration, Legal Identity, and the Post-2015 Agenda. In. Washington: Center for Global Development; 2014.

4 AbouZahr C, de Savigny D, Mikkelsen L, Setel PW, Lozano R, Nichols E, Notzon F, Lopez AD: Civil registration and vital statistics: progress in the data revolution for counting and accountability. The Lancet 2015, 386(10001):1373-1385.

5 Department of Economic and Social Affairs: Principles and Recommendations for a Vital Statistics System, vol. 19/3. New York: United Nations; 2014.

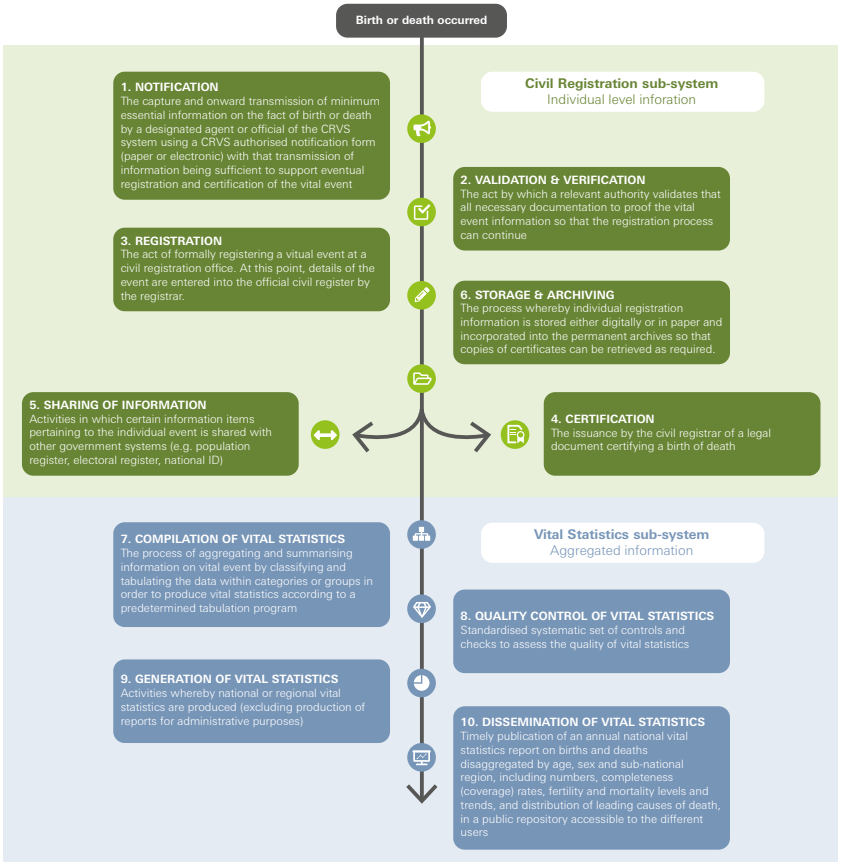
6 Mills S, Abouzahr C, Kim J, Rassekh BM, Sarpong D: Civil Registration and Vital Statistics (CRVS) for monitoring the Sustainable Development Goals (SDGs). In.: The World Bank; 2017.

7 de Savigny D, Cobos Muñoz D. Understanding CRVS systems: The importance of process mapping. CRVS development series. Melbourne, Australia: Bloomberg Philanthropies Data for Health Initiative, Civil Registration and Vital Statistics Improvement, the University of Melbourne; 2018.

8 Cobos Munoz D, Abouzahr C, de Savigny D: The 'Ten CRVS Milestones' framework for understanding Civil Registration and Vital Statistics systems. BMJ Glob Health 2018, 3(2):e000673.

9 United Nations: Handbook on Civil Registration and Vital Statistics System: Management, Operation and Maintenance, Revision 1. In. Edited by Mrkic S, Cobos MI, vol. 3rd Draft. New York: United Nations Statistics Division; 2017.

Figure 1 The 10 CRVS Milestones framework



We present in this document the different tools developed and their applications in three D4H countries (countries have been anonymized as per country request). The different tools have been developed in a way that can be used by countries with paper based, electronic or mixed systems. They can use the tools to routinely review their operations and adjust them to improve their results or increase their efficiency. Countries should also be able to model the results of different interventions or implementation scenarios without having to pilot them in real life.

Objectives

1. To define a set of metrics and modeling that could be used to analyse the performance of CRVS processes and to inform decisions in process reengineering activities;
2. To conduct a comparative analysis of different performance metrics of four CRVS core processes (birth and death in a health facility and in the community) in three countries;
3. To develop guidance to systematically and routinely assess the performance of CRVS processes in D4H countries that will help CRVS stakeholders identify bottlenecks, inefficiencies or data quality failure points in the system;
4. To provide standardized tools and visualizations to graphically show design flaws in CRVS processes, information flows and requirements of the system.

Methods

Overall methodological approach

There are several factors to consider when developing monitoring tools and approaches for complex adaptive systems as CRVS systems. Firstly, the monitoring framework must be able to capture the complexity of the CRVS system and identify appropriate metrics that can be used routinely to assess performance. Secondly, the tools must be flexible enough to accommodate multiple operational arrangements in different settings (i.e. the framework must be useful in paper-based systems as well as digital systems). Finally, the framework must cover all the requirements for a robust monitoring framework including a clear design and rationale, data collection tools, approaches for the data analysis and visualizations.

The set of tools and approaches developed under this project meet those demands and are ready for country use. The backbone of indicator selection, the data collection tool, and the visualizations are the "Ten CRVS Milestones"[8] and the As-Is process maps developed. They provide a comprehensive and systematic path to analyse and understand the performance of CRVS systems.

Several tools have been developed to measure the performance of CRVS systems (**Box 1**). They cover the essential requirements for any monitoring framework (indicators, data collection tools, approaches to data analysis and visualizations) as well as supporting documents to help users with the usage of the different tools.

Box 1: Tools in the CRVS performance toolkit

1. CRVS performance indicators description
2. CRVS performance indicators data collection tool
3. User guide for the data collection tool
4. Data source matrix template
5. Course prospectus, basic slides and agenda for training
6. Process maps in Bizagi ready to model different scenarios
7. Template for a CRVS performance dashboard using Power BI

Briefly, for the development of the different tools we first reviewed the existing knowledge and literature (including CRVS strategic plan of the countries) to develop an initial draft of the tools. We then tested the tools' feasibility and appropriateness for CRVS systems in three D4H countries located in Asia, Africa and Latin America. In an iterative process and based on feedback and experience from the three countries, we developed the tools further to produce a standardized approach for measuring the visualizing the performance of CRVS systems.

CRVS performance indicators selection

A comprehensive list of the essential performance indicators (PIs) was identified to be able to analyse the performance of CRVS processes and to inform decisions in process re-engineering activities (objective 1). A performance indicator is an agreed indicator used to determine progress made, or the lack thereof, towards achieving a given objective. A set of performance indicators used to assess the overall performance of a given system is defined as CRVS performance framework.

According to previous literature, a high-quality performance indicator should fulfil the 10 characteristics shown in **Table 1**:[10,11]

10 Institute of Medicine: Selecting Measures for the National Health Care Quality Data Set. In: Envisioning the National Health Care Quality Report. edn. Edited by Hurtado PM, Swift EK, Corrigan JM. Washington (DC): National Academies Press (US); 2001.

11 Brown D: Good Practice Guidelines for Indicator Development and Reporting. In: Third World Forum on 'Statistics, Knowledge and Policy'. Busan, Korea; 2009.

Table 1. Characteristics of high-quality performance indicators

Priority	Characteristic	Description
1	**Relevant**	The indicator is a relevant/important aspect for measuring the performance of the CRVS system.
2	**Accurate** (specific)	The indicator measures what it is supposed to measure and there is a clear link between the indicator and what ought to be measured.
3	**Reliable** and replicable	The indicator should produce the same results when repeated in the same population and setting.
4	**Sensitive**	The indicator should be responsive to changes in the underlying phenomenon.
5	**Meaningful**	The indicator should be understandable to at least one of the audiences and help inform them about important issues or concerns.
6	**Measurable**	The indicator can be measured, has a unit of measure, and the source document/ person exists.
7	**Trackable**	Data required for the indicator can be measured consistently over several years.
8	**Feasible**	Data required for the indicator can be collected relatively easy, on a timely basis and at a reasonable cost given a limited amount of time and resources.
9	**Ability to be disaggregated**	The indicator can be broken down into population sub-groups or areas of particular interest, such as ethnic groups or regional areas.
10	**Sufficient**	The set of indicators is sufficient to measure the intended changes/milestone.

There were two dimensions that were considered when identifying the list of core indicators. First, the list should be able to provide meaningful and actionable information about the Ten CRVS Milestones from the notification step to the dissemination of the vital statistics. Second, four domains were identified to show the different elements of the system to be assessed:

1. **Quantity** – Indicators measuring quantity give an idea about the coverage or the coverage of a certain CRVS milestone (e.g. completeness of birth registration)
2. **Time** – Indicators measuring time provide information about how long it takes to accomplish a certain CRVS milestone on average. They also allow analysis of whether a given milestone has been accomplished on-time or not, depending on the country's specific regulations (eg average number of days between the date of birth and the date of notification of the birth)
3. **Quality** – Indicators measuring quality look at whether a CRVS milestone has been accomplished in good quality. Quality standards might be imposed from the regulating framework of the CRVS system or they are devised internally (e.g. client satisfaction, consistency of databases or quality of storage of vital records)
4. **Cost** – Indicators measuring cost will provide information to assess the resources required to achieve certain milestone. This domain has a specific set of tools.[12]

It must be emphasized that these indicators are not meant to be related to the production of VS, they are rather process statistics and meant as an aid in the management of civil registration systems. For this reason, they have also been harmonized with the United Nation Statistics Division Handbook.[9] A separate document presents a clear description of the generic indicators that could be used as metrics to assess CRVS process performance (also described in the **Annex**).[13] It also describes the data required, the method of measurement or potential approximations as well as the data sources and alternatives if these sources are not available.

