Planning and Implementing Real-time Monitoring Approaches to Strengthen Vaccination Campaigns

Guidance for country partners

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Gavi
The Vaccine Alliance

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After this guidance document has been made available and used by governments and other immunization partners, its developers would like to hear your experiences and suggestions on how to improve this guidance to better support the use of real-time monitoring approaches and digital tools to strengthen vaccination campaigns. This document is not meant to be a static one; updates and adjustments to this guidance will be made periodically based on evolving country experience and user feedback.

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CONTENTS

ACRONYMS

ACSM	Advocacy, communication and social mobilization
AEFI	Adverse event following immunization
DHIS2	District Health Information Software
EHR	Electronic health record
EPI	Expanded Programme on Immunization
Gavi	Gavi, the Vaccine Alliance
GIS	Geographic information system
HMIS	Health management information system
HR	Human resources
IA2030	Immunization Agenda 2030
ICT	Information communication technology
M&E	Monitoring and evaluation
MDC	Mobile data collection
MDM	Mobile device management
MNO	Mobile network operator
MR	Measles and rubella
NGO	Non-governmental organization
ODK	Open Data Kit
RD4C	Responsible Data for Children initiative
RCA	Rapid convenience assessment
RCM	Rapid convenience monitoring
RTM	Real-time monitoring
SDG	Sustainable Development Goals
SIA	Supplementary immunization activities
SMS	Short message service
SOP	Standard operating procedure
UNICEF	United Nations Children's Fund
USSD	Unstructured Supplementary Service Data
WHO	World Health Organization

INTRODUCTION

Supplementary immunization activities (SIAs), also referred to as mass-immunization campaigns, are an effective strategy for improving immunity to vaccine-preventable diseases and delivering immunizations to children otherwise missed by routine services, including hard-to-reach and underserved groups and communities. At global and national levels, there are a number of challenges to maintaining high immunization coverage, implementing effective surveillance and allowing immunization programmes to react in a timely fashion to problems as they arise. Real-time monitoring (RTM) approaches which employ digital technologies and mature innovations to enable real-time data and corrective action, are being used by countries around the world to help national partners overcome challenges in planning, logistics management, vaccination administration, and immunization monitoring with the overall aim to strengthen national immunization systems. Having real-time access to data is critical to ensuring that intensive, time-limited high-quality immunization activities are planned and implemented well, and issues are addressed promptly.

Although RTM is enabled due to technology and Internet connectivity, technology alone cannot ensure the success of establishing and implementing a real time monitoring system, as it is only one component of an RTM approach. It is equally important to consider existing national capacities and accountability structures at all levels for the use of real-time data and information so that the data can be used for corrective action and to improve programme effectiveness. Establishing accountabilities is critical, as the introduction of new ways of working through the use of digital real-time solutions requires a change management process to help stakeholders at all levels embrace new processes, skills and tools required to enable the national scale of real-time monitoring approaches. And it is critical that real time monitoring efforts are nested within the larger national ecosystem and architecture of health and immunization data collection and governance to ensure alignment, interoperability and coherence of efforts. When embedded in existing immunization structures, RTM can benefit not only country vaccination campaigns, but routine immunization as well.

Timely access to reliable data provides new opportunities for national programmes to monitor and continually improve immunization performance, reach, efficiency and accountability. Global efforts are increasingly supporting the use of digital technologies in countries to improve quality of vaccination campaigns (against measles, cholera, tetanus, etc.,) through RTM – especially in settings that are using manual systems for data collection, analysis and feedback. At the same time, the move to RTM substantially changes the way that data is collected, shared and used, and requires that specific attention be given to the data governance arrangements throughout planning, design and implementation, to ensure that children's rights are protected and the positive benefits of RTM data are not undermined by concerns with regard to data protection and privacy.

As documented in the 2021 Gavi Alliance and UNICEF publication, 'The Use of Real Time Monitoring Approaches and Tools for Supplimentary Immunization Campaigns: Good practices and lessons learned'[1], the use of electronic digital tools to monitor preparedness and implementation in real time results in improving efficiency and effectiveness of vaccination campaigns. Where digital tools and approaches have been successfully rolled out in support of routine immunization programmes or immunization campaigns, other countries should, as part of overall national systems-strengthening efforts, consider assessing the use of the RTM approaches and digital tools to address programme and operational bottlenecks and capacity gaps. Based on multiple country experiences and lessons, this document aims to provide guidance to help countries realize the potential of real-time monitoring approaches and technologies as part of their national immunization programmes.

1. The Use of Real Time Monitoring Approaches and Tools for Supplimentary Immunization Campaigns: Good Practices and Lessons Learned New York: United Nations Children's Fund (UNICEF), 2020. https://www.unicef.org/reports/digital-technologies-real-time-monitoring-immunization-activities.

Purpose of this guidance

To date there has been little guidance on the use of real-time monitoring approaches and technologies and how they can support and strengthen national vaccination campaign planning and implementation. There is also a lack of common guidance to help practitioners and policy makers better understand what is meant by the use of real-time monitoring approaches for vaccination campaigns [the 'what'] underpinned by a theory of change and by the key elements enabling practical implementation [the 'how']. Practical implementation also includes the use of common real-time technology platforms and technology considerations to be navigated by national stakeholders.

This document aims to address these gaps to:

1. Introduce real-time monitoring approaches and how RTM can strengthen vaccination campaigns and routine immunization programmes;
2. Provide guidance to decision-makers and planners on the key considerations enabling implementation of real time approaches and digital solutions in order to strengthen vaccination campaigns and routine immunization programmes, thereby enhancing immunization service delivery;
3. Elaborate on implementation aspects related to real-time monitoring technologies.

This document provides guidance and practical tools to support countries to realize the potential use of real-time monitoring approaches and technologies as part of national immunization programmes. This includes the main elements that should be considered to ensure government ownership; alignment of national digital systems and approaches; interoperability; and sustainability. Though this guidance is focused on immunization delivery and coverage in low and middle-income countries, the real-time approaches can be easily transferred to other programmes and country contexts. The guidance provides a reference to help policy makers and managers address questions such as:

- What is the role of real-time monitoring in the planning, monitoring and implementation of immunization delivery and coverage?
- Why should real-time monitoring approaches and tools in immunization programmes be considered?
- What are the key implementation considerations for the roll-out of real-time monitoring approaches?
- What are the risks involved in the use of real-time approaches in immunization planning, service delivery and coverage?
- What types of digital platforms and tools are most commonly used to enable real-time monitoring, and what are the strengths and weaknesses of each?

This guidance relies significantly on recommendations, case studies and insights drawn from the 2021 UNICEF and Gavi publication, 'The Use of Real Time Monitoring Approaches and Tools for Vaccination Campaigns: Good practices and lessons learned'. This document compiled good practices and lessons learned from countries implementing real-time monitoring activities that employ digital technologies to accelerate the sharing, analysis and use of data to improve campaign quality for vaccination campaigns. Data and information were collected using a mix of interviews and consultations with key partners, a field mission to Pakistan and review of documents and journal articles. Four countries with robust experience implementing RTM technologies for vaccination campaigns – Indonesia, Pakistan, Uganda and Zambia – were included as case studies while many others were incorporated in the literature reviewed. Lessons from the use of real-time data and monitoring to support the COVID-19 response have also been reviewed in the development of this guidance. Readers of this guidance seeking additional case study information are encouraged to refer to this document.

Structure of the guidance

Section 1 provides an introduction to strengthening immunization service delivery through digitalization and real-time monitoring; discusses country vaccination campaign strategies and common challenges; explores the use of real-time digital monitoring in the COVID-19 immunization context; defines what is meant by real-time monitoring (RTM) for vaccination campaigns and its benefits and uses; and considers the risks related to using RTM approaches for vaccination campaigns.

Section 2 includes elements required to achieve an effective environment for planning and implementation of an RTM system, including ensuring country ownership; developing a digital health situation analysis and data needs assessment; data ownership and data security; planning for scale and sustainability; and cost considerations among other areas.

Section 3 explores implementation aspects related to real-time monitoring technologies, including software and hardware selection and common digital tools used for real-time monitoring of SIAs and their strengths and weaknesses; network connectivity; mobile device management; technical support; working with mobile network operators and aggregators; data collection forms; data reports and dashboards; and user testing.

Target audience

This document 'Planning and Implementing Real-Time Monitoring Approaches to Strengthen Vaccination Campaigns' is a guide for all stakeholders, including national governments, UNICEF and WHO Country Offices, partners and others who are advocating for, investing in or considering adopting real-time monitoring (RTM) approaches and digital technologies for vaccination campaigns and the strengthening of routine immunization programmes. No prior knowledge of real-time monitoring approaches or technologies is required to read this guidance.

Section 1

Strengthening immunization programmes and service delivery through digitalization and real-time monitoring

The Global Immunization Agenda 2030 (IA2030) sets an ambitious overarching global vision and strategy for vaccines and immunization for the decade 2021–2030. It focuses on maximizing impact through more effective and efficient use of existing resources, accelerating innovation to improve performance, and striving towards financial and programmatic sustainability. One of its strategic priority goals is to introduce and scale up new and underused technologies, services and practices. Achieving measles and rubella (MR) elimination, as established in the Global Measles and Rubella Initiative strategic plan, will be an important milestone in public health, and every effort towards elimination, including vaccination campaigns, should be of high quality and improved with the use of mature and tested digital solutions.

In recent years, vaccination campaigns targeting a wide range of children have been part of global strategies to eradicate polio[2] and reduce measles[3] mortality. Achieving uniformly high coverage in the target area is critical to reaching herd immunity and disease control goals. To support campaign activity monitoring, many countries are turning to real-time monitoring approaches and tools to improve the campaign effectiveness and efficiency, as well as strengthen national Expanded Programme of Immunization (EPI) systems.

Switching from manual, paper-based solutions to digital real-time monitoring systems at all stages of a campaign (pre, during/intra and post) can hasten the flow of information, reduce printing, transportation and transcription costs, and improve accuracy of reporting, accountability and oversight. Ultimately, having more responsive, cost-effective, data-driven and transparent supplementary immunization activities (SIAs) can help countries reach their targets and eradicate vaccine-preventable diseases. The use of digital assets (hardware, software, data) across campaigns can lead to greater efficiencies and improved cost-effectiveness over time.

What is monitoring?

Monitoring is the systematic and continuous process of examining data, procedures and practices. It helps to measure progress, identify problems, develop solutions, and guide policies and interventions. It can help improve the quality of the immunization programme by ensuring: :

- All infants and pregnant women are vaccinated.
- Vaccines and safe injection equipment are delivered in correct quantities and on time.
- Staff are well trained and adequately supervised.
- Information on disease incidence and adverse events following immunization (AEFI) are collected and analysed.
- The community has confidence in the vaccines delivered and the immunization services they received

2. Centers for Disease Control and Prevention. Progress toward interruption of wild poliovirus transmission – worldwide, January 2005– March 2006. Morbidity and Mortality Weekly Report, vol. 55, 2006, pp. :458-62.
3. Wolfson LJ, Strebel PM, Gacic-Dobo M, Hoekstra EJ, McFarland JW, Hersh BS. Has the 2005 measles mortality reduction goal been achieved? A natural history modelling study. Lancet 2007;369:191-200.

Lessons from multiple country case studies[4,5], indicate that real-time data can, in the right circumstances and with the right enabling conditions, enable real-time decision-making to improve the quality of vaccination campaigns. Real-time data systems can support and catalyse data-driven tactical adjustments and data-enabled strategic adaptations to:

- Strengthen the planning, implementation and assessment phases of SIAs;
- Enhance the quality of supplementary immunization activities (SIAs) and campaigns by assisting planners and implementers to review progress against targets and SIA readiness at national and district level at different points in time;
- Identify programmatic and operational issues and gaps;
- Track supplies, human resources and vaccination sessions;
- Enable decision-making for prompt corrective action;
- Help achieve campaign targets;
- Support more timely campaign responses.

Country vaccination campaign strategies and common challenges

Countries rely on both routine health systems and campaign-based delivery to extend the reach of vaccines. Many programmes – including immunization, neglected tropical diseases, nutrition, malaria and polio – regularly rely on such campaigns to support accelerated disease control, make progress towards elimination and eradication goals, and achieve large-scale health impacts. They can be conducted at the national or sub-national level and as single antigen or integrated, depending on the country needs and objectives. There are different types of vaccination campaigns:

Supplementary immunization activities (SIAs)

Campaign-based delivery of health interventions are typically time limited, intermittent and implemented at scale regardless of a person's vaccination status (prior history). The aim is to rapidly raise population level immunity and reduce the number of those susceptible to achieve disease control or elimination goals. All countries utilize vaccination campaigns in some capacity – such as preventive campaigns and for outbreak response – and research shows they are effective. Measles vaccination campaigns are estimated to reach 66 per cent of measles 'zero-dose' children who are not otherwise vaccinated by routine health systems.[6]

Still, the performance of vaccination campaigns is variable and they often do not realize their potential impact. Campaign evaluations may show they consistently miss a subset of populations – most often the most vulnerable – resulting in reduced equity and effectiveness of the health intervention.