12 Swiss Tropical and Public Health Institute and the University of Melbourne. CRVS Costing Tool. . CRVS resources and tools. Melbourne, Australia: Bloomberg Philanthropies Data for Health Initiative, Civil Registration and Vital Statistics Improvement, the University of Melbourne; 2019.

13 Cobos Muñoz D, Sant C, Renggli S, de Savigny D. CRVS performance metrics: Indicator guideline (V1.7). CRVS resources and tools. Melbourne, Australia: Bloomberg Philanthropies Data for Health Initiative, Civil Registration and Vital Statistics Improvement, the University of Melbourne; 2019.

Data collection tool

A data collection tool based on Microsoft Excel© has been developed to support the collection of all the information required to calculate the core CRVS performance indicators. The complexity and diversity of CRVS systems, and the involvement of multiple stakeholders, requires a data collection tool which facilitates data collection in a consolidated and systematic way. At the same time, the tool should be adaptive enough to be applicable in different contexts and used as a standardized tool across several countries. We also created a data collection tool user guide to accompany the tool.

The experiences in the three pilot countries revealed that the tool should have specific characteristics to fulfil a number of requirements (**Annex**). The data collection tool uses macros and hyperlinks to facilitate the navigation throughout the different sections. In its current version the tool consists of 13 sections (**Annex**). Further details regarding the data collection tool can be found in the data collection tool user guide.[14]

CRVS dashboard & visualizations

In addition to using a generic data collection tool, a standardized visualization tool to graphically display the CRVS performance assessment results was developed. The visualization tool should be suitable for the dissemination of key results. It should expose to CRVS stakeholders the problems in the design of CRVS processes and help them to identify bottlenecks, inefficiencies or data quality failures in the system.

We have developed two different tools: CRVS performance dashboards in Microsoft Power BI® and "live" CRVS process maps with Bizagi. A dashboard is "a visual display of the most important information needed to achieve one or more objectives, consolidated and arranged on a single screen so the information can be monitored at a glance".[15] In addition, dashboards should present information using small, concise, direct and clear display media.[16] Based on the needs identified, we aimed to ensure that the dashboards allow for the following:[17,18]

- Sharing of insights with all stakeholders involved
- Imparting information quickly
- Identifying of trends, inefficiencies and outliers
- Enabling an understanding of the current situation and next steps, "connecting the dots"
- Informed decision making and aligning strategies and overall goal
- Making important insights memorable
- Gaining the stakeholders' interest and commitment
- Exposing information gaps in the system.

Guided by these requirements and the characteristics, we developed a standardized visualization tool for application across several countries in Power BI®. The tool is based on the list of identified performance indicators and the data collection tool, both described elsewhere.[19] In its current version the visualization tool consists of six dashboards, one general dashboard and one for each performance domain. The specific characteristics of each dashboard can be seen in the **Annex**.

In addition to the standardized visualization tool, we also continued working with Bizagi Modeller to model the performance of the system. Bizagi Modeller allows for simulations of processes, which can easily visualize flows and losses through the system. Furthermore, since flows at each milestone constitute conditional probabilities, it is also possible to model the expected effects of different combinations of interventions across the milestones. To start using simulation in Bizagi a validated process map is required. Bizagi also needs information regarding:

- Input quantity (e.g. number of vital events occurring) and the conditional probabilities at each decision point
- Time needed for an activity
- Resources required for an activity.

These inputs are not interdependent, but if incorporated, they add more complexity and provide a coherent analysis of the processes.

Further details regarding the simulations in Bizagi Modeller can be found in the Bizagi Modeller user guide, which includes a step-by-step guide to get to the simulation with screen shots and some information about nomenclature used.

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14 Cobos Muñoz D, Sant C, Renggli S, de Savigny D. CRVS performance metrics: User guide. CRVS resources and tools. Melbourne, Australia: Bloomberg Philanthropies Data for Health Initiative, Civil Registration and Vital Statistics Improvement, the University of Melbourne; 2019.

15 Few S: Dashboard Confusion. Intelligent Enterprise 2004.

16 Few S: Information Dashboard Desig: Display data for at-a-glance monitoring, 2nd edn. Burlingame, California: Analytics Press; 2013.

17 The Kini Group. 'The importance of data visualization in your business and 10 ways to pull it off easily.' Available at https://thekinigroup.com/importance-data-visualization/

18 Kerzner H: Project Management: Metrics, KPIs, and Dashboards, 3rd edn. Hoboken, New Jersey: John Wiley & Sons.

19 Available at https://crvsgateway.info/CRVS-performance-metrics-data-collection-tool~3081

Preliminary results of the pilot

The following section describes some of the results of the pilots during which we tested the tools' feasibility and appropriateness for CRVS systems. The three countries were selected to pilot the tools in very different settings and across all three continents in which the D4H initiative is working. Also, the selected countries themselves indicated interest to test such tools to better understand the performance of their CRVS systems. The three countries were visited in the order listed here.

The main objective of this innovation project was to develop a series of tools that will help countries assess the performance of their CRVS system processes on a routine basis. The development of these tools was an iterative process and each tool evolved tremendously during and after their pilot in countries. Some of the tools were not even envisioned when this project started (e.g. data source matrix) and they were developed to meet some of the requirements of the three countries.

When presenting the results of the pilots, we have excluded those visualizations that could identify the countries. This includes the maps showing geographical differences in some of the indicators calculated.

Country 1 – The importance of notification

One of the main outputs and most essential measures of the performance of CRVS systems is the number of vital events that flow throughout the system from their occurrence to their inclusion in the vital statistics. Countries usually have the starting point (number of expected births or deaths in a specific region in one year) and the final step (e.g. proportion of vital event included in the vital statistics) to monitor the performance of their system. However, this only provides information about the overall performance of the system but not about any problems or bottlenecks. The CRVS performance dashboards in this CRVS performance assessment toolkit provide the detail of where and when vital events do not progress to the next step in the process, and will help countries with parts of their system that require specific attention (or resources).

The analysis of the information collected in Country 1 provides interesting insights on the usefulness of this performance domain (Quantity). An estimated total number of deaths of 227,230 in the year 2016 were expected by the CRVS system in the country.

However, only 18 per cent of those deaths (39,841 deaths) were captured in the national statistics of the country (death registration completeness).

If analysed with a health systems lens, there could be a number of bottlenecks in the system that could produce this same result. The funnel plot in **Figure 2** and **Figure 3** clearly shows the biggest reduction on the number of deaths transmitted to the next step is before the notification step (from 227,230 deaths expected to 33,368 deaths notified). The health sector recorded those 33,368 deaths in health facilities, which represented 15 per cent of the total number of deaths expected in the country.

There are three main messages in those figures. First, there is a significant number of deaths (most probably) occurring in the community that are invisible to the system. Second, the great majority of the deaths occurred in the country were not reported to the CRVS system in any way. The very first CRVS milestone (notification) which is the gateway to rest of the registration process, was not fulfilled. On the other hand, it seems that those deaths that are notified and fulfil the notification milestone the system manages to translate the great majority of those into civil registrations and are compiled at the national level.

The analysis of the quantity domain in Country 1 should lead to a drastic redesign of the notification step in the country in order to increase the completeness of the estimates at the national level. However, the distribution of death registration completeness was unequal across regions in Country 1 with lowest registration coverage in the north of the country. The highest registration completeness among the different sub-national levels was 29 per cent and the lowest was 3 per cent. These differences should be taken into account when re-designing the CRVS processes to accommodate different factors that could be hindering death registration completeness.

On average, 933 days were required to implement the entire process from the occurrence of the vital event until the generation of the vital statistics (**Figure 4**). This corresponds to 92 days for civil registration activities (notification to storage) and 841 for vital statistics activities (compilation to generation).

The distribution of the number of days from the date a vital event occurred until the collection of the death certificate by the family varied widely across regions. Even though 92 days could be considered high for death registration activities (death registration must be obtained before burial which happen a few days after the event),

the bulk of the delay in producing the vital statistics is related to the processes at the national level to compile, analyse and generate the final estimates.

Country 1 was the only country where the data collection team could assess the quality of the national archive for vital event registrations (**Figure 5**). The national archive received a score of more than 75 per cent in 4 of the 5 domains evaluated (general infrastructure, information management, security and confidentiality and SOP & regulation). It performed poorly in the human resources and training quality subdomain, mainly due to the use of volunteers with limited training in the facility due to lack of permanent positions.

Figure 3. General CRVS performance dashboard, Country 1

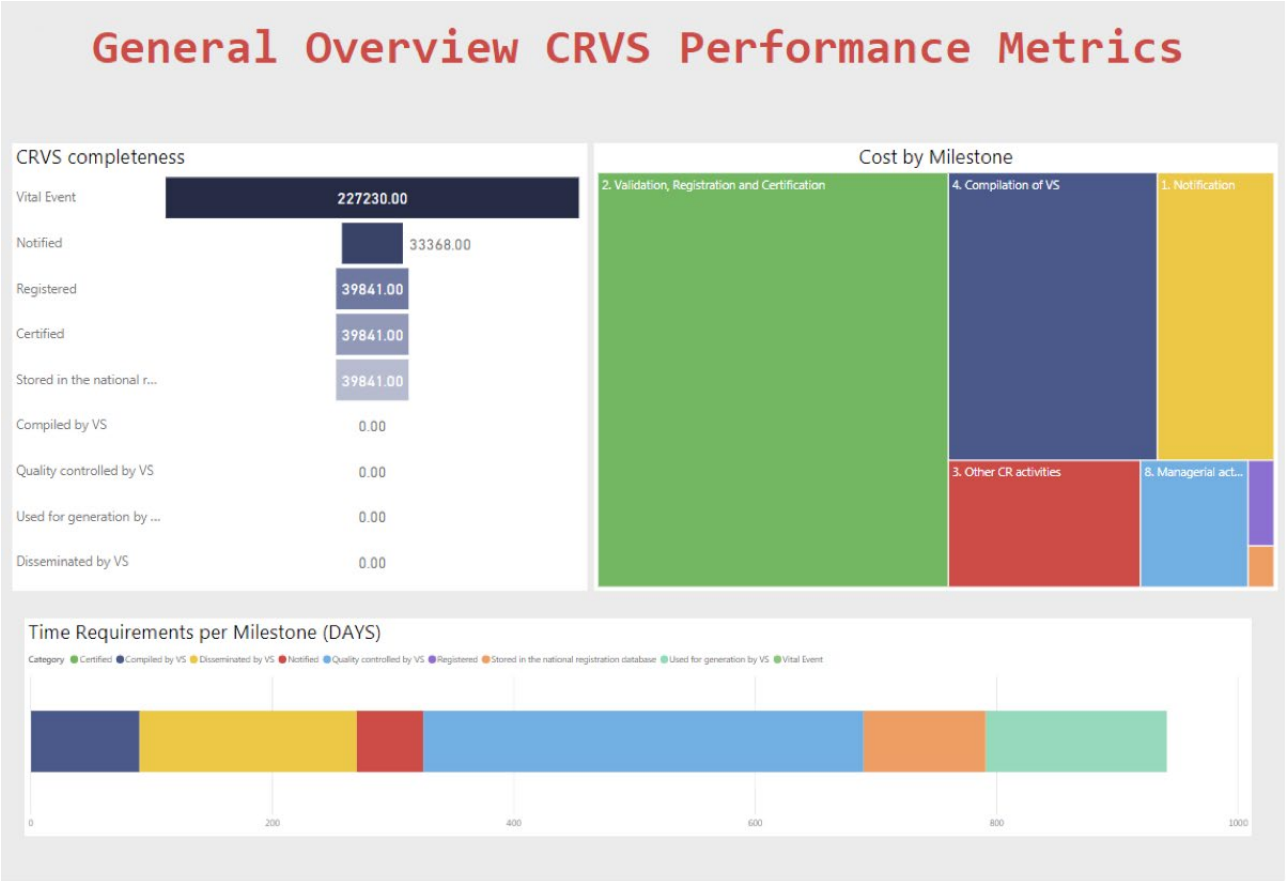


Figure 4. CRVS Performance dashboard for the QUANTITY domain, Country 1

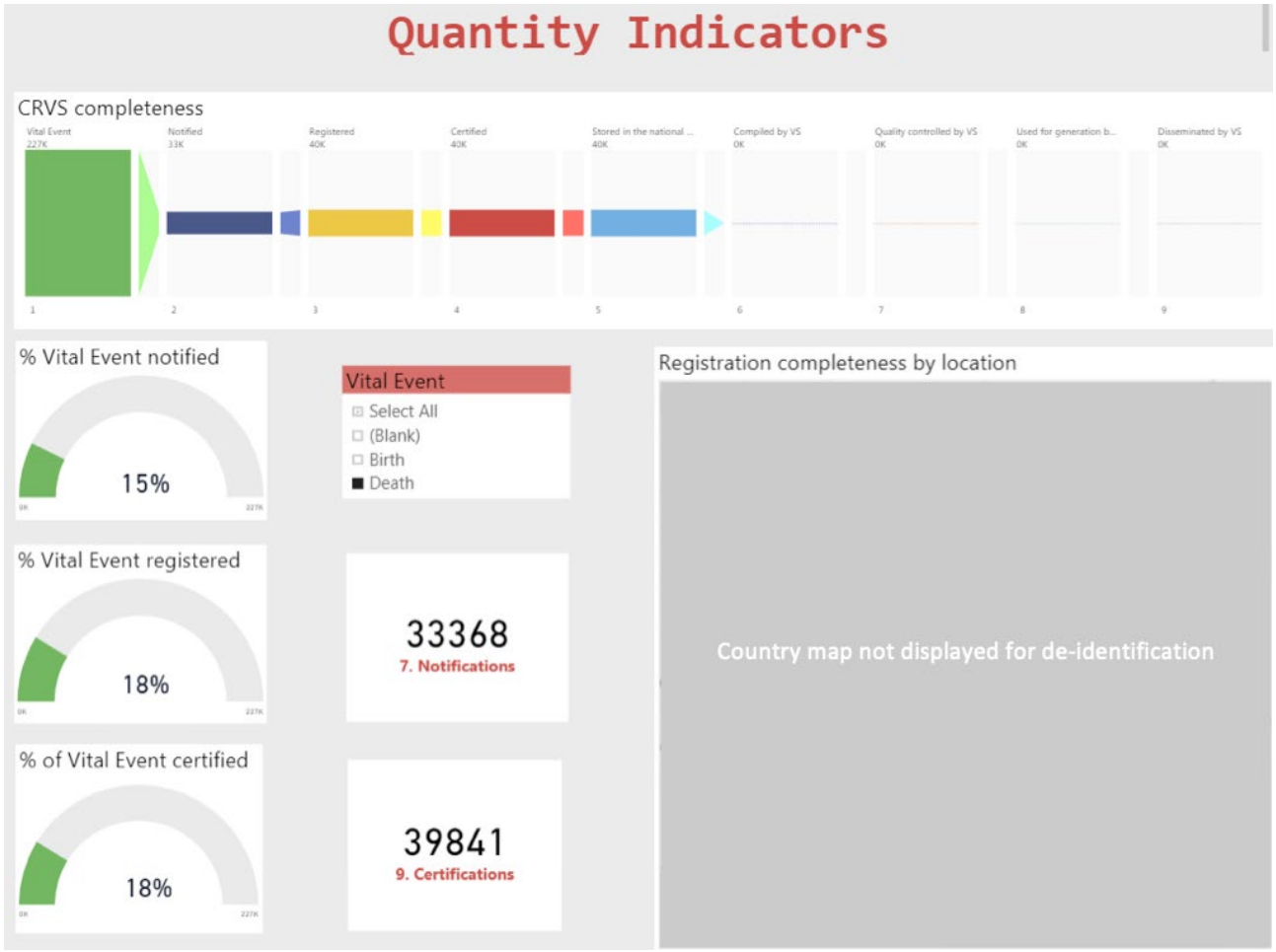


Figure 5. CRVS Performance dashboard for the TIME domain, Country 1

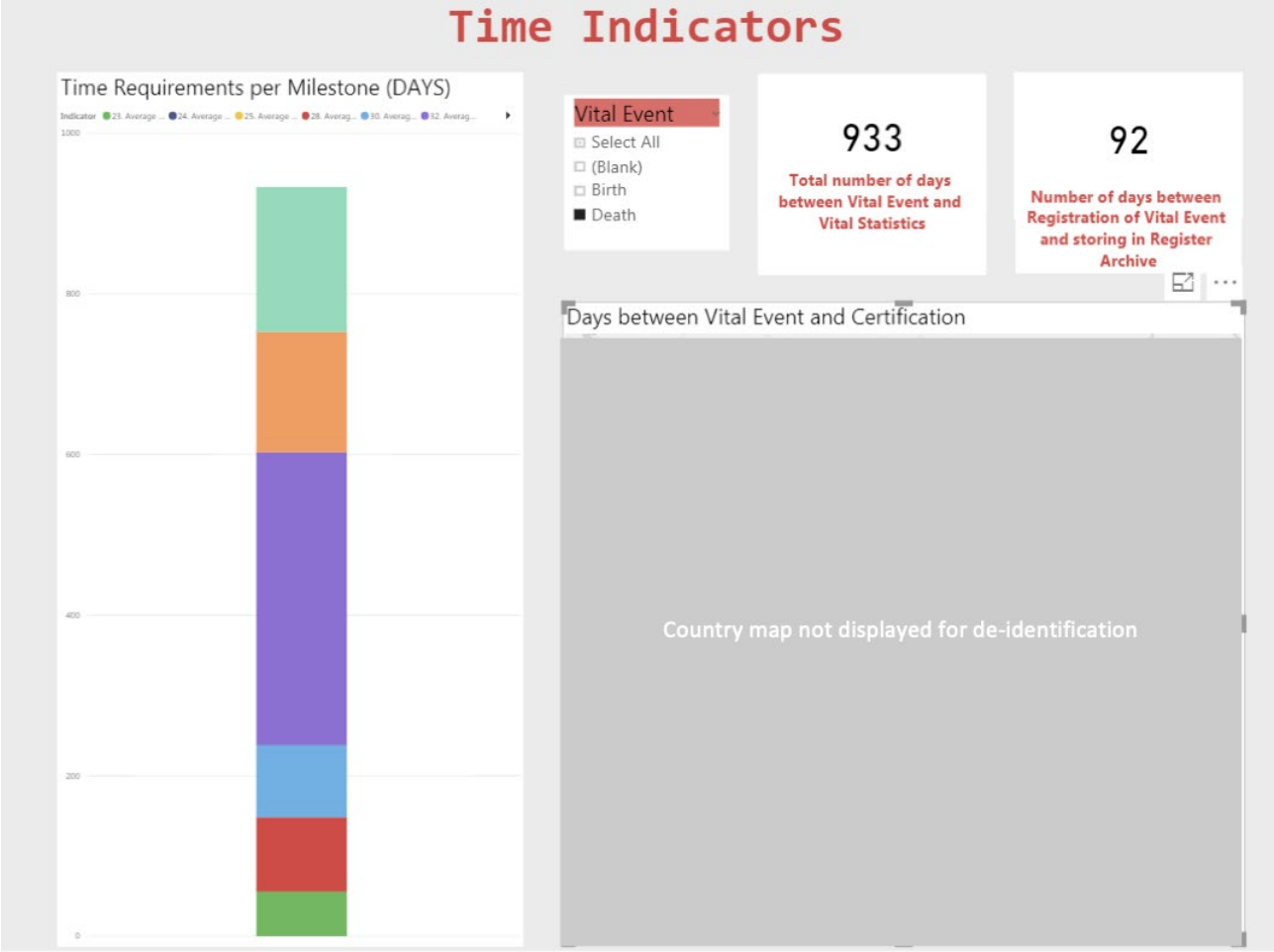
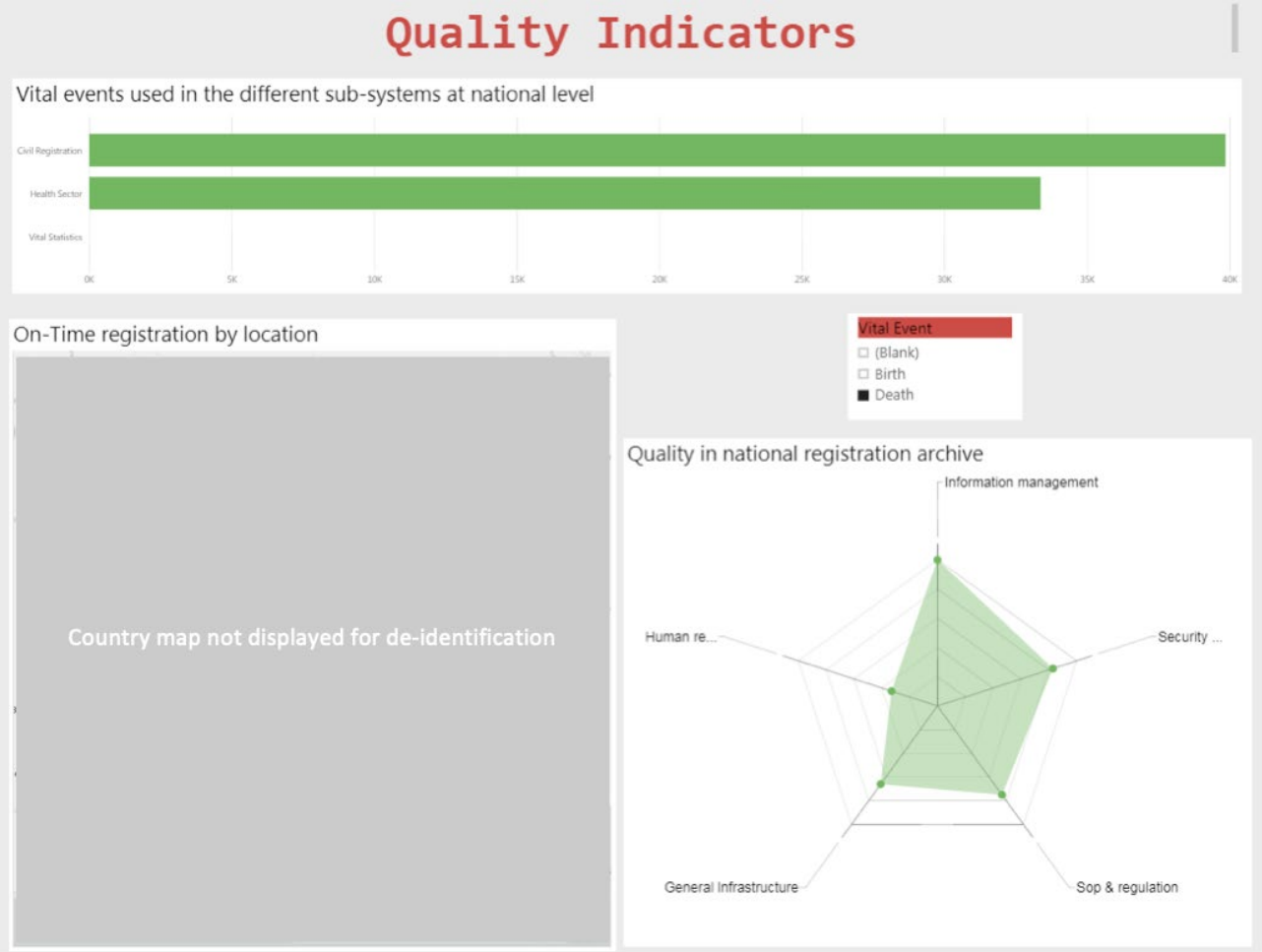