4. The Use of Real Time Monitoring Approaches and Tools for Vaccination Campaigns: Good Practices and Lessons Learned New York: United Nations Children's Fund (UNICEF), 2020. https://www.unicef.org/reports/digital-technologies-real-time-monitoring-immunization-activities.
5. Ramalingam, B. et al., Bridging Real-Time Data and Adaptive Management: Case Study Report, October 2017, https://www.usaid.gov/sites/default/files/documents/15396/RTD4AM_Case_Study_Report.pdf.
6. Portnoy A, Jit M, Helleringer S, Verguet S. Impact of measles supplementary immunization activities on reaching children missed by routine programs. Vaccine. 2018 Jan 2;36(1):170-178.

Real-time monitoring (RTM)

RTM is collecting, sharing, analyzing and interpreting data; communicating the findings to users; and providing clear cues to actions in real or near real time using digital technologies (such as computers, tablets, mobile phones, sensors) and specialized software applications (RapidPro, DHIS2, KoBo Toolbox, etc.).

The aim is to inform more rapid, timely and effective decision-making to improve the effectiveness and efficiency of a vaccination campaign.

Campaigns are time-bound, intermittent activities deployed to address specific epidemiologic challenges, expediently fill delivery gaps, or provide surge coverage for health interventions.

They can be used to respond to disease outbreaks, eliminate targeted diseases as a public health problem, eradicate disease altogether, or achieve other health goals.

Table 1: Vaccination campaign strategies

	Term	Defintion
Supplementary immunization campaigns/ activities (SIAs))	Catch Up	One time SIA, usually nationwide, to vaccinate the cohort missed between the most recent mass campaign and the introduction of routine immunization in order to rapidly reduce the number of susceptible individuals.
	Follow-up	A periodically scheduled vaccination campaign (typically every 3–4 years) aimed at reaching children born after the previous campaign in order to reach the unreached and those who did not gain immunity after the first vaccination.
	Mass drug administration	Based on the principles of preventive chemotherapy, where populations or subpopulations are offered treatment without individual diagnosis.
	Mass integrated preventive campaign	A one-time SIA to vaccinate the main target population with an additional dose of targeted vaccine, regardless of their vaccination status (prior history). The campaign may deliver other child health/ nutrition interventions and antigens.
	Mop-up	Targeted door-to-door delivery in a community (in specific areas) after an initial round of SIA that is intended to reach the community members not reached.
	Reactive / Outbreak response	Mass campaign in response to an outbreak or existing epidemic.
Periodic Intensification of Routine Immunization (PIRI)		Time-limited, intermittent activities/campaigns used to administer routine vaccinations to under-vaccinated populations after screening for eligibility based on age and immunization history, and/or to raise awareness of the benefits of vaccination.

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The vaccination campaign mode strategies in Table 1 experience many of the same challenges of health service delivery in low-resource settings, which has an impact on effectiveness, including:

- **Coverage:** Poor data quality and insufficient monitoring obscures coverage and makes identifying gaps more difficult, adversely affecting planning and targeting. Additionally, frequent campaigns can overwhelm communities, resulting in the refusal of interventions and possible coverage backsliding (e.g., polio in Pakistan).
- **Equity:** Fixed-rate funding (e.g., 65 cents per child) does not allow for flexibility or variation in the activities necessary to contact the hardest to reach.
- **Cost-effectiveness:** Campaigns can reduce service utilization and are more expensive than routine systems and integrated delivery strategies.
- **Impact:** Shortcomings in coverage, equity and cost-effectiveness compromise the downstream impact on the ultimate objectives of disease control, elimination or eradication and the reduction of associated morbidity and mortality.

Historically, supplemental doses of vaccination were commonly given in large-scale campaigns and routine doses were provided in fixed-site health centres, through outreach services or by mobile teams. Today however, with the implementation of Periodic Intensification of Routine Immunization (PIRI) activities, this distinction has become blurred and some campaign-style activities provide supplemental and routine doses simultaneously. Therefore, the delivery strategy alone can no longer be reliably used to define the nature of the vaccination dose.

What is real-time monitoring (RTM) for vaccination campaigns?

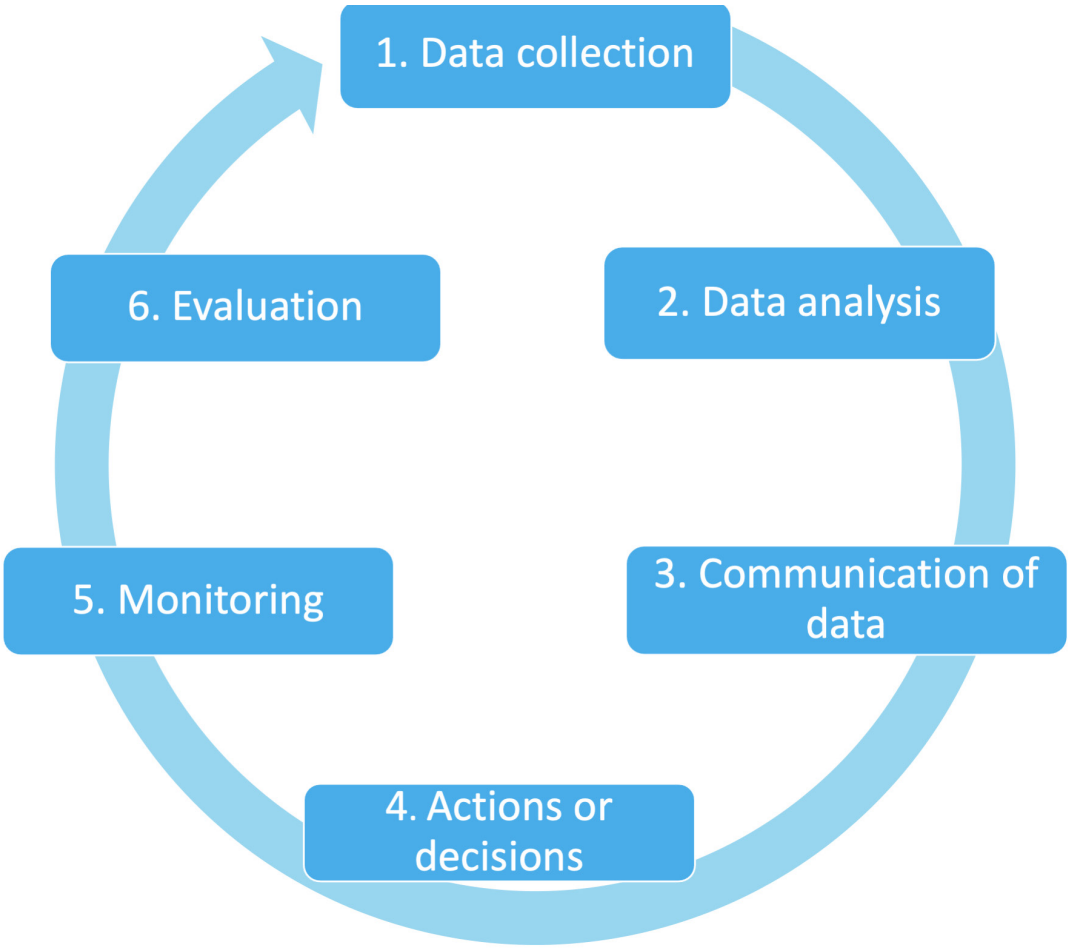
Supplementary immunization activities are an effective strategy for delivering vaccinations to children otherwise missed by routine services (including hard-to-reach and underserved groups and communities). Having real-time access to monitoring data is critical to ensuring that these intensive, time-limited, high-quality activities are planned and implemented well, and issues are addressed promptly. This is also true of other types of vaccination campaigns that are not SIAs, e.g., Child Health Days, Child Health Weeks, and National Vaccination Weeks, etc.

Real-time data and monitoring systems have six stages (see Figure 1):

1. Prioritized and actionable data is collected through real-time data technologies;
2. Data is consolidated, analysed, interpreted and transformed into information;
3. Information is communicated and disseminated to users in a variety of forms (not to be confused with publicly sharing data widely);
4. User uptake of information leads to actions or decisions in response;
5. Data is monitored throughout the campaign;
6. Data is evaluated after the campaign

The ideal real-time system needs to collect, analyse and support interpretation of the data; communicate the findings to users; and provide clear cues to action, with increased frequency when compared to non-digital systems, and in real-time.

Figure 1: Stages of real-time data systems



Although RTM is possible because of technology and Internet connectivity, technology alone cannot ensure the success of a real-time monitoring system. It is equally important to consider existing national capacities and accountability structures – at all levels – for the use of real-time data and information so that the data can be used for corrective action and to improve quality service delivery and programme effectiveness. The monitoring and evaluation of national real-time systems deployed to support vaccination campaigns is also important to make sure the design and implementation of such systems is on track as intended.

Use of real-time monitoring to strengthen routine immunization

When embedded in existing immunization structures, RTM can benefit not just the campaign, but routine immunization in several ways:

- RTM can strengthen routine immunizations by identifying zero-dose and under-vaccinated children through more accurate microplanning and identification of missed settlements. It can then implement the most appropriate immunization strategy and refer these children to routine immunization structures to ensure they are not missed in the future
- RTM can also strengthen routine immunization by improving service delivery through better planning, monitoring and tracking of immunization activities, including the optimal distribution of vaccines, so that problems can be rapidly identified and corrected.
- RTM is a more intense form of monitoring than many routine systems employ. It can identify cold-chain gaps or weaknesses, can update cold-chain inventory, inform about broken equipment and, to the extent possible, follow up with the availability of budget for fuel and electricity, all of which benefit routine immunization.
- RTM can help immunization managers at central and district levels identify staff capacity gaps and challenges and aid in identifying specific skills and knowledge gaps that require additional support.
- RTM can lead to improved relationships for stakeholders working on routine immunization. During campaigns, stakeholders come together daily to review RTM data and use the data for course correction and fostering relationships between them. Even after the campaign is complete, these relationships between stakeholders continue, and the stakeholders have a basis for working together in the future towards routine immunization.

Benefits and uses of RTM for vaccination campaigns

In the publication, *The Use of Digital Technologies for Real-time Monitoring of Supplementary Immunization Activities: Lessons Learned, countries that have used RTM* reported many benefits, chiefly: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Haiti

In Haiti, a cholera vaccination campaign was carried out through house visits by operators equipped with wireless tablets. Children's immunization status was assessed and recorded using a family-specific bar code and data was geo-localized and sent to a central system, which provided staff with a real-time map of vaccination coverage[7]. A similar approach was used in China, with a mobile app for recording immunization data, tracking unvaccinated children, and booking appointments[8].

Improved planning – RTM data can help countries refine outreach strategies and plans. GIS mapping can further support planning in hard-to-reach communities.

Achievement of campaign targets – The use of RTM during implementation can help countries monitor their campaigns' progress and as a result, better forecast the overall campaign timeline and the positioning of staff, commodities and other resources that RTM data helped identify, such as missed children and/or settlements, and refine communication and immunization strategies.

Improved service delivery – RTM allows for simultaneous visibility on implementation quality delivery. For example, if vaccinators are using the wrong needles or not storing vaccines properly at multiple sites across the campaign, the relevant authorities at higher levels can be notified and help inform and support the response. In addition to helping campaigns meet quantitative targets, it also can improve the routine immunization programme, helping projects reach their goal of improving effectiveness and efficiency.

Reduced vaccine hesitancy, increased trust and demand – The use of real-time data to track demand for vaccination services can identify locations that warrant immediate demand-generation, risk communication and community engagement interventions (RCCE). RTM can define and reinforce communication and behaviour change strategies.

Better data quality – RTM can improve the timeliness, comprehensiveness and accuracy of reporting. Programme managers can see data within the same day, and course-correct to quickly resolve problems in the field. Data quality checks built into software and supervisory systems can reduce data-entry errors.

Safety improved with more timely AEFI detection and investigation – Real-time and geolocated information on suspected AEFI incidents enables rapid assessment and response.

Reduced misuse of funds and improve timely distribution of incentives to health workers – Real-time data can help programme managers to forecast and allocate resources quickly in response to outcomes and trends. RTM can also verify the timely receipt of cash and other incentives to health workers through real-time feedback.

Learning from non-immunization programmes
Improving ITN campaign efficiency through use of digital tools[9]

Digital tools are increasingly being used by national malaria programmes and their partners to solve campaign bottlenecks, in particular those related to collection, compilation and analysis of data in a timely manner during household registration and Insecticide Treated Net (ITN) distribution activities. The use of digital tools shows great promise for increasing the efficiency of ITN campaign and continuous distribution and improving ITN accountability.