Figure 6. CRVS Performance dashboard for the QUALITY domain, Country 1



Country 2 – The importance of the flow of information

CRVS systems are complex adaptive systems with multiple stakeholders with their own information systems. One of the main challenges for CRVS managers is to integrate these different information systems and to assure a smooth flow of information throughout and within them. A mix of paper and digital systems, non-harmonized data collection tools recording non-standard information, closed digital solutions without the capability of sending or receiving data, or weak governance structures that impede or limit the sharing of information are some of the root causes of fragmented CRVS systems.

The CRVS performance toolkit could be used to assess the degree of integration of the different information systems. Country 2 represented an opportunity to test this use case since their organizational set up could influence how CRVS information flowed through the system.

The CRVS system in Country 2 registered 128,163 deaths from an estimated total number of deaths of 181,727 in the year 2017 (estimated CDR of 5.71/1000) (**Figure 6**). This represented an estimated death registration coverage of 71 per cent. The health sector recorded 97,645 deaths that represented 54 per cent of the total number of deaths expected in the country. The national statistics office reported 145,521 deaths in 2017 that probably account for deaths recorded in the electronic system used by the civil registration authority plus all deaths recorded in the paper system.

It was surprising to find that the notification coverage (number of deaths captured by the health system) was lower than the registration coverage (number of deaths registered by the CR authority) given the high maturity of the CRVS system in Country 2 and the wide coverage of health facilities (**Figure 7**). By law a death cannot be registered without a Medical Certificate of Cause of Death (MCCD) as proof of death, so it was unclear how these 30,000 extra deaths where registered by the Civil Registration (CR) authority and which proof of death they used. For the first time in Country 2, they were able to look at the performance of the CRVS system as a whole and not based on a fragmented view of the different institutions.

The team investigated the causes of this gap in the two information systems using the process maps and following each activity in the process by visiting the different local offices from each institution. There were a number of findings after the investigation:

- Doctors were compliant with the issuance of the MCCDs (notification form) when a death event occurred and the majority of deaths known by a doctor working in a public or private institution was reported using a paper form or the digital system of the Ministry of Health;
- There were several versions of the MCCD being used which created confusion among the different stakeholders on what can be considered as a legal notification coming from a doctor;
- When the MCCD was not issued with the electronic system the likelihood of this notification form NOT being digitized was high;
- There was a backlog of paper MCCDs to be digitized at district health offices;
- All registered deaths in the CR system had a MCCD but the local CR office did not keep a copy of the notification form as proof (not required in their SOPs).

It was clear that even though there could be some deaths that were not notified by doctors, the main bottleneck was at the district health offices responsible for digitizing the paper MCCD forms and recording those deaths in the electronic system (from which the Ministry of Health estimates the number of deaths captured by the health system). This was particularly relevant in regions with rural and remote areas. Two strategies were identified as a consequence of this analysis. First, there would be advocacy activities to promote the use of the electronic system by doctors to issue the MCCD that will not require any digitization activities, and second, the national level would directly support some districts in the digitization of the MCCD forms to reduce the backlog.

On average, 497 days were required to implement the entire process from the occurrence of the vital event until the generation and dissemination of the vital statistics in 2017. This corresponds to 5.8 days for civil registration activities (notification to storage) and 491 for vital statistics activities (compilation to dissemination).

Figure 7. General CRVS performance dashboard, Country 2

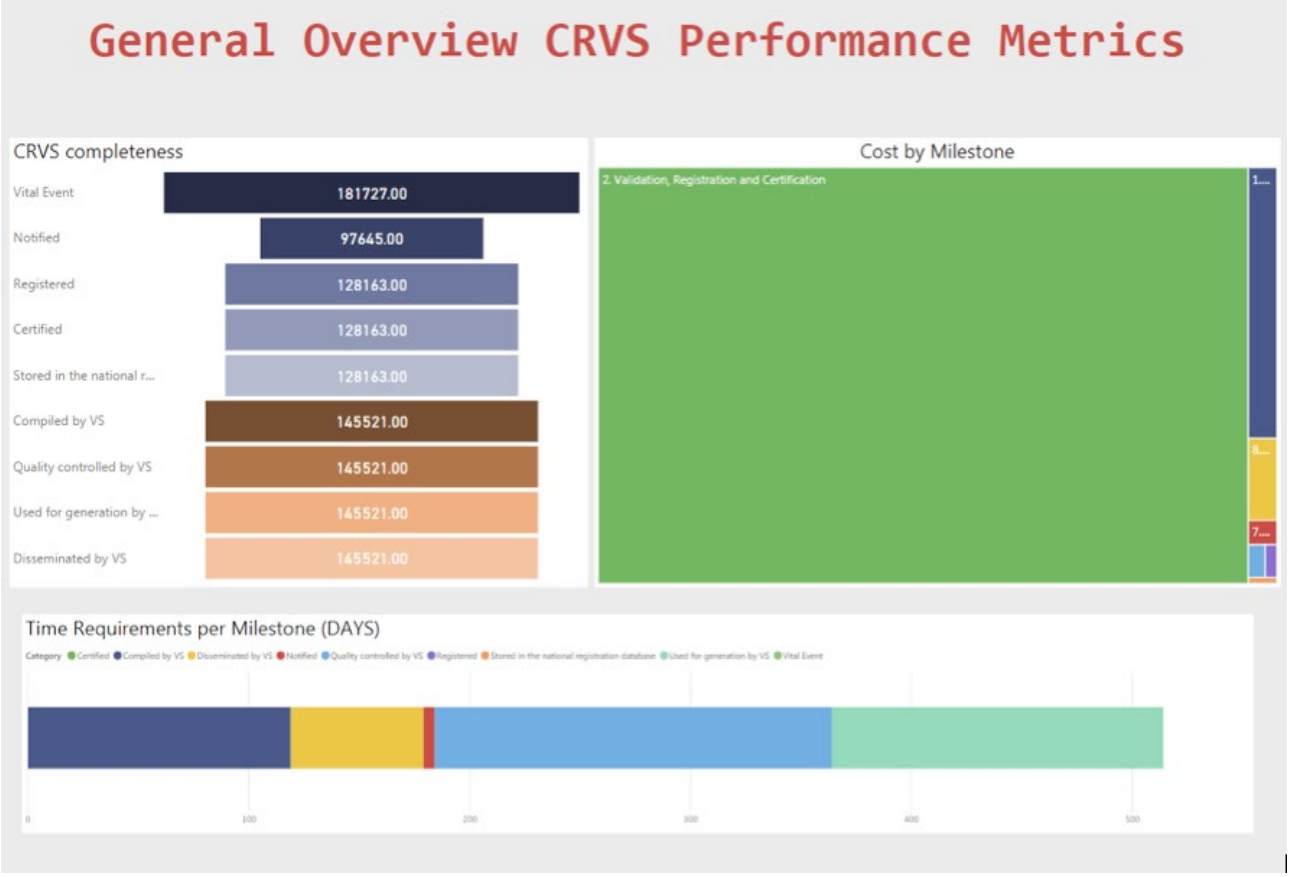


Figure 8. CRVS Performance dashboard for the QUANTITY domain, Country 2

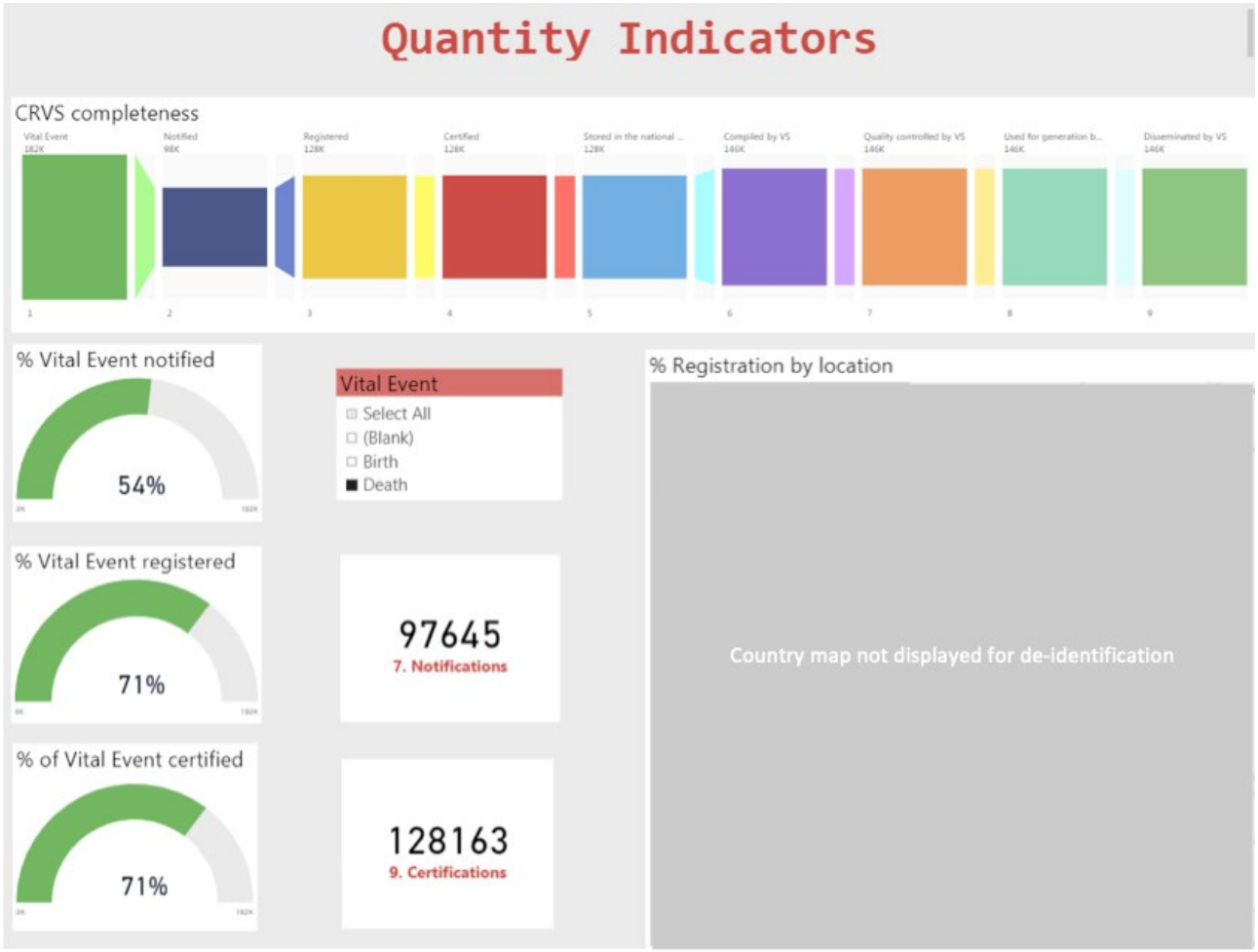
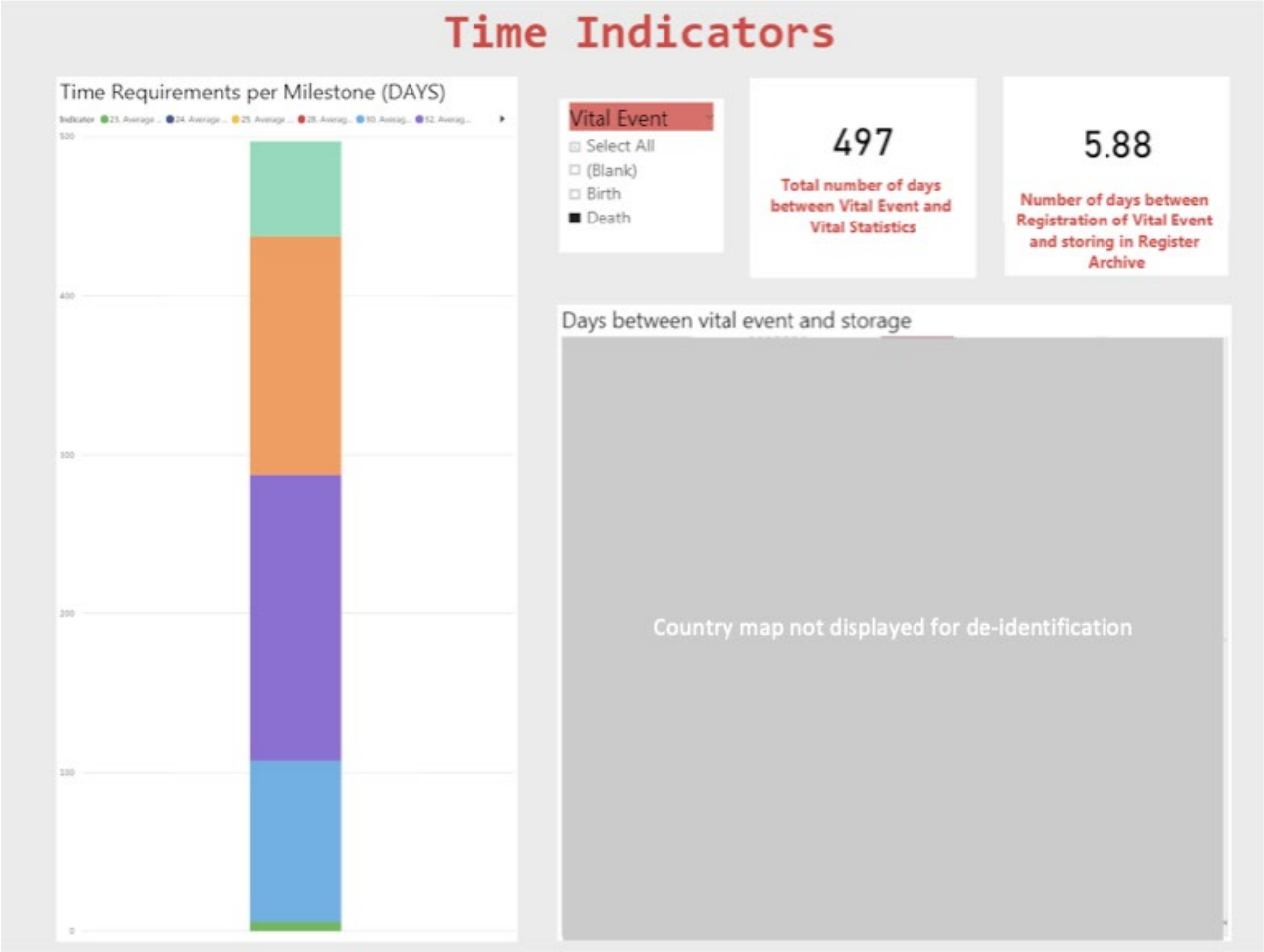


Figure 9. CRVS Performance dashboard for the TIME domain, Country 2



Country 3 – The importance of integration

The integration and coordination of the different sub-systems within the CRVS system are major challenges faced by countries. Institutions usually operate in silos with little interaction with the rest of the stakeholders in the system. This CRVS performance assessment toolkit together with process mapping tools[7] can facilitate this process by indicating not only the areas where the interconnection among stakeholders should be strengthened but also the potential performance gains of doing so.

The results of the analysis of the CRVS performance in Country 3 showed the potential gains in overall performance when integrating the different sub-systems. The CRVS system in Country 3 registered 156,145 births and 208,897 deaths from an estimated total number of 2,976,100 for births and 807,934 for deaths in the year 2017 (**Figure 9** and **Figure 10**). This represents an estimated birth registration coverage of 5 per cent for births and 26 per cent for deaths.

In the same year, the health sector recorded 2,556,189 births and 306,117 deaths in health facilities, representing 86 per cent and 36 per cent of the total number of births and deaths expected in the country respectively. No vital statistics were generated from the information produced by the CR authority at the time of the pilot, therefore zero vital events were included for the CRVS milestones after storage (**Figure 11**).

The results of this analysis clearly show a number of issues in the system:

- There is no integration between the health sector and the civil registration sector in most of the country. The health sector captures most births, but these do not end up being registered on time, which is a missed opportunity for the CRVS system;
- A significant number of deaths occur outside of health facilities (62 per cent) and neither the health system nor the registration system is capturing them properly;
- There is a discontinuation in the information flow and none of the information coming from the civil registration sub-system is being used in the production of national vital statistics and published by the national statistics office in the country.

Specifically, for births, there is a massive missed opportunity in registering births occurring in health facilities (close to 90 per cent of all births) or at least in making the CR authority aware of the gap in birth registrations compared to birth notifications. As opposed to the example presented from Country 1, the system is aware of most birth events through the health sector and there is a wealth of information about those events that could be used for registrations. Interventions aimed at increasing the coordination between the CR and the health authorities and to make their systems interoperable could drastically improve the performance of the system.

One of the most striking finding of the analysis in Country 3 is the difference in the proportion of on-time registrations between births and deaths. In most districts less than 5 per cent of the birth registrations are done on-time according to the law (within 45 days) with just 2 districts above 10 per cent on-time registration. On the other hand, death registration is virtually on-time in all districts.