7. Teng, J.E. et al., Using mobile health (mHealth) and geospatial mapping technology in a mass campaign for reactive oral cholera vaccination in rural Haiti', PLoS Neglected Tropical Diseases, 8(7): e3050, 2014, doi:10.1371/journal.pntd.0003050 32.
8. Chen, L. et al., 'Effectiveness of a smart phone app on improving immunization of children in rural Sichuan Province, China: study protocol for a paired cluster randomized controlled trial', BMC Public Health, 14: 262, 2014, doi:10.1186/1471-2458-14-262 33.
9. Improving ITN campaign efficiency through use of digital tools - The Alliance for Malaria Prevention

Better collaboration, partnership and communication among all levels – Having data immediately available and in association with daily reports, WhatsApp groups, dashboards and cross-level (facility, district, province, national) conference calls supports increased transparency, accountability and reactivity. This has resulted in higher levels of motivation and engagement from staff, at the field level all the way to stakeholders at the national and even regional and international levels.

Opportunity for course correction and corrective actions – Studies from countries show that real-time data monitoring provides more adaptive decision-making and management in several ways, including:

- Identifying successes and failures to show which activities are working or where course-correction is needed in real-time;
- Spotting unexpected behaviours, incidents or patterns (e.g., conflict shifts or health behaviour changes);
- Reallocating resources faster in response to outcomes or trends (e.g., increasing/reducing deliveries of vaccines to certain health facilities, changing targeting of cash transfers in humanitarian settings);
- Generating new and real-time insights and ideas about a specific immunization process, issue or bottleneck;
- Supporting strategic reflection about overall programme direction and effectiveness;
- RT tracking of vaccination teams through GPS can provide RT information on gaps in the areas visited, allowing corrective action to be taken;
- Geolocation of supervisory visits can strengthen supportive supervision;
- Provide real-time overview of campaign progress through spatial visualization for improved monitoring, response and advocacy.

Matching People with Covid-19 Vaccines in DRC

To address the issue of access to information while bringing the vaccines to where they are most needed, the government of the DRC launched an SMS pre-registration system for the COVID-19 vaccination. To access the pre-registration platform, users send the word INFO by SMS to the free number 100. Once they are registered, they are entered into a database. When the vaccines are available in their community, an SMS is sent to them with the list of vaccination centers. The information also helps the government to prioritize delivery to high interest centers and avoid wastage. The database allows them to direct the EPI logistically to avoid losing doses of vaccine by prioritizing delivery according to the zones where there is high interest. The platform also allows communities to provide feedback about their experience at the vaccination center, thus helping the government to support real-time monitoring of the campaign.

Title: WHO Classification of Health System Challenges[10]

HEALTH SYSTEM CHALLENGES

1 INFORMATION

1.1	Lack of population denominator
1.2	Delayed reporting of events
1.3	Lack of quality/ reliable data
1.4	Communication roadblocks
1.5	Lack of access to information or data
1.6	Insufficient utilization of data and information
1.7	Lack of unique identifier

2 AVAILABILITY

2.1	Insufficient supply of commodities
2.2	Insufficient supply of services
2.3	Insufficient supply of equipment
2.4	Insufficient supply of qualified health workers

3 QUALITY

3.1	Poor patient experience
3.2	Insufficient health worker competence
3.3	Low quality health commodities
3.4	Low health worker motivation
3.5	Insufficient continuity of care
3.6	Inadequate supportive supervision
3.7	Poor adherence to guidelines

4 ACCEPTABILITY

4.1	Lack of alignment with local norms
4.2	Programs which do not address individual beliefs and practices

5 UTILIZATION

5.1	Low demand for services
5.2	Geographic inaccessibility
5.3	Low adherence to treatments
5.4	Loss to follow up

6 EFFICIENCY

6.1	Inadequate workflow management
6.2	Lack of or inappropriate referrals
6.3	Poor planning and coordination
6.4	Delayed provision of care
6.5	Inadequate access to transportation

7 COST

7.1	High cost of manual processes
7.2	Lack of effective resource allocation
7.3	Client-side expenses
7.4	Lack of coordinated payer mechanism

8 ACCOUNTABILITY

8.1	Insufficient patient engagement
8.2	Unaware of service entitlement
8.3	Absence of community feedback mechanisms
8.4	Lack of transparency in commodity transactions
8.5	Poor accountability between the levels of the health sector
8.6	Inadequate understanding of beneficiary populations

10. WHO, 'Classification of Digital Health Interventions: A shared language to describe the uses of digital technology for health', World Health Organization, Geneva, 2018, WHO-RHR-18.06-eng.pdf

Table 2: Potential uses of digital tools in immunization programmes[11]

Bottlenecks to be Addressed	Health System Challenge[12]	Actions based on digital tools and platforms
Poor coordination among sectoral ministries and partners for vaccination campaigns.	**INFORMATION** Communication roadblocks Lack of access to information and data **EFFICIENCY** Poor planning and coordination **COST** High cost of manual processes Lack of effective resource allocation	Real time data and information available to all ministries at central and subnational levels through integrated Health Management Information Systems and related dashboards and websites. Coordination and information sharing through social media channels [e.g.,
Delay in disease incidence reporting and low specificity of signals.	**INFORMATION** Lack of access to information and data Delayed Reporting of Events	Epidemic intelligence based on aggregation of different information and data sources. Integration of epidemiological data into automated and real time visuals i.e., dashboards, maps and reporting formats. Participatory surveillance. Geolocation of surveillance.
Lack of timely evidence-based data and information for immunization programmes.	**INFORMATION** Lack of access to information and data Delayed Reporting of Events Lack of unique identifier	Implementation and integration of immunization registries with electronic health records.
Poor logistics and dose tracking. Need to simplify logistics in vaccine management, reduce errors and improve safety	**AVAILABILITY** Insufficient supply of commodities Insufficient supply of equipment	Barcodes for dose tracking. Integration of barcode scanning technology in electronic health records (EHRs). Geolocation of barcodes.
Poor decision support tools for health care workers	**UTILIZATION** Low demand for service	Electronic decision support systems for health-care professionals. Adoption of personal health records.
Lack of feedback mechanism to alert of late disbursement of funds to health care workers and other staff.	**QUALITY** Low health worker motivation	Digital feedback mechanisms to alert delayed or missing payments to health care workers established.
Underreporting and under- recognition of adverse events following immunizations (AEFIs).	**INFORMATION** Delayed reporting of events Lack of access to information and data	Integration and analysis of information on AEFIs obtained from EHRs and real-time information channels.

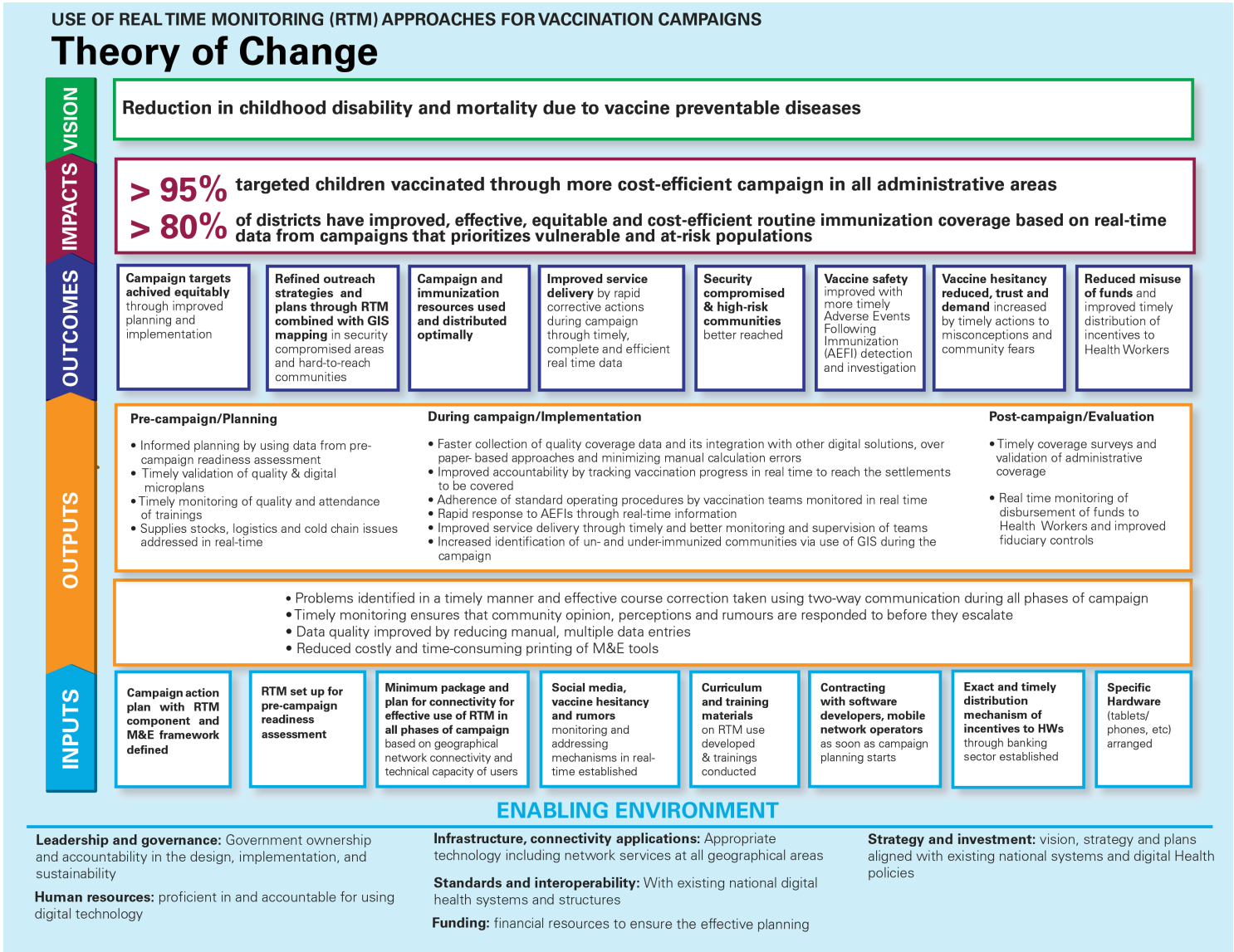
11. Tozzi, A.E. et al., 'Can Digital Tools Be Used for Improving Immunization Programs?' Front Public Health, Vol. 4, No. 36, 2016, doi: 10.3389/fpubh.2016.00036.
12. WHO, 'Classification of Digital Health Interventions: A shared language to describe the uses of digital technology for health', World Health Organization, Geneva, 2018, WHO-RHR-18.06-eng.pdf

Table 2: continued

Bottlenecks to be Addressed	Health System Challenge	Actions based on digital tools and platforms
Inadequate training of staff	**QUALITY** Insufficient health worker competence	Use of digital tools, including IVR and social media platforms [i.e., WhatsApp] to reinforce training content, and refresher training.
Inadequate supervision of teams	**QUALITY** Insufficient health worker competence Inadequate supportive supervision Poor adherence to guidelines **ACCOUNTABILITY** Poor accountability between levels of the health sector	Close monitoring of real-time coverage data and targets through digital platforms, with daily staff meetings to support supervisory activities and address performance and programme effectiveness. GPS tracking of vaccination teams. Deploy geo-localization tool for integrated supportive Supervision through geo-mapping coverage of supervision visits
Reduction of public confidence in vaccines and poor community feedback and listening mechanisms	**ACCEPTABILITY** Lack of alignment with local norms Programmes which do not address individual beliefs and practices **UTILIZATION** Low demand for services **ACCOUNTABILITY** Insufficient patient engagement Absence of community feedback mechanisms Inadequate understanding of beneficiary populations	Review and interpret data on vaccine confidence from social media listening mechanisms. Conduct mobile surveys to gather feedback from the public.
Lack of effectiveness of integrated behaviour change and communication strategies on COVID-19 situation and vaccine promotion.	**ACCEPTABILITY** Lack of alignment with local norms Programmes which do not address individual beliefs and practices **UTILIZATION** Low demand for services **ACCOUNTABILITY** Insufficient patient engagement Absence of community feedback mechanisms Inadequate understanding of beneficiary populations	Support integration of digital and non-digital approaches to ensure effective and targeted communication strategies. Address information gaps and misconceptions through analysis of digital feedback provided by the public. Provide public websites with real-time COVID-19 data to support accountability and transparency
Loss of patients to follow up.	**QUALITY** Insufficient continuity of care **UTILIZATION** Loss to follow up	Use of digital appointment reminders, e.g., SMS.

An illustrative theory of change in Figure 2 shows how RTM can help to achieve the primary end goal of improving the coverage and efficiency of SIAs, as well as a secondary end goal of strengthening the routine immunization system. The theory of change references RTM contributions during the pre-campaign, campaign and post-campaign phases.

Figure 2: Theory of Change model for using RTM for improved decision-making for vaccination campaigns



Further elaboration on the Theory of Change and how RTM can be used at various stages of an vaccination campaign may be found in Table 3 below.

Periodic intensification of routine immunization

More recent campaign-style activities, such as 'Periodic Intensification of Routine Immunization' (PIRI) – an umbrella term to describe a spectrum of time-limited, intermittent activities used to administer routine vaccinations to under-vaccinated populations – effectively blur the old boundaries between routine immunization and campaigns.