Figure 10. General CRVS performance dashboard for DEATHS, Country 3

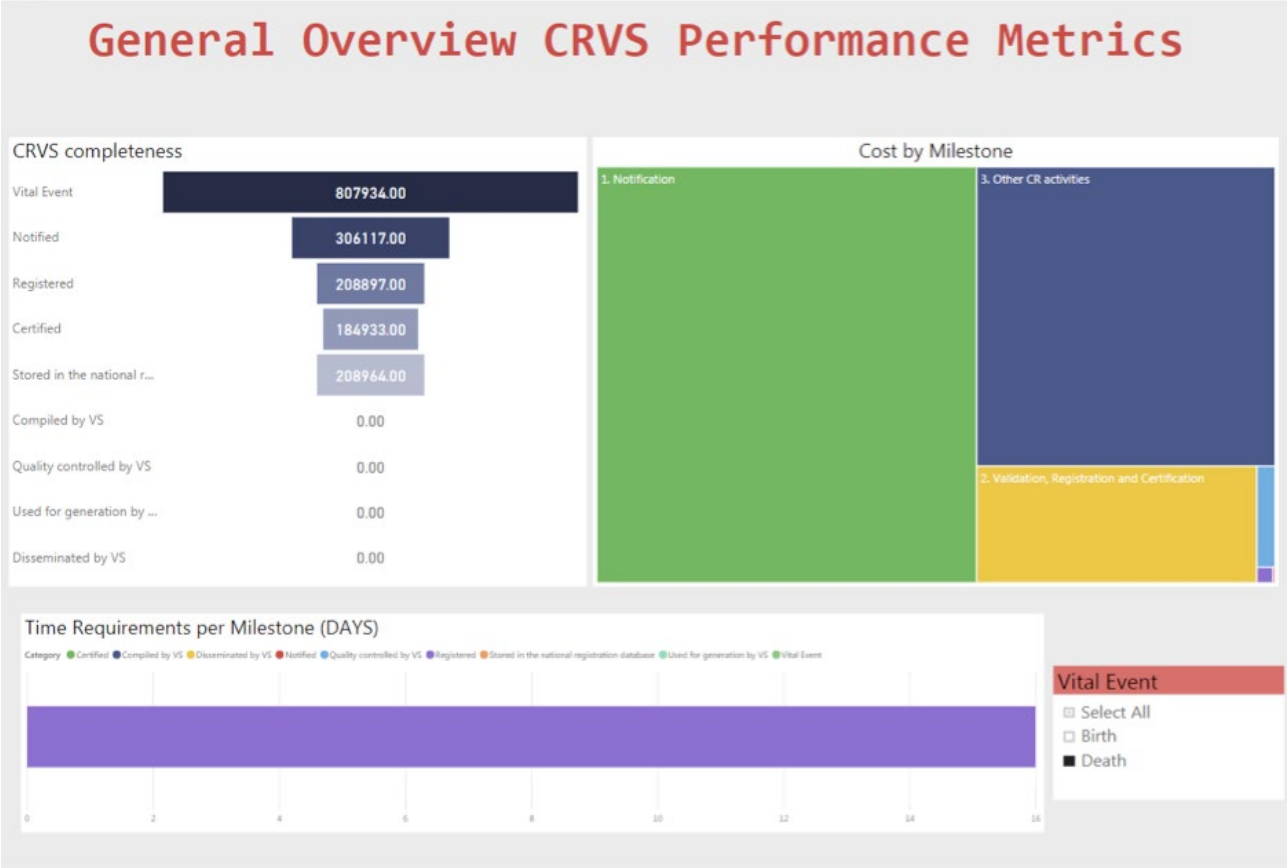


Figure 11. General CRVS performance dashboard for BIRTHS, Country 3

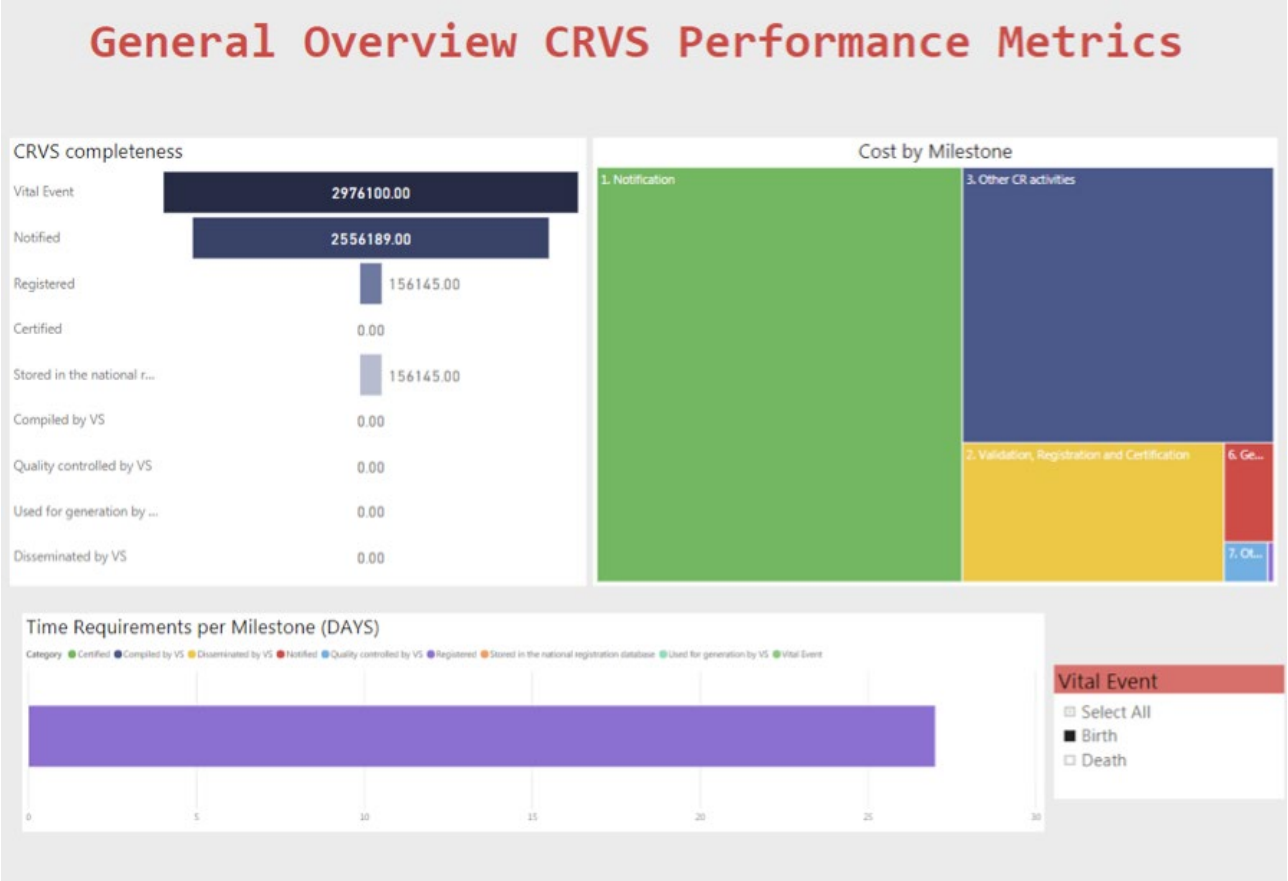


Figure 12. CRVS Performance dashboard for BIRTHS for the QUANTITY domain, Country 3

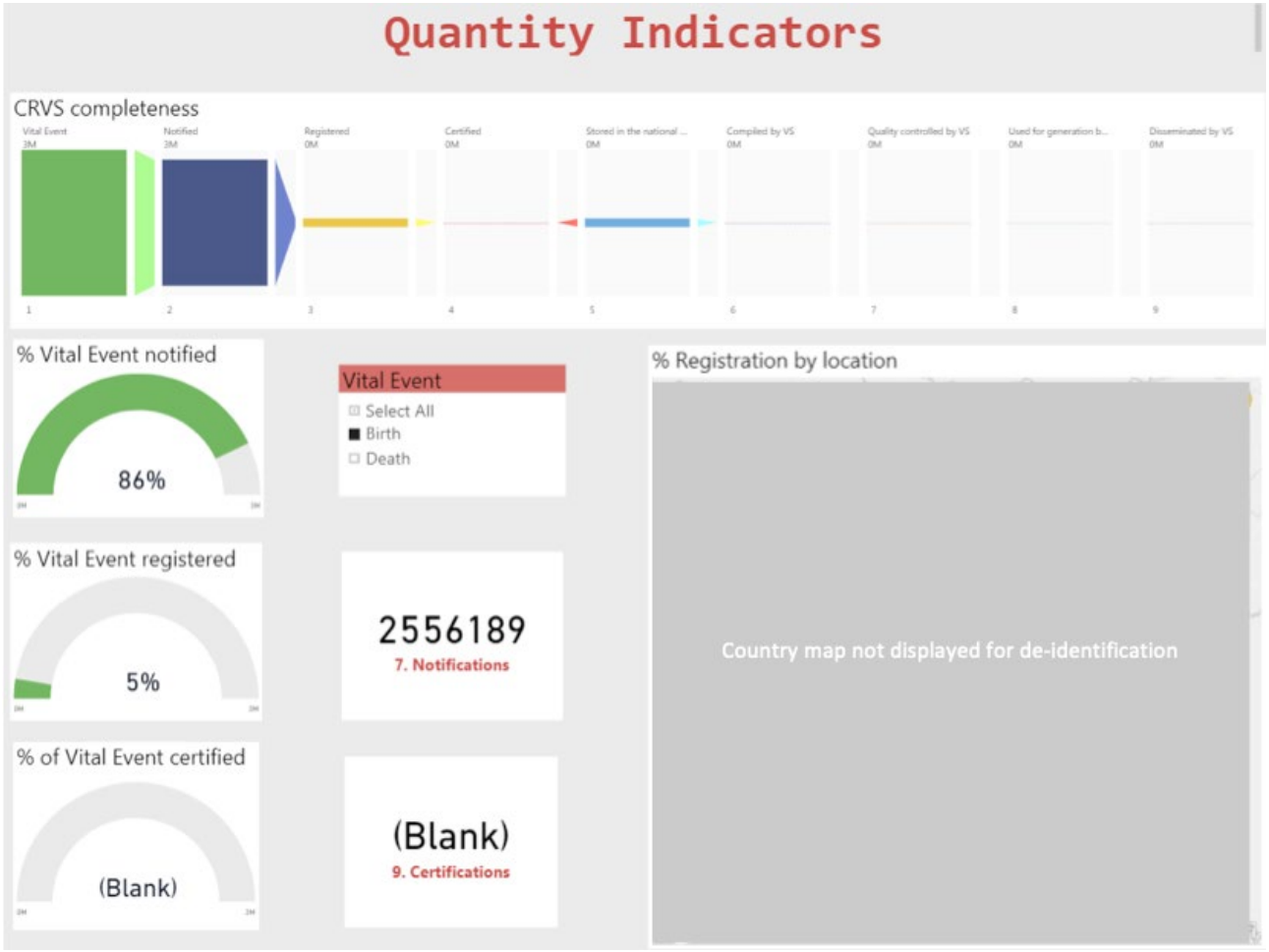


Figure 13. CRVS Performance dashboard for BIRTHS for the TIME domain, Country 3

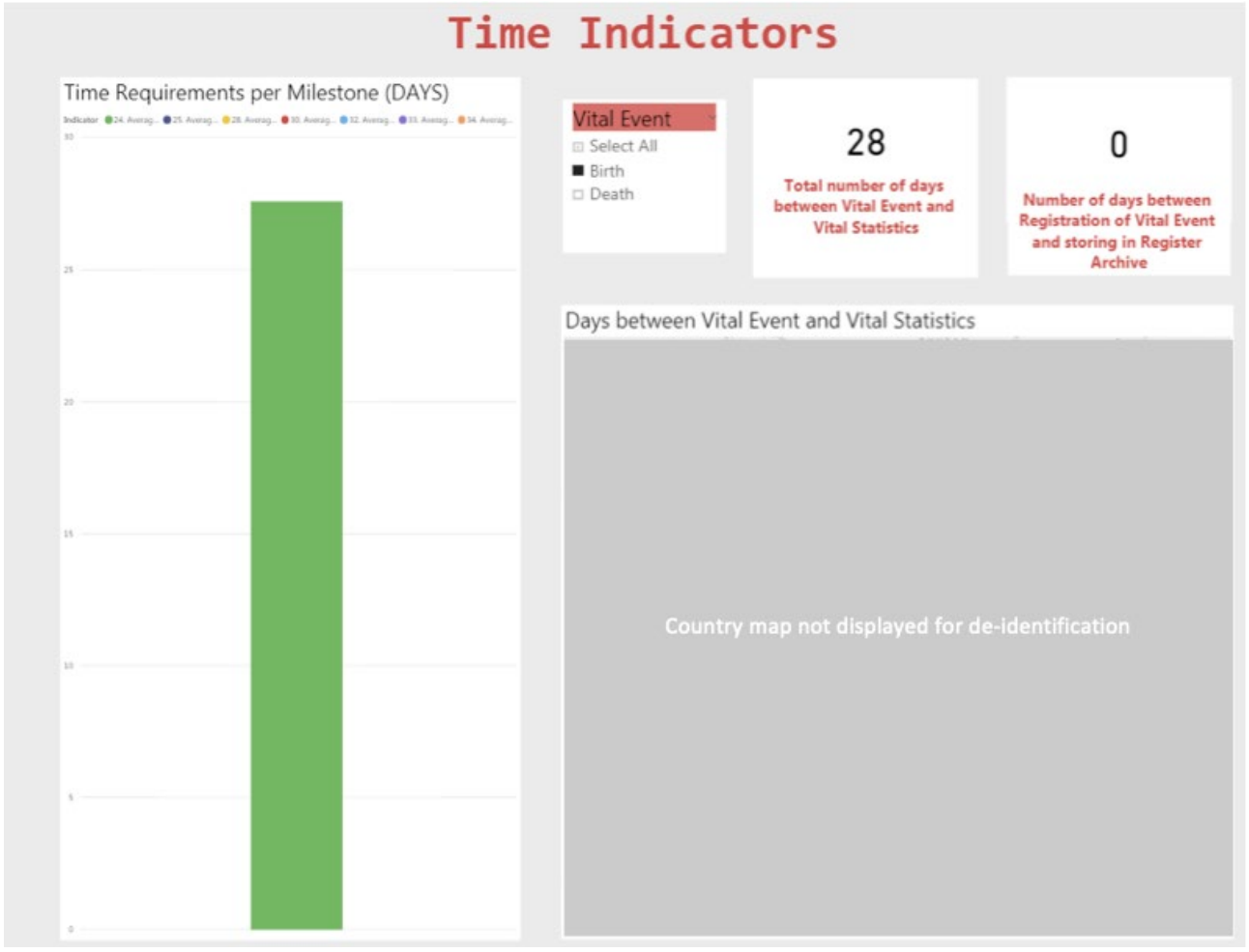
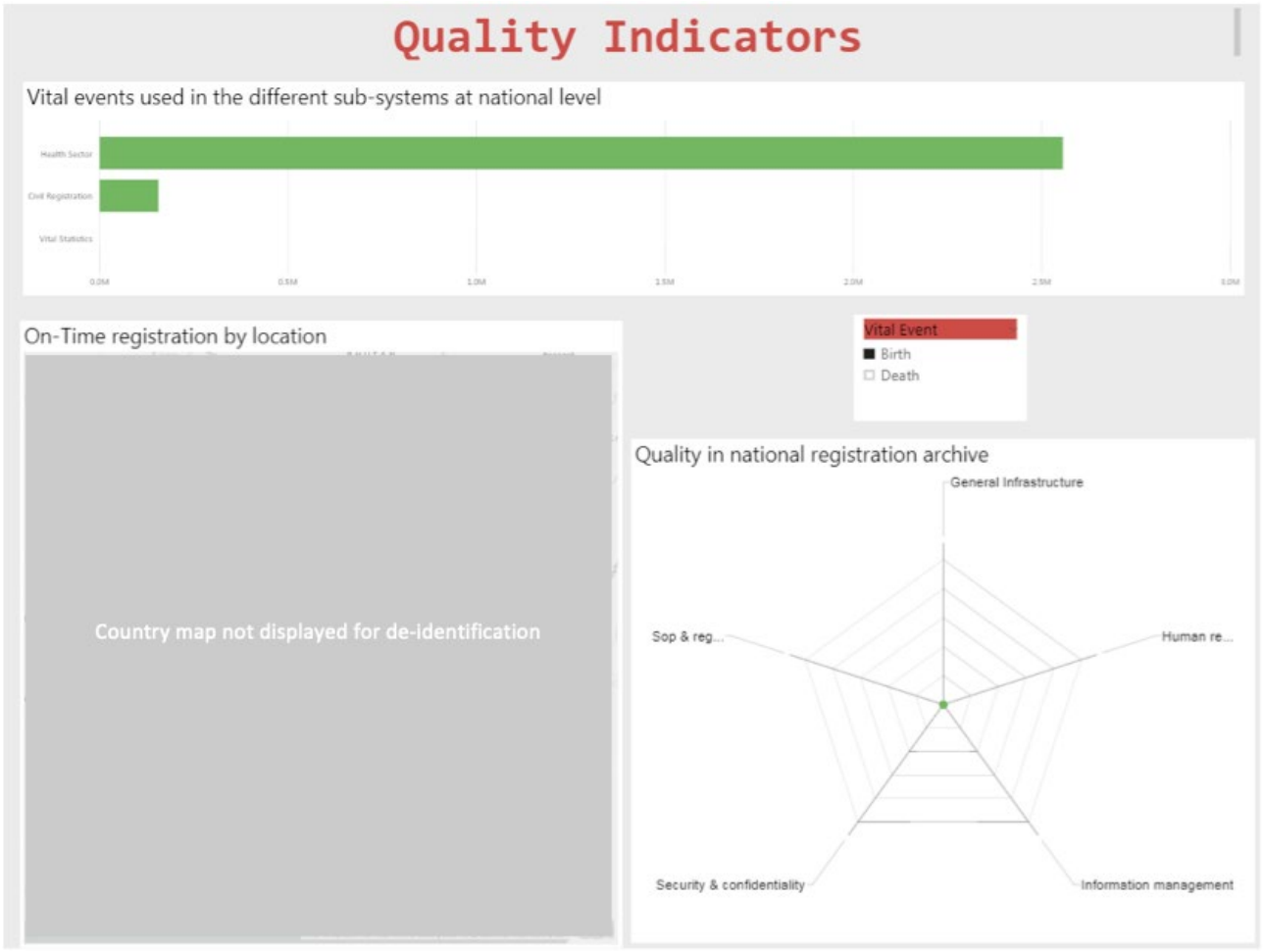


Figure 14. CRVS Performance dashboard for BIRTHS for the QUALITY domain, Country 3



Lessons learned and way forward

Countries now have access to a CRVS performance assessment toolkit to monitor their progress towards fulfilling the objectives of their CRVS. The development and application of the different tools exposed some information gaps in countries as well as significant fragmentation in the information system related to CRVS activities. Even though the three pilot countries went through a BPM exercise in Phase 1 of the Bloomberg D4H Initiative, there is still work to be done to remove silos and streamline the information architecture of the system. The three main institutions involved in CRVS operations (ministry of health, civil registration authority and national statistics office) have their own parallel information systems with different structures that added substantial complexity to the performance indicator data collection. **The fact that all three countries lacked a method for uniquely identifying each vital event (birth or death) across different systems made it impossible to follow vital events through the 10 CRVS milestones from notification to dissemination of vital statistics.**

Another difficulty faced during the pilot was the **coexistence of several sub-systems collecting information about vital events** (usually as a result of donor-driven projects). In one of the countries, the team found at least four systems collecting information about births in different regions. These different systems were not integrated, and one birth event could be recorded in several (or none) of the systems. This made it impossible to get an accurate picture of a basic indicator, such as the number of births registered in the country. Similarly, standardization of the different databases would greatly facilitate the calculation of some of the indicators.