PIRI are service delivery activities are time-limited, targeted campaigns to administer routine vaccinations – including catch-up doses – to unvaccinated or under-vaccinated populations (and sometimes adults) or to reach populations traditionally underserved by routine services. Examples include Child Health Days, National Vaccination Weeks, or intensified social mobilization efforts.

A key distinction between PIRI and SIAs is that PIRI doses are recorded on the home-based record/immunization card as routine immunization doses to under-vaccinated populations within the usual target age range for routine vaccination services. In essence, they provide a catchup opportunity for children who are the usual target for routine services but who have been missed or not reached during the year and who are included in the administrative coverage data. In contrast, SIA doses are considered 'supplemental' and are not included as part of the administrative routine immunization coverage.

A PIRI differs from a vaccination campaign in a few key ways:

1. A PIRI will use the same target population as routine vaccination services, whereas a campaign will generally include a much broader age range.
2. A PIRI will generally include all routine vaccines, whereas a campaign may include few antigens.
3. A PIRI targeted delivery activity will focus on only a small number of previously selected communities known to be under-vaccinated, whereas a campaign may be regional or nationwide and/or irrespective of previous vaccination history.

As PIRI and vaccination campaign service delivery approaches are similar and need proper preparedness and implementation to achieve desired targets, rigorous monitoring is required.

The COVID-19 pandemic has severely affected routine immunization in numerous countries – with many planning vaccination campaigns and PIRI activities during the recovery phase for catch-up of missed children. RTM of those campaigns (including the planning, implementation and evaluation stages) would help to improve their efficiency and ensure all children are immunized.

At global and national levels, there are several challenges to maintaining high immunization coverage, implementing effective surveillance and allowing immunization programmes to react to problems in a timely fashion as they arise.

To successfully control and eliminate vaccine-preventable infectious diseases, appropriate vaccine coverage must be achieved and maintained. WHO and UNICEF have issued specific recommendations to address potential obstacles that may arise and improve immunization programmes. Many of these challenges and bottlenecks to immunization programmes could benefit from the adoption of digital tools and approaches, to enable real-time data, information and monitoring (see Table 2).

Table 3. RTM Uses for Various Stages of an Vaccination Campaign

Uses for RTM	Adjustments that can be made
Pre-campaign (Planning stage)	
Monitor the creation and validation of micro-plans in real-time, monitor readiness checklists. Use GIS to produce accurate maps of campaign area and use to optimize outreach strategies.	Adjust timelines or resource personnel deployed based on per cent complete or validated; if many are not complete or not correct, review gaps and possibly delay next steps. Verify quality/completeness of geospatial data of campaign area (esp. location of human settlements, households [for door-to-door], local administrative boundaries and transportation networks.
Conduct pre-campaign surveys to assess coverage, or to conduct spot checks on reach of advocacy, communication and social mobilization (ACSM) activities.	Ensure micro-plans include previously missed areas and that all human settlements/households are accounted for. Monitor data quality and movements/accountability of data collectors. Adjust pre-campaign ACSM activities.
Monitor trainings in real time, both for the quality of the training as well as for the logistics associated with the training.	If attendance is low, plan refresher trainings to address low attendance (such as inconvenient location or time). If post-test results are low, improve content or delivery. If materials are not available in time for training, ensure subsequent trainings are well stocked.
During campaign (Implementation stage)	
Track administrative coverage – identify communities with low coverage and reasons/causes.	Plan mop-up, advocacy or social mobilization activities. Track whether corrective actions have been taken.
Monitor whether standard operating procedures (SOPs) are being followed. Use geographic information systems (GIS) to verify location tracking data from mobile devices with assigned locations and agreed micro-plans to ensure staff accountability. Identify staff/teams with poor data quality.	If vaccines are being administered incorrectly, the cold chain is insufficient, or vaccinators are not following protocol, then corrective guidance can be shared with the individual site, and more broadly if the problem is widespread. If staff are not submitting data from assigned locations, or the data is not being collected during the expected time frames, disciplinary action may be required. If staff are not following the routes prescribed, further investigation may be needed, as this may result in missed households or micro-plan maps being incorrect. If certain teams have a high number of duplicates or missing or incorrect records, more training or supervision may be needed.
Support rapid service delivery and corrective interventions in response to real-time data	If access to real-time data and information reveal the need for rapid response to adjust programme strategies, this can be more quickly addressed with the support of real-time evidence-based data.

Table 3. continued

Monitor social media in real time.	If rumours or harmful stories are spreading, these can be addressed with corrective messages and stories and/or by having the stories taken down if they violate terms of service or laws.
Monitor vaccine logistics and cold chain.	If sites do not have adequate vaccine stocks, materials or cold chain equipment, corrective action can be taken to obtain the required amount (such as redistribution from sites with projected surpluses)
Link registration data to vaccine administration.	If registration was carried out, digitized registration data (perhaps in the form of barcodes or another unique identifier for the household) can be linked to forms so vaccinators do not have to enter data twice, saving time and enabling them to see more beneficiaries as a result.
Post-campaign (Evaluation)	
Monitor the disbursement of funds to health workers in real time.	If health workers are not receiving funds as planned, see if there is a certain bank or mobile operator that is performing worse than others and work with them to correct the issue. Examine the extent to which it may be associated with network access or fraud.
Conduct a post-campaign survey: (a) Use geographic information systems (GIS) to verify location tracking data from mobile devices with assigned locations and agreed micro-plans to ensure accountability, and/or (b) identify staff/teams with poor data quality. Compare location tracking data from mobile devices of vaccinators (during the campaign) with hand-drawn micro-plan maps.	Monitor data quality and movements/accountability of enumerators. If staff are not submitting data from assigned locations, or the data is not being collected during the expected time frames, disciplinary action may be required. Adjust maps and routes for vaccination teams for the next round/campaign; inform vaccination teams of specific areas to be revisited. If inconsistencies exist between location tracking data and local administrative boundaries and/or micro-plans, location data can be used to improve accuracy of micro-plans for next phase (e.g., re-draw realistic local administrative boundaries).
Cross-cutting	
Compile campaign report data and identify major gaps or issues with the data as part of data quality reviews. Use GIS to visualize pre- and post-campaign coverage and campaign information (human resources, etc.,) for monitoring purposes.	Follow-up with staff to ensure they complete and submit missing forms and/or correct mistakes.

Real-time digital monitoring in COVID-19 immunization context

The COVID-19 pandemic has disrupted billions of lives worldwide and led to unprecedented morbidity and deaths, but the start of vaccination campaigns around the world now raises hopes for a global recovery. Achieving high coverage and rapid vaccine deployment will be key to launching an inclusive and resilient recovery of economies and societies.

Vaccine delivery – including distribution and administration –comes with such challenges as the availability or reliability of ultra-cold supply chains; risks of delays in vaccine shipments; prioritization of populations to receive vaccinations; tracking of recipients for follow-up; and ensuring that most people are mobilized and vaccinated.

> RTM may be used to overcome challenges in planning, logistics management, vaccination administration, and immunization monitoringadministration, and immunization monitoring

Mass vaccination of adults, with strategic prioritization of certain groups and different types of vaccines at such a scale and urgency, has not previously been done. This includes deploying highly scalable, reliable, and interoperable digital (software) solutions to identify and prioritize recipients; track inventory and supply chains; distribute doses efficiently; and monitor uptake, effectiveness, and adverse events in real time.

Given the anticipated scale and speed of the vaccine delivery process, real-time monitoring using digital technologies can overcome challenges and play a critical role in supporting the planning, delivery, monitoring, and management of immunization programmes. It can help systematically identify targeted groups for vaccination, critical in countries with no national identification scheme. With COVID-19 vaccines still in short supply, RTM can be used to ensure that vaccines are transported safely and reach priority groups first, with minimal wastage.

The design and implementation of RTM needs to consider the infrastructure and regulatory environment of each country. These vary significantly across and within countries and interventions will typically need to be designed specifically for the context in which they are to function.

Risks of using RTM approaches for vaccination campaigns

There are risks associated with using RTM approaches for decision-making in campaigns. These risks should be anticipated and mitigated. The introduction of new approaches, including the use of technologies that may replace paper-based systems currently in use, must be well planned at all levels so that data collectors and reviewers understand the benefits of the new system or platform being used. Provision of adequate training for data collectors and supervisors at all levels can help mitigate risk of low uptake of new innovative methods using digital technologies. Because of the speed at which the RTM data is used for decision-making, it does not go through the same level of scrutiny as traditional post-evaluation data. Using RTM allows for decisions to be informed by data, but that data is likely imperfect. Limitations must be communicated to a broad range of stakeholders, including the media and politicians, who may make rapid judgments based on incomplete data. A risk management strategy can help with planning for when RTM data is incorrect, misleading or misunderstood. Some common risks and mitigation measures are elaborated in Table 4.

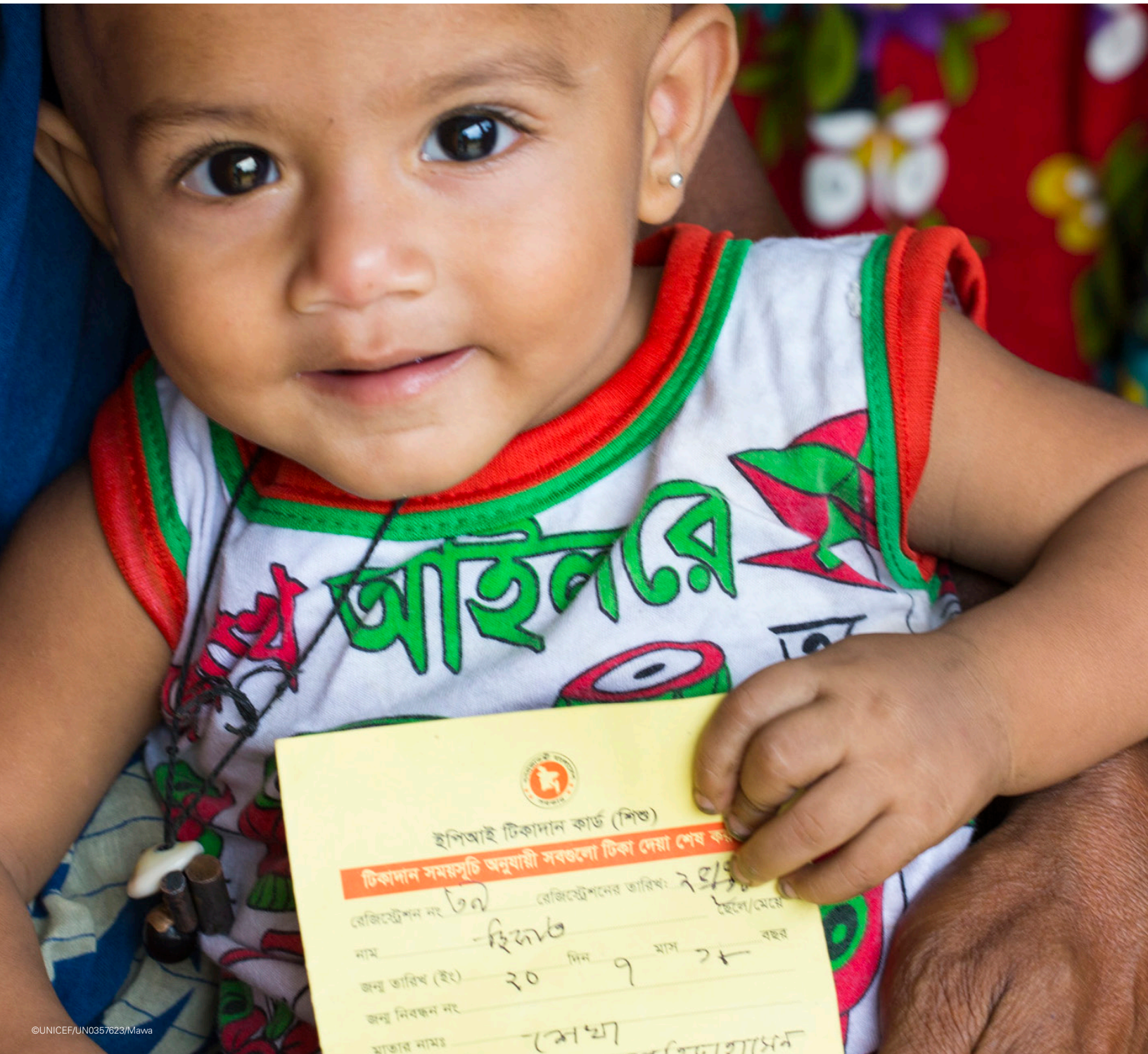


Table 4: Managing risks in using RTM approaches in vaccination campaigns

Risks with using RTM	Mitigation of risk
The introduction of a technology and digital approach to replace paper-based or manual systems may not be well received by stakeholders.	It is important that stakeholders at all levels be oriented by government to the vision of the new approach using digital RTM tools, why it is being employed and how it will make a difference. It will be helpful to introduce change management processes to support the uptake of new digital tools and platforms by users and other stakeholders. It will be useful to work with stakeholders to better understand priority data gaps and needs that may be addressed in part through RTM approaches, including how information and data should be visualized. Utilize a human-centered design approach to understand data and implementation workflows and related bottlenecks. It is critical that stakeholders at all levels receive appropriate training to support RTM implementation, including data security handling. Training may need to be repeated. This might include training to build stakeholders' capacity to accurately interpret and use real-time data. User feedback should inform training curriculum and RTM design in an iterative manner.
Multiple RTM platforms are introduced as parallel data collection platforms without adequate government ownership and without adequate consideration of data privacy and security.	Government should help partners align RTM efforts to support national health systems strengthening in order to save time and money by not duplicating effort and creating parallel systems. Coordination of the real time monitoring approach across sectors and partners is important to ensure coherence and complementarity of efforts. RTM systems should be designed to streamline health worker workflows. Consider the national laws/regulations related to data storage, protection and security in the country. If the data collection is handled and/or stored in different countries or agencies, sign an agreement/MoU in case of data sharing among countries/agencies. The introduction of an RTM approach and related digital tools should be done while considering the broader national digital health system information architecture and governance processes which should be led by government. Consult the national digital health information landscape analysis and data needs assessment, and where it does not already exist, government should develop one.
New technology and/or new users produce challenges related to quality, timeliness, and interoperability of platforms.	It is important that the RTM approach be pre-tested before a campaign. This can reveal interoperability and user experience (UX) issues, which can be corrected.
There may be data privacy concerns as multiple stakeholders may have access to digitized data and therefore easily sharable.	Only data that will help with decision-making should be collected, and collecting the most sensitive data (for example, data that tracks individual children) should be done rarely and should be anonymized. Stakeholders should sign a data use policy and have appropriate training. Data administrators should only have access to the data that is necessary for their specific role.
With rapid builds, and many users, data protection and potential external breaches can become an issue.	A country's information technology (IT) department should be involved in planning and testing of the RTM system to ensure data protection, privacy and security standards are adhered to.
Sustainability of the RTM approach and system has not been well-considered	Consider sustainability from the start, including fixed and recurring costs. Moving from a pilot or a specific geographic region to national scale must be anticipated from the outset and planned accordingly.

Section 2

Planning and implementing a real-time monitoring system to strengthen vaccination campaign delivery

To monitor and evaluate a high-quality vaccination campaign, good-quality data is needed quickly and (ideally) inexpensively, for better decision-making, to build collaboration and transparency and make data open as a reusable public good. Data driven by the use of digital technologies are changing the way that health and immunization programmes are implemented. Governments also protect the privacy of these data, especially when data is sensitive (such as personal health information) and data must be managed responsibly.[13]

Careful planning is essential for developing a sustainable RTM system. The planning process includes assessing data requirements and frequency, ensuring RTM systems are embedded in country ownership, integrating sustainability considerations, and learning. A good planning process can prevent many of bottlenecks that have been experienced in the past, some illustrative examples are further detailed in Appendix 1.

Ensuring country ownership

RTM data should be sustainable and useful for decision-making, ,and data should not be redundant or generated outside of existing national data structures and information architecture. National ownership is critical to support quality planning, implementation, data use, and sustainability.

There are several ways to ensure government ownership:

Participatory stakeholder identification and engagement through a national task force or advisory group. The RTM system should not be designed for end users; it should be designed with them. Data collectors, people who review the data, and developers should be present during the design process to ensure that the tools improve current processes, i.e., save time, use fewer resources and improve quality.[14]

A government-led SIA M&E task force - or equivalent at the country level - should include representatives from relevant sectors of government and ministries, including communication/ technology experts, to bring diverse experiences, perspectives, and problem-solving approaches. Moreover, lessons learned in this campaign will reverberate wider with diverse representation. For example, involving units outside immunization, such as health information systems, can be helpful for interpreting government policies regarding such things as hosting of data, choice of platforms, and identification of in-country developers. Beyond the technical units, representatives could be invited from administrative units in countries where they hold substantial political and financial influence, to help ensure uptake of the system.

The SIA M&E task force could set up a sub-group that would be responsible for the development and implementation of RTM with relevant government entities, implementing partners with overlapping scopes, potential technical partners, and relevant local non-governmental organizations (NGOs).

13. For more information, see https://www.ictworks.org/tag/mobile-data-collection/#.YRrVPohKiUk
14. Principles for Digital Development (digitalprinciples.org)

When identified, digital partners – such as IT staff and mobile network operator (MNO) aggregators – should be involved in the planning process as soon as possible. Finally, people with expertise in GIS and data visualization may also need to be briefed and invited to participate when necessary.

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One of the principles of the Responsible Data for Children initiative (RD4C) is that data is participatory, meaning those who use and are affected should be consulted. This includes children, their caregivers and their communities.

It is also important that aggregate immunization data, to the extent possible, be publicly available on external websites and public-facing platforms, to ensure transparency, accountability and to increase trust.

Create a shared vision A key undertaking of the government-led SIA M&E Task force, or equivalent, is to create a shared vision. The vision should articulate the goal of the RTM system and could serve as the filter for prioritizing the RTM system's functions, particularly as it will be easy for the priorities of different organizations to dilute the focus of the project/system. For example, the shared vision could read: "The RTM system will help ensure that all children are reached with vaccinations". It should be inspirational, so people are motivated to find the best solution when reflecting on the shared vision.

Articulate the need to anchor RTM initiatives within existing digital health and immunization programmes, structures and processes. It is important to situate RTM within existing HMIS structures and processes to reduce reporting burdens while contributing seamlessly to national data and statistics. As noted above, duplication of systems can increase burden, take resources away from other essential programmes, and hamper sustainability. It is important that the vision be an articulated focus on national systems strengthening and ensuring that the existing national Health and IT policy, governance, information architecture and IT infrastructure provide the frame for the development of the RTM components.

Create a plan for involving representatives from subnational levels. The users of the RTM system – the data collectors and decision makers – include people from provincial, district, facility and other levels. The overall planning process should include opportunities for them to voice their needs and to participate in user testing. Representatives from these groups can participate in initial planning meetings at the national level, or a select group from the national level can travel to at least two provinces to conduct interviews with representatives from all levels during the digital health situation analysis development. Similar approaches can be taken for user testing which is further detailed in Section 3.

Involving people from all subnational levels is a multi-step process that takes time and engagement with multiple individuals within the same organization. Although technical focal points (immunization and M&E) may need to provide input into system design, it will also be important to brief the political and administrative heads of government at the provincial and subnational levels and obtain their support. Involving them early on can prevent implementation challenges during the campaign.

Responsible Data for Children

The Responsible Data for Children Initiative (RD4C) is a joint endeavor between UNICEF and The GovLab at New York University to highlight and support best practice in responsible data management. The work is intended to address practical considerations across the data lifecycle, including routine data collection and one-off data collections; and compliments work on related topics being addressed by the development community such as guidance on specific data systems and technologies, technical standardization, and digital engagement strategies.

Indonesia

During an MR campaign, health facilities in East Java were hesitant to use RapidPro because they were comfortable with the manual reporting system.[15] The project team from UNICEF presented the benefits of RapidPro to the governor who then helped to advocate for the new tool. Demonstrating the dashboard, which showed a low reporting rate for East Java, also helped get government support. Within a few weeks, the reporting rate improved.

Having diverse representation from political and technical experts and implementers at all levels is beneficial because they can share insights on what is and is not working, as well as what could work based on their understanding of the current situation.

Uganda

The process of consulting the health information systems unit and following their recommendation to use DHIS2 (which was required by the national eHealth policy, and which was used for the national health management information system [HMIS]) helped ensure that the RTM system was using and buttressing national systems and structures. Deciding to use DHIS2 made it easier for users at all levels to interact with the RTM system because Ministry of Health staff were familiar with DHIS2. Programme planners were also able to leverage the expertise of the country's DHIS2 software developer.

15. Jusril H, Ariawan I, Damayanti R, Lazuardi L, Musa M, Wulandari SM, Pronyk P, Mechael P. Digital health for real-time monitoring of a national immunisation campaign in Indonesia: a large-scale effectiveness evaluation. BMJ Open. 2020 Dec 10;10(12):e038282.

Set a realistic timeline

As countries often carry out several campaigns in a year or over a couple of years, investing time in a well-planned system that can be used across multiple campaigns provides value for money. Other countries' experiences in the past include timelines of as little as one and three months, and they and their partners learned this was insufficient. A realistic timeline recognizes that developing an RTM system is far more than just putting campaign forms on a cell phone or tablet; it requires detailed planning on how the system should work and be jointly developed with all stakeholders and end users and then tested. Countries with previous experience using digital technologies to generate real time data may find adaptation of existing tools and platforms easier, and they will benefit from lessons learned from early implementation of RTM.

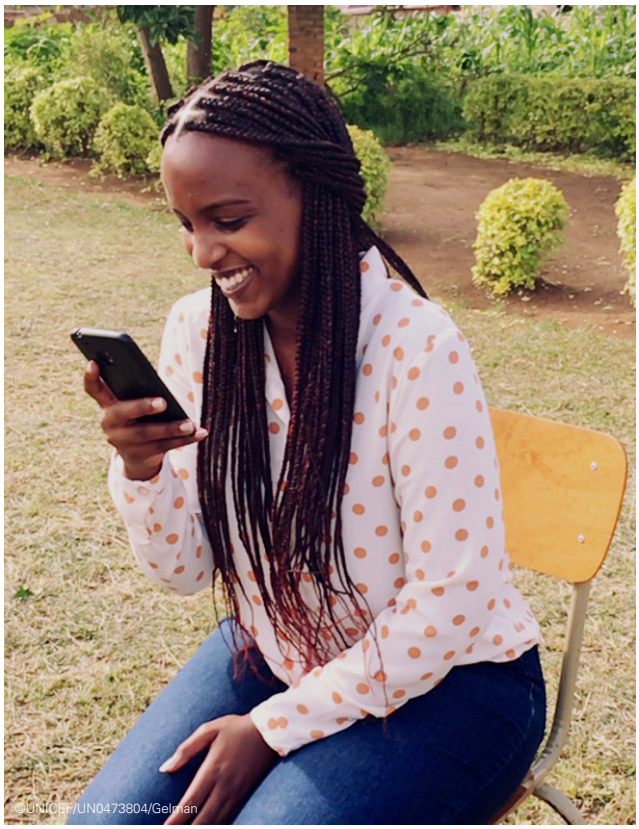
For countries without solid experience in using real-time monitoring approaches, starting the planning process six to nine months before launching the first campaign could ensure that investments made confer substantial benefits for subsequent campaigns, not just the immediate one as part of an integrated approach and effort to support routine immunization systems.

Planning for scale and sustainability at the outset

Scale and sustainability should be considered from the start. Designing for scale and sustainability means planning for implementation beyond a "pilot" by making choices that will enable widespread adoption later, as well as determining what will be affordable and usable by a whole country or region.[16] Planning will be helpful for (a) minimizing design costs by linking to or building on existing systems and processes as much as possible, and (b) considering how the RTM system can support multiple campaigns and routine immunization so maintenance costs can be integrated into future funding plans.

Conduct a digital health situation analysis, data needs and readiness assessment to inform RTM planning

A digital health situation analysis, data needs and readiness assessment is a process of understanding the digital health landscape, including existing systems, current national and subnational digital health policy frameworks,



16. Principles for Digital Development (digitalprinciples.org)

communication access, Internet connectivity and data governance.[17] Data governance is the process of managing data based on internal standards and policies to ensure its reliability and prevent misuse. Key programmatic bottlenecks and user needs for the RTM system should be specified. It should uncover what has been done so far, what is and is not working, how the campaign should ideally be implemented, and how the RTM system may help implementers achieve a high standard of quality. This involves assessing several areas

- the current and developing eHealth context
- past and ideal data flow processes
- past and ideal systems for implementation and rollouts, training, maintenance and supervision
- priority data needs and gaps

If a digital health situation analysis, data needs and readiness assessment does not already exist, the Ministry of Health's Health Information Department should determine whether an analysis would be needed. Countries with decentralized governments, for example, may require an analysis. Key components of the eHealth situation analysis are described below.

Digital Health and the SIA context

Over the past two decades, many digital health programmes have been piloted. Countries interested in implementing RTM systems have likely had past experience with digital technologies for immunization, data collection or both. Some of the key areas to explore as part of the digital health and data needs situation analysis may include:[18, 19]

- **Digital policy environment**: What digital policies exist in the country? For example, is there a digital health policy? How do these policies affect the RTM system? Are there restrictions about where data should be stored? Are there standards for interoperability? How are past and current initiatives navigating these requirements?
- **Existing eHealth programmes for immunization and data collection**: Is there a strategy to integrate the RTM system for SIAs within existing electronic health information systems? Are there existing digital health or health information systems being used for SIAs already, particularly for RTM? What about for routine immunization? What about for other campaign-like activities, such as mosquito net distribution, mass drug administration or deworming? Has digital health/RTM ever been used for performance or activity reporting, logistics management, supervision, etc., for the above? What about for routine immunization? What aspects of these systems have worked well and are appropriate for adaptation or adoption for SIAs? Why? What aspects would not work for SIAs? Why not?
- **Human resources:** Who has been responsible for designing and implementing these systems? Consider whether there are implementing partners, software developers, government focal people and other resource people who can provide expertise for the planned RTM system.
- **Financial resources and planning cycles:** How have these past and current initiatives been planned and funded? When does the planning process begin, and how does it work?
- **Coordination and oversight of SIAs:** Who are the implementing partners and government agencies involved in SIAs at each level? What are their roles? How frequently do they meet? What campaigns are planned in the next two to three years? What are their roles regarding data? Will they all have the same access to the data? Are data-sharing agreements/protections needed?
- **Network connectivity and devices:** Consider the types of users (health workers, field monitors, district management health teams) and – what kinds of mobile devices do they own? What per cent of the country has network coverage? Which areas are 'black spots' or have weak to no coverage?