Some basic data entry quality measures such as using drop down menus for locations or standard ways of entering dates would reduce the number of errors in the database and increase the accuracy of estimates. A validation step before recording the vital event in the electronic database was an issue in one of the countries with potentially multiple entries for the same vital event.

Finally, the process of gathering information using the process maps to understand where the information was supposed to be recorded exposed a number of bottlenecks and problems in the design of the countries' information systems. The level of detail required to construct the CRVS performance indicators described in this package also enabled a greater understanding of the current processes in the system. In one of the countries it was uncovered that the main cause of a death registration rate below the pre-defined goal was related to disruption in the information system used to transfer notification forms filled by physicians to the digitization point at the district health office rather than doctors failing to notify death events.

The development and application of the CRVS performance package raised some of the limitations in terms of data availability and provided some useful lessons that could be useful for D4H countries:

1. The integration of the different information systems recording CRVS information is essential to understand the performance of the system as a whole. In order to be comparable, the different data systems must collect information in a systematic way, following standard data requirements across platforms. In addition, the use of a unique identifier to track vital events through the system would be of great value when comparing information from different sources;
2. A positive finding of this project is that the three pilot countries are moving rapidly towards full digitization of their CRVS system. Once fully functional, most information required to calculate the CRVS performance indicators will be available in a single repository at the national level and potentially accessible from all administrative units;
3. The coexistence of multiple data collection systems posed a challenge when trying to get a full picture of the performance of the CRVS system. These sub-systems and pilots created significant fragmentation of the information architecture within each system and created a risk of duplication of vital events. These sub-systems were usually donor driven pilots and created separate processes in parts of the country. Although this approach is not negative per se, at some point the information collected in these systems must be integrated with the main information system recording vital events;
4. Data entry at the local level was shown to be extremely important when calculating indicators. Some of the databases contained multiple data entry errors that made the analysis complex and probably not accurate. Misspelling names of locations and errors in entering dates were the issues with most impact on the analysis;

5. The use of the process maps to identify the different indicators to measure the performance of CRVS systems was extremely useful. The maps provided the level of detail required to understand CRVS operations and to define the type of information required;
6. The CRVS performance assessment toolkit was useful not only to assess the performance of the system but also to identify actions to improve it. The combination of the dashboard, indicator calculations and process maps were very useful; and
7. The CRVS performance indicators and the accompanying dashboard developed as part of this project represent a generic set of measures and visualizations for countries. However, most countries would probably like to adapt both the list of indicators and visualization to their monitoring needs. In order to do this, CRVS stakeholders should be equipped with the technical knowledge both to identify performance indicators and to develop dashboards either using Power BI or another application.

Annex

CRVS performance indicators for each milestone and performance domain

No.	Milestone	Indicator name
		Quantity
1.1	Notification	Percentage of VE notified
1.2	Registration	(a) Percentage of VEs registered (b) Percentage of notified VE registered
1.3	Certification	Percentage of registered VE certified
1.4	Storage	Percentage of registered VE stored in (a) the national registration database and (b) the national register archive
1.5	Compilation	Percentage of registered VE shared by the CR sub-system for compilation
1.6		(a) Percentage of registered VE received by VS sub-system for compilation or (b) Percentage of registered VEs compiled by the VS sub-system
1.7	Quality Control	Percentage of compiled VEs with sufficient quality in the VS sub-system database
1.8	Generation	Percentage of quality controlled VEs used for generation of VS by the VS sub-system
1.9	Dissemination	Percentage of VEs used in the generation of the vital statistics used for dissemination of VS by the VS sub-system
1.10		Percentage of registered VEs used for dissemination by the (a) CR sub-system (b) health system
		Time
2.1	Notification	Average number of days between VE and notification
2.2	Registration	Average number of days between notification and registration of VE
2.3	Certification	Average number of days between (a) VE and certification and (b) registration and certification of VE
2.4	Storage	Average number of days between registration and storage of VE in (a) the national registration database and (b) in the register archive
2.5		Average number of days between the VE and storage of VE in the national health system database
2.6	Compilation	Average number of days between the registration of the VE and its compilation for the production of vital statistics
2.7	Quality control	Average number of days between the VS compilation and VS quality control[5] in the VS sub-system
2.8	Generation	Average number of days between VS quality control[20] and VS generation in the VS sub-system
2.9	Dissemination	Average number of days between the VS generation and VS dissemination in the VS sub-system
2.10		Average number of days between the end of the year and VS dissemination in the (a) VS sub-system (b) CR sub-system (c) health system
		Quality
3.1	Validation	Percentage of correctly validated VE notifications
3.2	Registration	Client satisfaction score for CR services at local level
3.3		Percentage of on-time registrations
3.4	Certification	Minimum number of visits needed by the client to achieve certification
3.5	Storage	Ratio of VE data at national level (health system vs. the VS sub-system)
3.6		Quality of VE storage in the (a) national registration database (b) national register archive (c) health system database

20 By quality control measures, we refer to those activities conducted at the national level to assess and improve the quality of vital statistics after the information has been compiled and before generating the final set of vital statistics for the country.

3.7	Quality control	Percentage of deaths with (a) a MCCOD (b) with a MCCOD of usable quality
3.8	Generation	Data quality score for VS generation in the VS sub-system
*Cost/resources**		
4.1	Registration	Average full financial cost to (a) notification (b) registration
4.2		Average number of registrations per registrar
4.3		Ratio of registrars to the size of the population in each administrative area
4.4	Certification	Direct financial cost carried by the client to achieve certification
* Refer to the CRVS Costing and Budgeting tool for a detailed description of the cost/resource indicators required to monitor CRVS processes		

Data collection tool requirements and characteristics

Requirement	Characteristics
Flexibility in the selection of indicators to be collected, but at the same time ensure availability of key indicators which allow for a comparison among countries	Differentiation between the key and optional indicators
Intermediate step where data collectors need to list the data source at each administrative level prior to the start of the data collection to ensure efficient data collection	Matrix showing the source of data to be collected for each data point by administrative level
Flexibility to collect a data point at any administrative level as in each country data might be available at another administrative level	Possibility to collect each data point at any administrative level
Flexibility to collect the same data at various administration levels (if the data is available) in order to avoid estimations at higher administrative levels as much as possible	Possibility to define for each data point at how many administrative levels data is available
Possibility to disaggregate data, but at the same time still make it feasible to collect data relatively easily, on a timely basis and at a reasonable cost	Stick to basic disaggregation of total figures
Possibility to collect national-level data by stakeholder and not as a whole to ensure a better overview of data to be collected when visiting each stakeholder at the national level	Data collection at the national level for each stakeholder
Possibility to collect data at a flexible number of sampling units	Tool allows for up to 40 sampling units[21]
Being able to use the data collected to build a CRVS dashboard	The data collection tool can be uploaded to Power BI and the data can be used in the standard CRVS performance dashboard
Possibility to accommodate either data from a sample of administrative units or all administrative units in the country	The tool has two separate ways of collecting the different indicators depending on whether a sample or all administrative units will be included in the analysis

21 More than 40 sampling units were considered as not feasible given that the tool should serve routine monitoring purposes.

Description of data collection tool sections

Section	Description
Background	Captures background data about the assessment and the countries' administrative structure
Cost data entry	Includes the tables to capture the results of a CRVS costing exercise using the CRVS costing and budgeting tool
Quality data entry	Includes the tables to calculate the indicators for the quality domain
Data entry ALL	This section must be completed if all administrative units of the country are included in the analysis or if no local data collection is required
Indicator selection	Allows the user to select the indicators to be assessed by tracer area and indicates which are seen as key indicators and which are optional
Source of data to be collected	Requires the user to list the source of the data required by administrative level depending on the indicator selection done.
Level of data availability	Requires the user to select at which administrative level data is available
Sampling I	Requests the user to list all units to be sampled
Sampling II	Requests the user to provide background information (population size, crude birth/death rate, male/female ratio, proportion health facility/community vital events) about the sampling units in order to estimate the key denominator (expected number of VE) and to allow for results to be disaggregated in case real data is not available
Sampling III	This section can be used by the user as a data entry hub. It contains hyperlinks to every tab where some data must be entered and all tabs have a hyperlink to bring the user back to the hub once the data in entered
General data collection (i.e. tabs like NatVS_01, SuNa1_01, Local_01…)	Requires the user to enter all the required data for each sampling unit and all its administrative levels above (if data is available) depending on indicator selection and level of data availability
Indices data collection	Provides the user with support tools to calculate some indices like client satisfaction, storage quality, quality of quality control, and data quality
Results	Presents the results of the calculations for the different indicators disaggregated by location.

Characteristics of the dashboards for each tracer area

Information displayed	Visualization used
Performance domain: General dashboard	
Coverage of the different CRVS milestones (quantity)	Funnel plot ordered according to the 10 CRVS milestones (vertical)
Time required for production of VS by milestone	Timeline
Cost by milestone	Treemap
Performance domain: Quantity	
Coverage of VE across all milestones	Funnel plot ordered according to the 10 CRVS milestones (horizontal)
% of VEs notified/ registered/ certified	Gauge graph
Coverage of VE registration	Map with administrative boundaries
Total number of notifications/ certifications	KPI displayed as a single figure
Performance domain: Time	
Time required for production of VS by milestone	Timeline
Days between VE and VS dissemination	KPI displayed as a single figure
Days between VE and certification	KPI displayed as a single figure
Days between VE and certification	Map with administrative boundaries
Performance domain: Quality	
Consistency of VE data at national level	Clustered bar chart
% of on time registrations	Map with administrative boundaries
Quality of the national registration archive	Radar chart with 5 sub-domains
Performance domain: Cost	
Financial and economic cost by sub-system	Clustered column chart
Cost per VE/registration	Simple text
Cost by funding source / activity / input	Tree map
Cost by administration level and CRVS sub-system	Sunburst chart
Full-time equivalent by type of staff	Doughnut chart
Performance domain: Human resources	
Number of staff and FTE per job category	Infographic with bars

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The University of Melbourne recognises the Swiss Tropical and Public Health Institute for their partnership and contribution

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