The WHO Digital Implementation Investment Guide[20] identifies three types of bottlenecks:

- **Physical:** Tangible, material items failed in some way
- **Human:** People did something wrong or did not do something required
- **Organizational:** A system, process or policy that people use to make decisions is faulty

The above can provide a lens to help determine key RTM gaps and investment priorities.

Determining priority data and information needs and data uses

For each campaign stage [pre, during and post], explore the critical data and information data needs and gaps and how such data can inform decision making.

Some considerations may include:

- What elements of the campaign (microplanning, training, logistics, supervision, AEFI, ACSM, payments, etc.) needed improvement during the last few rounds?

17. Pan American Health Organization. Electronic Immunization Registry: Practical Considerations for Planning, Development, Implementation and Evaluation, 2018. https://www.paho.org/en/documents/electronic-immunization-registry-practical-considerations-planning-development
18. Pan Odendaal WA, Anstey Watkins J, Leon N, Goudge J, et.al.. Health workers' perceptions and experiences of using mHealth technologies to deliver primary healthcare services: a qualitative evidence synthesis. Cochrane Database Syst Rev. 2020 Mar 26;3(3):CD011942.
19. The GovLab and United Nations Children's Fund (Responsible Data for Children initiative), RD4C Opportunity and Risk Diagnostic Tool – Version 1, 2020, https://files.rd4c.org/RD4C_Opportunity_Risk_Diagnostic_Tool.pdf
20. World Health Organization, Digital implementation investment guide: integrating digital interventions into health programmes, WHO, 2020, https://apps.who.int/iris/bitstream/handle/10665/334306/9789240010567-eng.pdf.

- What information would be useful in identifying when corrective action is needed?
- What parts of the campaign are the most challenging and time-consuming to implement and oversee?
- How might RTM make those processes easier?
- Were there missed opportunities to use pre- and post-implementation data? What are they?

Generally, questions would cover the following issues, leading to possible follow-up decisions:

Information flows and data use practices/needs

During situation analysis, information should be collected on how immunization data (both routine and campaign) is currently collected in the country or area and ascertain data workflows. Who are the stakeholders involved? How frequently is the data shared? What are the types and quality of the data? What are the formats for sharing, review and use? Are there any challenges or missed opportunities?

The digital health situation analysis should reveal what data is needed at local levels for decision-making and how it can and should be accessed by users. Map the data flow and use at each level and the corresponding accountability. As much as possible, having stakeholders demonstrate their processes and tools will be illuminating.

Finally, after assessing how immunization data is currently collected and used, stakeholders and users at all levels should discuss, thorough an analysis of common bottlenecks and appropriate Digital Health interventions mentioned in Figure 2, how RTM can improve the use of that data for corrective action.

An Illustrative Digital Health Situation Analysis and Data Needs Checklist may be found in Appendix 2.

Ultimately, the successful implementation of an RTM approach to strengthen vaccination campaigns requires a supportive enabling environment including:

Questions	Possible Follow-up
What kinds of priority data needed for decision making are collected before/during/after campaigns, and with what frequency?	Ensure the necessary data is collected.
Who are the different partners involved? What is their role? What kinds of data do they need?	Ensure partners have access to the type of data they need. For instance, if one partner is involved in community mobilizing and another is involved in logistics, they will need access to different types of data.
What tools are used? How is this data collected? By whom? How long does it take? Are there any challenges in data collection currently?	Identify any bottlenecks in data collection and where in the process they occur.
How is data compiled? How is it analysed? By whom? How long does it take? Are there any challenges in data analysis currently?	Identify bottlenecks in the data analysis process.
What processes are used to share information? How often do these meetings/exchanges occur? Who shares the information with whom? What kinds of decisions are made with the information?	Determine whether all the data is being used for decision-making (if not, this data does not need to be collected). Identify whether decision-making meetings are occurring frequently enough.
Invite people to show existing forms, reports and dashboards. Probe specific indicators they find most useful and what types of decisions are made through these indicators.	Identify what data is essential and what data is not necessary.
How well do existing information-sharing systems work? Are there any challenges in accessing and sharing information currently? Are dashboards being used at national/province/district/subdistrict level? Why or why not? How do people handle these challenges?	Improve dashboard based on use
To what extent did past/current initiatives alleviate or increase staff workload?	Ensure that staff's time is being properly allocated and that RTM is not making workloads unmanageable.

Figure 4: WHO Classification of Digital Health Interventions

1.0 Clients

- **1.1 Targeted client communication**
  - 1.1.1 Transmit health event alerts to specific population group(s)
  - 1.1.2 Transmit targeted health information to client(s) based on health status or demographics
  - 1.1.3 Transmit targeted alerts and reminders to client(s)
  - 1.1.4 Transmit diagnostics result, or availability of result, to client(s)
- **1.2 Untargeted client communication**
  - 1.2.1 Transmit untargeted health information to an undefined population
  - 1.2.2 Transmit untargeted health event alerts to undefined group
- **1.3 Client to client communication**
  - 1.3.1 Peer group for clients
- **1.4 Personal health tracking**
  - 1.4.1 Access by client to own medical records
  - 1.4.2 Self monitoring of health or diagnostic data by client
  - 1.4.3 Active data capture/ documentation by client
- **1.5 Citizen based reporting**
  - 1.5.1 Reporting of health system feedback by clients
  - 1.5.2 Reporting of public health events by clients
- **1.6 On-demand information services to clients**
  - 1.6.1 Client look-up of health information
- **1.7 Client financial transactions**
  - 1.7.1 Transmit or manage out of pocket payments by client(s)
  - 1.7.2 Transmit or manage vouchers to client(s) for health services
  - 1.7.3 Transmit or manage incentives to client(s) for health services

2.0 Healthcare Providers

- **2.1 Client identification and registration**
  - 2.1.1 Verify client unique identity
  - 2.1.2 Enrol client for health services/clinical care plan
- **2.2 Client health records**
  - 2.2.1 Longitudinal tracking of clients' health status and services
  - 2.2.2 Manage client's structured clinical records
  - 2.2.3 Manage client's unstructured clinical records
  - 2.2.4 Routine health indicator data collection and management
- **2.3 Healthcare provider decision support**
  - 2.3.1 Provide prompts and alerts based according to protocol
  - 2.3.2 Provide checklist according to protocol
  - 2.3.3 Screen clients by risk or other health status
- **2.4 Telemedicine**
  - 2.4.1 Consultations between remote client and healthcare provider
  - 2.4.2 Remote monitoring of client health or diagnostic data by provider
  - 2.4.3 Transmission of medical data to healthcare provider
  - 2.4.4 Consultations for case management between healthcare provider(s)
- **2.5 Healthcare provider communication**
  - 2.5.1 Communication from healthcare provider(s) to supervisor
  - 2.5.2 Communication and performance feedback to healthcare provider(s)
  - 2.5.3 Transmit routine news and workflow notifications to healthcare provider(s)
  - 2.5.4 Transmit non-routine health event alerts to healthcare provider(s)
  - 2.5.5 Peer group for healthcare providers
- **2.6 Referral coordination**
  - 2.6.1 Coordinate emergency response and transport
  - 2.6.2 Manage referrals between points of service within health sector
  - 2.6.3 Manage referrals between health and other sectors
- **2.7 Health worker activity planning and scheduling**
  - 2.7.1 Identify client(s) in need of services
  - 2.7.2 Schedule healthcare provider's activities
- **2.8 Healthcare provider training**
  - 2.8.1 Provide training content to healthcare provider(s)
  - 2.8.2 Assess capacity of healthcare provider(s)
- **2.9 Prescription and medication management**
  - 2.9.1 Transmit or track prescription orders
  - 2.9.2 Track client's medication consumption
  - 2.9.3 Report adverse drug events
- **2.10 Laboratory and diagnostics imaging manangement**
  - 2.10.1 Transmit diagnostic result to healthcare provider
  - 2.10.2 Transmit and track diagnostic orders
  - 2.10.3 Capture diagnostic results from digital devices
  - 2.10.4 Track biological specimens

3.0 Health Systems Managers

- **3.1 Human resource management**
  - 3.1.1 List health workforce cadres and related identification information
  - 3.1.2 Monitor performance of healthcare provider(s)
  - 3.1.3 Manage certification/ registration of healthcare provider(s)
  - 3.1.4 Record training credentials of healthcare provider(s)
- **3.2 Supply chain management**
  - 3.2.1 Manage inventory and distribution of health commodities
  - 3.2.2 Notify stock levels of health commodities
  - 3.2.3 Monitor cold-chain sensitive commodities
  - 3.2.4 Register licensed drugs and health commodities
  - 3.2.5 Manage procurement of commodities
  - 3.2.6 Report counterfeit or substandard drugs by clients
- **3.3 Public health event notification**
  - 3.3.1 Notification of public health events from point of diagnosis
- **3.4 Civil Registration and Vital Statistic**
  - 3.4.1 Notify birth event
  - 3.4.2 Register birth event
  - 3.4.3 Certify birth event
  - 3.4.4 Notify death event
  - 3.4.5 Register death event
  - 3.4.6 Certify death event
- **3.5 Health financing**
  - 3.5.1 Register and verify client insurance membership
  - 3.5.2 Track insurance billing and claims submission
  - 3.5.3 Track and manage insurance reimbursement
  - 3.5.4 Transmit routine payroll payment to healthcare provider(s)
  - 3.5.5 Transmit or manage incentives to healthcare provider(s)
  - 3.5.6 Manage budget and expenditures
- **3.6 Equipment and asset management**
  - 3.6.1 Monitor status of health equipment
  - 3.6.2 Track regulation and licensing of medical equipment
- **3.7 Facility management**
  - 3.7.1 List health facilities and related information
  - 3.7.2 Assess health facilities

4.0 Data Services

- **4.1 Data collection, management, and use**
  - 4.1.1 Non-routine data collection and management
  - 4.1.2 Data storage and aggregation
  - 4.1.3 Data synthesis and visualization
  - 4.1.4 Automated analysis of data to generate new information or predictions on future events
- **4.2 Data coding**
  - 4.2.1 Parse unstructured data into structured data
  - 4.2.2 Merge, de-duplicate, and curate coded datasets or terminologies
  - 4.2.3 Classify disease codes or cause of mortality
- **4.3 Location mapping**
  - 4.3.1 Map location of health facilities/structures
  - 4.3.2 Map location of health events
  - 4.3.3 Map location of clients and households
  - 4.3.4 Map location of healthcare providers
- **4.4 Data exchange and interoperability**
  - 4.4.1 Data exchange across systems

Analysis of data and information use bottlenecks to identify priority RTM interventions

Not all vaccination campaign challenges and bottlenecks can be addressed through real-time monitoring approaches supported by digital solutions. Therefore, it is important to identify the bottlenecks related to data and information flows, data use practices and decision making and link these bottlenecks to the most appropriate RTM interventions to address these challenges. As an example, a number of bottlenecks are identified in Table 2 and articulated as Health System Challenges. Working with multi-stakeholder groups, including end users, can point to the most appropriate real time monitoring approaches to be employed, using the lens of WHO Digital Health System Interventions.

Figure 5: Example bottlenecks, and health system challenges addressed through digital health interventions and RTM activities

Identified bottlenecks to be addressed	Health System Challenge[20]	Digital Health System Intervention[21]	Activities based on real time monitoring approaches using digital tools and platforms
Poor coordination among sectoral ministries and partners for vaccination campaigns.	**INFORMATION** Communication roadblocks Lack of access to information and data **EFFICIENCY** Poor planning and coordination **COST** High cost of manual processes Lack of effective resource allocation	**DATA COLLECTION STORAGE AND MANAGEMENT** Non-routine data collection and management. Data storage and aggregation Data synthesis and aggregation Automated analysis of data to generate new information or predictions on future events **LOCATION MAPPING** Map location of health facilities and structures Map location of health events Map location of healthcare providers **DATA EXCHANGE AND INTEROPERABILITY** Data exchange across systems	Real time data and information available to all ministries at central and subnational levels through integrated Health Management Information Systems and related dashboards and websites. Coordination and information sharing through social media channels [e.g., WhatsApp].
Delay in disease incidence reporting and low specificity of signals.	**INFORMATION** Lack of access to information and data Delayed reporting of events	**DATA COLLECTION STORAGE AND MANAGEMENT** Non-routine data collection and management Data storage and aggregation Data synthesis and aggregation Automated analysis of data to generate new information or predictions on future events **LOCATION MAPPING** Map location of health events	Epidemic intelligence based on aggregation of different information and data sources Integration of epidemiological data into automated and real time visuals i.e., dashboards, maps and reporting formats Participatory surveillance Geolocation of surveillance

21. World Health Organization, 'Classification of Digital Health Interventions: A shared language to describe the uses of digital technology for health', WHO, Geneva, 2018, WHO-RHR-18.06-eng.pdf.
22. World Health Organization, 'Classification of Digital Health Interventions: A shared language to describe the uses of digital technology for health', WHO, Geneva, 2018, WHO-RHR-18.06-eng.pdf.

- Government leadership and ownership of health information system architecture and related decisions;
- Appropriate national strategies, costed plans and investments to support the design and roll out of the RTM approach;
- An agile health workforce, poised to assume new digital skills and expertise through orientation and training;
- Supporting legislation and policies, including safeguards for data privacy and security of citizens;
- Provision of health information infrastructure and services aligned with national strategies and priorities, and related governance.

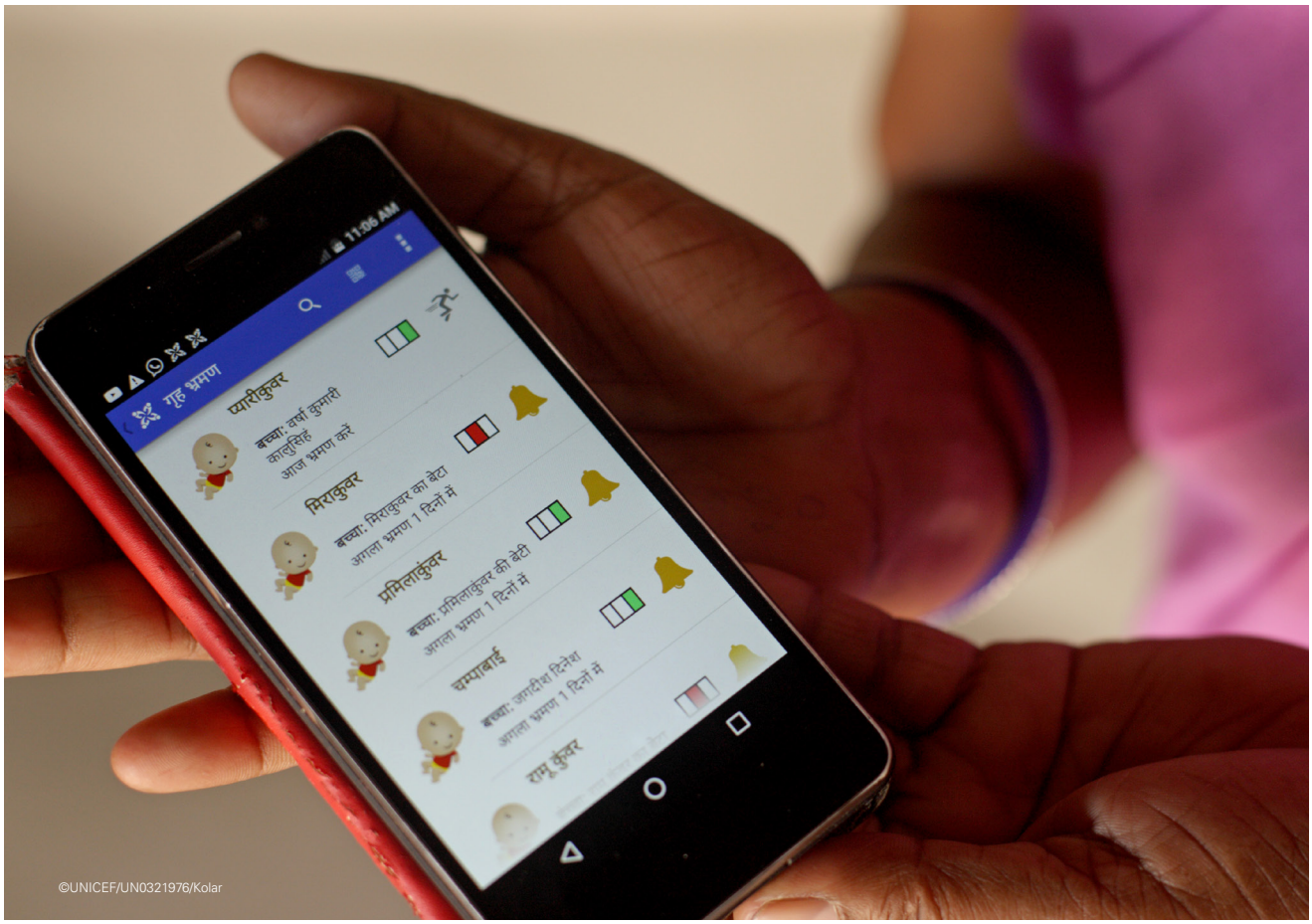
Data Management Planning

It is important to be clear during the RTM design stage how data will be collected, transmitted, stored, analysed and curated, and how all interventions will be tracked and documented.

One best practice at the activity-planning level is to develop a data management plan to outline the resources and data needs discussed above in a greater level of detail than what is already required in the M&E plans.

A data management plan should:

- **Be grounded** in the activity's theory of change and M&E plan.
- **Identify** data needs related to the following:
  - achieving desired outputs and outcomes,
  - monitoring an activity's performance against results and adapting as necessary, and
  - evaluating outcomes and impacts.
- **Identify** whether third-party data sources are available or necessary (e.g., demographic information, household surveys and geospatial information).
- **Describe** how activity managers and implementers will store, manage, process, analyse and document this data throughout the activity.
- **Describe** plans for curation.
- Identify which data can or cannot be released publicly because of privacy concerns.
- **Describe** costs and benefits of collecting and using these data, considering the administrative and beneficiary burden.



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Implementation

Stakeholders should consider what has worked well in rolling out past or current RTM or digital health and immunization initiatives, and what challenges should be anticipated. A review of past campaign or programme reports and training materials might be especially helpful, in addition to interviews with users and stakeholders.

- **Training:** How was training conducted in the past? Who was trained? What were the topics? How much emphasis was there on data collection and use? What is the level of digital literacy among field workers who will collect data, as well as managers and supervisors who will support them? How are knowledge and skills assessed during and post-training? Looking back, in what areas do users and stakeholders wish they had better skills or information? What further interventions are needed to ensure adequate skill levels are present at the beginning of the intervention and maintained?

- **Maintenance:** Who is responsible for maintaining the software and hardware used in the current/past system? How were issues with data entry forms, dashboards, permissions/data access, and data quality detected and corrected? How were data plans issued and recharged? What is the device replacement rate for previous interventions? What services are in place to managed broken and detective devices?

- **Supporting environment:** If the RTM system will be designed to improve certain aspects of SIAs (such as identifying gaps in advocacy, communication, and social mobilization activities, or monitoring adherence to SOPs at vaccine posts), is the broader programme prepared to support the additional corrective actions that the RTM system may detect?

- **Governance and responsibilities**: Clarity regarding governance and responsibilities in respect to data is important. It must be clear who is responsible for follow-up if there are data breaches. It must also be clear who is responsible for communications. This will ensure that the campaign is speaking with a consistent voice and information is not contradictory.

Data ownership and data sovereignty

Data sovereignty defines which country's laws apply to data during processing. For example, if data is processed within the borders of any given country, its laws are paramount, regardless of who did the processing and for what reason, or by whom the data was funded. Data ownership considers who has final, legal authority over access and use of the data.

Using responsible data practices to meet data quality standards

Table 5 outlines ways to best meet data quality standards. Example questions are included to help with incorporating responsible data into a quality analysis and improve results.

Figure 6: Considerations for meeting data quality standards

Standard	Questions	Possible Follow-up
Validity	Data should clearly and adequately represent the intended result.	What staff training processes are in place to facilitate accurate and unbiased data collection?
Integrity	Data collected should have safeguards to minimize the risk of transcription error or manipulation.	Who can edit data, at which point, and for what purposes? Are rights to edit as restricted as possible, both in terms of who can edit the data and during whichever intervention phase(s) they access it?
Precision	Data should have a sufficient level of detail to permit management decision-making.	Do any of the privacy protections (i.e., data aggregation or lean data) impede data use for decision-making?
Reliability	Data should reflect stable and consistent collection processes and analysis methods over time.	Are there standard protocols in place to promote responsible data handling, such as protocols/ approaches for aggregation to promote reliable interpretation?
Timeliness	Data should be available at a useful frequency, should be current, and should be timely enough to influence management decision-making.	In planning the frequency of collection, has the burden to the beneficiary been considered?

Pakistan

Pakistan does not allow data to be stored in the cloud; it must be stored in the Ministry server in Islamabad. In a decentralized system, this can present lags in availability when data for a provincial campaign is stored and cleaned at the federal level, but the province has to implement and manage the campaign and adapt their activities on a day-to-day basis.

Egypt

Government restrictions meant RapidPro data had to be hosted in-country. This required additional training from a local firm for administrators to maintain and manage data.

Data storage

Data storage considerations are sometimes decided by a country's digital guidelines and policies; some countries require data to be stored in-country and some require it to be stored with the government. Other options may also exist. For example, WHO AFRO provide server space for countries without their own data servers, and the requirement to use only a country's servers may apply just to individualized health data and not to aggregated, de-identified programme data. It is recommended to pay a third party to manage data hosting in countries where there is weak, inadequate information technology infrastructure and facilities (see Technical Support Assistance for Digital Tools and Systems section in Section 3).

Understanding these requirements demonstrates the importance of conducting a situation analysis and of starting the planning process early.

Finally, issues regarding who can access data and what they can do with it will also need to be articulated during the planning process and based on the sensitivity of the data, shall be encrypted while in storage. The selected system should allow very few users to manipulate or change data but allow as many as possible to easily access key results like de-identified, aggregate data for the geographic and technical areas they need to support. The level of access to the data should coincide with their role. One of the principles of RD4C is that responsible data is proportional, so the collection and retention of data should be relevant, limited and adequate to what is necessary for achieving intended purposes.

Data Security

Information security plays a critical role in the development of any 'solution' and should be a foundational guiding principle. The information that is collected and/or further processed and/or stored needs to be classified, as do the systems used in the information chain. In assessing the appropriate level of classification, the system shall consider the risks that are exposed and undergo an analysis that may include local situational awareness and the potential impact to individuals whose information is compromised due to accidental or unlawful destruction; loss; alteration; unauthorized disclosure of; or access to personal data.

Prevention of harms across the data life cycle should be one principle. Risks across the data life cycle should be prevented, including data collection, storage, sharing, analysis, and use. Personally identifiable data require specific consideration, and personally identifiable information should be collected only when it is necessary for decision-making and where there are protections for the subject. The Responsible Data for Children Opportunity and Risk Diagnostic Tool,[23] noted in the resources below, can be used to assess risks.

All information should be classified by risk and sensitivity to protect children's rights, e.g., biometric and health data and data about those in conflict areas can increase risks to privacy and security.

Appropriate technical and organizational measures should be implemented to ensure a level of security appropriate to the risk, including as appropriate:

23. Singh, J., Cobbe, J. and Norval, 'Decision Provenance: Harnessing Data Flow for Accountable Systems', IEEE Access, volume 7, 2019, https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=8579125

Indonesia

Data security and privacy concerns were discussed during the planning stage. RapidPro was designed to collect and report only aggregated data, while the paper-based manual system used by nurses recorded individual-level data that were then kept only at clinics.

- The capability to ensure ongoing confidentiality, integrity, availability and resilience of processing systems and services;
- Following the principle of least privilege, guaranteeing that users, groups, roles, and device identifiers will be unique and assigned to each entity;
- Implementing encryption of personal data to protect data in transit and in storage where only authorized users can access the information;
- The capability to restore availability and access to personal data in a timely manner in the event of a physical or technical incident;
- Deleting confidential/personal data so that it cannot be reconstructed once the data is not needed;
- Performing a process to regularly test, assess, and evaluate the effectiveness of technical and organizational measures for ensuring the security of the processing;
- Generating and processing auditing tracks covering all actions taken on personal data;
- Notifying of security incidents, with its escalation formally documented.

See Appendix 3 for a list of considerations when mitigating risks associated with data management and protecting data privacy by implementation phases.

Resources for data security

- Industry Toolkit: Children's Online Privacy and Freedom of Expression[24]
- Responsible Data for Children[25]

See Appendix 3 for a list of considerations when mitigating risks associated with data management and protecting data privacy by implementation phases.

Indonesia

Training of district managers took place face-to-face in their respective districts, and health facility staff received training by programme managers. Additionally, a manual and short video were disseminated through existing social media networks for further reference.

Uganda

The RTM system for data collection and reporting was incorporated into training at all levels of health systems. The Health Information Systems Programme trained the national coordinators on how to display and find information on the dashboard. A user guide was developed and shared with the sub-national teams on how to submit form data and use the dashboard application, and incorporated into the cascade trainings.

24. DISCUSSION PAPER SERIES: Children's Rights and Business in a Digital World. PRIVACY, PROTECTION OF PERSONAL INFORMATION AND REPUTATION RIGHTS. UNICEF_CRB_Digital_World_Series_PRIVACY.pdf
25. THE RD4C PRINCIPLES. Responsible Data for Children (rd4c.org)

Training and capacity-building

Everyone involved in RTM should have practical training focusing on their specific tasks. For example, data collectors should have practice entering electronic forms, and supervisors and district/provincial/national teams should have practice reviewing results and identifying their implications. Ideally, practical skills in data entry, review and interpretation should also be paired with skills in implementing the range of actions needed. For example, supervisors should learn and have practice in providing feedback, and ACSM staff should know how to reallocate/redirect ACSM activities. As a good practice, RTM training is not conducted as stand-alone but is incorporated into the overall curriculum for that group's campaign-related training, so the development of technical skills is linked with improved skills in data use.

Trainings should also address maintenance issues. It should be clear who is responsible for maintaining the software and hardware, who to go to for assistance, and how data plans are issued and recharged.
Trainings may not be a one-off event, particularly if RTM data is used for multiple campaign phases. If RTM data is used for pre-campaign purposes, then a training may focus on data collection as well as interpretation and use for conducting cross-sectoral advocacy and microplanning. More training may be needed at the start of the intra- and post-campaign phases if the required skill sets are different. To minimize costs, in-person trainings should be consolidated as much as possible.

The terms of reference for software developers/consultants involved in the digital platform design have sometimes often included conducting trainings and developing materials as a good practice. In addition to face-to-face trainings, user guides/manuals and short videos have been used. Finally, another resource for capacity-building and building data leadership is peer support, whereby staff are explicitly encouraged to help

Supervision and feedback

Performance feedback can be motivating for staff. RTM systems can be designed to provide confirmation that submissions of data by staff have been received and can issue feedback on their performance. Such was the case in Indonesia, where field staff received daily SMS feedback reports through RapidPro on coverage. RTM using RapidPro also facilitated supervisors' work by providing reminders of data submission.

In addition to providing feedback, RTM systems can be designed to help supervisors and programme managers identify performance issues. Some countries have used GPS tracking to monitor the movements of field staff; data quality checks on data-collection forms can identify staff who need closer monitoring or assistance; and supervision checklists can be automatically scored to see whether SOPs are being followed adequately. Although the immediate supervisor would have been aware of any problem after completing the supervision checklist, higher-level managers can be alerted if there are systematic issues (issues occurring at multiple sites at significant rates – see Pakistan example on page 44). Finally, having performance data can help in the selection of staff for future campaigns or promotions and/or new roles.

Monitoring and evaluation

Countries or programmes wishing to add RTM to their SIAs may also wish to assess the performance of the RTM component itself (monitoring) and its contribution to the campaign (evaluation).

RTM tools can be particularly helpful for tracking the quality of data collection and degree of data use.
.
After the campaign, additional qualitative methods like after-action reviews with stakeholders and a review of programme documents can be used to obtain specific examples of how RTM may have contributed to various aspects of SIA planning, implementation, and routine programmes. These reviews can also be used to understand user satisfaction and glean ideas for improvement.

The Tables in Appendix 4 highlight questions and objectives for monitoring and evaluating an RTM system, the types of data and indicators involved, and potential data sources. Planning is essential, as having a clear plan for how RTM data will be used informs what data will be collected, and how the RTM system will be assessed. Note that the indicators in Appendix 4 are focused on monitoring and evaluating the RTM system, not on monitoring and evaluating the SIA itself, for which there is already existing WHO guidance.[26]

Incorporating RTM into Government workplans and funding cycles

Workplans and budgets for RTM should be a part of the overall government work plan and budget governed by a government-led and coordinated governance mechanism supporting digital transformation and digital systems strengthening in the health and immunization sector. By including RTM in government workplans, one can reduce redundancies or gaps that can occur by agencies working in silos. Having a government workplan focused on the achievement of agreed- to results can also expose potential avenues for partnership and collaboration across government agencies and external partners.

Cost and budget considerations

Table 6 contains a list of cost drivers to consider when budgeting for RTM. Not every campaign will involve every one of the costs shown. Cost savings can be found in the areas of printing and transporting forms as well as in staff time spent on data cleaning. However, some start-up costs can be incurred in conducting a situation analysis, digital platform design and testing, and in designing training materials. Maintenance costs can include Internet or data packages, data storage, software licences, and IT support.

Uganda

Going paperless helped the country save money on printing forms and in the costs and time associated with transporting forms and data.

26. World Health Organization, 'Planning and Implementing High-Quality Supplementary Immunization Activities for Injectable Vaccines Using an Example of Measles and Rubella Vaccines: Field guide, WHO, Geneva, 2016. . https://www.who.int/publications/i/item/9789241511254

When evaluating the potential expense of an RTM system, financial costs should be weighed against benefits such as better visibility over field activities, being able to take corrective measures more promptly, improved data quality and increased campaign efficiency.

Table 7: Costs associated with RTM systems

Cost Category	Examples of associated costs
Planning	• Time for a team to conduct a digital health situation analysis • Daily travel and meeting costs
Development	• Developer costs • System customization costs if a system is being adapted • Costs of pilot deployment and subsequent modifications • User testing
Hardware	• Computers • Cell phones • Tablets, smartphones • External power banks • Printers • Surge protectors
Software	• System software licensing (free, per user, per environment, etc.)
Network infrastructure	• Internet connectivity costs
Physical infrastructure	• Space for hardware and data-entry equipment and personnel • Office supplies
Training	• Development of training materials • Costs of travel and meetings for trainers and participants • Hours devoted to staff training
Data Servers	• Servers for data storage and protection
Maintenance	• Cost of software maintenance (changes to fix and prevent errors, or to adapt it to new systems [e.g., new operating system updates or to add functionalities • Renewal of software licences • Replacement of obsolete or lost equipment
Human resources	• Wages or compensation for data collectors, supervisors, administrative personnel, data analysts and programme managers
M&E of the RTM system	• Time and wages for data collection and analysis • Travel and meeting costs for data collection and dissemination

Learning from RTM experience

M&E activities can help with assessing how well the RTM system worked and how it can be improved so investments are built upon and not lost. RTM utilization data can be analysed and a qualitative process evaluation/review with users can be conducted to obtain this type of feedback and inform scale-up and continuity plans.

Indonesia

Indonesia piloted the use of RapidPro during Phase 1 of the 2017 MR campaign on Java Island. Analysis of administrative data found a high level of congruence between paper and digital data (95 per cent), which suggested that RapidPro could be used at scale. The tool was refined and used during the nationwide campaign (Phase 2). After the campaign, an evaluation found its use positively influenced overall immunization coverage. Sites where respondents indicated that RapidPro was useful for problem identification and corrective action were more likely to have achieved targets. Districts that had higher reporting compliance were more likely to reach 100 per cent coverage. Articulating a theory of change (i.e., how RapidPro can contribute to the campaign) was useful for driving improvements to the tool and for conducting the evaluation.[26]

26. Jusril, Hafizah & Ariawan, Iwan & Damayanti, Rita & Lazuardi, Lutfan & Musa, Miriam & Wulandari, Suci & Pronyk, Paul & Mechael, Patricia. (2020). Digital health for real-time monitoring of a national immunisation Campaign in Indonesia: a la=rge-scale effectiveness evaluation. BMJ Open. 10. e038282. 10.1136/bmjopen-2020-038282.

Section 3

Key considerations in the selection and use of digital technologies to support real-time monitoring of vaccination campaigns

Platform selection and design

Integration and interoperability

Various software applications have been used for RTM for vaccination campaigns, and each has strengths and weaknesses. These should be considered in light of users' needs, as identified in the situation analysis and existing systems already in use, and their capacities.

As mentioned in Section 1, an RTM system has six components: data collection; data analysis and visualization; communication/dissemination; use (action/decision); monitoring; and evaluation. The Theory of Change illustrated in Section 1 describes how RTM can contribute to results in multiple areas at the Impact level – including achievement of campaign targets, optimization of campaign resources, improved service delivery among other areas. Given the multitude of options for RTM investment, it is unlikely that a single digital technology platform will satisfy every function or support the achievement of each impact area.

National partners may choose to focus on one specific programme bottleneck to be addressed by real-time approaches, before considering expansion into other areas. Focusing digital investments in one or two key areas would allow for learning and adaptation before further scale.

Lessons learned from real-time data and adaptive management across development sectors overseas,[27] found that no country had solely used off-the-shelf existing or novel solutions or innovations that were not mature or tested.

The critical challenge is the selection of the RTM tool and platform and its integration and interoperability with existing tools, platforms, and systems.

27. USAID 'Bridging the Gap: How real-time data can contribute to adaptive management in international development', Briefing Paper, USAID, Washington, D.C., . https://www.usaid.gov/sites/default/files/documents/15396/RTDAM_Briefing_Paper.pdf

Integration and interoperability refers to the ability of different data systems to exchange information. Compared with devising a one-size-fits-all type of system, being able to link different applications/platforms allows campaigns to use the best combination of software solutions for each context. Some of the resulting benefits include:

- Maximizing fit to programme needs: The combination of linked tools ensures that all the important processes of the RTM system are supported in the desired ways;
- Reduced development costs: Rather than building entirely new modules or features from scratch, existing software applications can be linked together;
- Increased ability to conduct more analyses: For example, the routine immunization programme can link to and draw from a list of recently registered children from polio SIAs to identify those who need follow-up. Logistics management information systems can also be compared with service delivery statistics to account for commodity consumption;
- Minimize data collection: For example, a platform can pull lists of registered children from a recent polio campaign to inform microplanning for an MR vaccination campaign;
- Supporting routine immunization services: Campaigns largely exist because of low uptake of routine immunization services. For this reason, RTM for campaigns should try to strengthen and build on routine immunization programmes as much as possible;
- Strengthening government staff's skills using existing systems: This is linked to sustainability. It may be worthwhile using software that government partners are already comfortable with and willing to support, even if it is less ideal than other software in other ways.

Zambia

Zambia has been using RTM for SIAs since 2012. Its RTM system links software applications that are particularly good at specific tasks. OnaData is used for data collection, and results are displayed in Power BI dashboards. These dashboards are accessible at subnational levels and users can drill down to granular details (even at community level). Dashboards are complemented with other methods for data use such as the production of situation reports for high-level officials, daily review meetings and WhatsApp groups for people in the field.

Uganda

One technology may not always satisfy every need and multiple technologies can be utilized. In Uganda, the ODK-DHIS2 RTM system combined the strengths of two platforms. ODK was known for effective field-based cell phone data collection but had weak dashboard/data visualization features. Pairing it with DHIS2's dashboard allowed Uganda to have the best of both worlds.

Commonly used RTM digital tools and platforms

Table 7 compares tools used for RTM for campaigns. Because of the frequency with which software is updated and developed, this table summarizes high-level features. It is often more realistic to find software applications that can meet key needs well and find a way to connect them, rather than looking to enhance or deploy a single platform fitting all programme bottleneck requirements.

Table 7: Digital tools commonly used for SIAs and their strengths and weaknesses for performing RTM tasks

Software used for RTM of SIAs	Essential elements of an RTM System			Considerations		
	Data Collection	Data analysis and visualization	Communicating/ discussing findings and decisions	Open Source Y/N	Fee Liscnece Y/N	Works Online Y/N
ODK-based platforms (KoBo, OnaData, etc.)	Very user-friendly. Easy to create forms on Excel. Quantitative survey-like interface only. Data collection is done through ODK, and services like KoBo and ODK allow for review of the data. Data collection can be done offline, but users must be online to upload. Requires smartphones.	Charts and graphs are only for national totals; they cannot scale results for local levels. Visualizations are not optimized for phones. Not designed for visualizing thousands of surveys; often, ODK platforms are used in conjunction with data visualization platforms. GPS data can be collected using ODK-based platforms.	None. These were primarily designed for data collection.	Yes	Yes	Yes
Power BI	Not a data-collection platform.	Data can be pushed to Power BI for real-time data visualization from several data collection tools and other platforms. Power BI also integrates with GPS platforms, i.e., ArcGIS. Power BI also integrates with DHIS2. Visuals (graphs, charts, maps) can be scaled to any level (national, district, facility).	Business rules can be added to dashboards to flag whether actions are needed. However, discussion of their implications would need to take place outside the software..	No	No Users that have a free license have limited capabilities	Yes
DHIS2	Native data collection clients in both web and mobile (Android). Very flexible and configurable data collection forms for individual based or aggregated data. Configuration also allows for dynamic data collection forms and decision support. Full offline data collection functionality is supported when using the DHIS2 Android app. Internet is required for first log in. Data can be sent over Internet connection or mobile network (SMS). DHIS2 allows users to capture GPS coordinates and polygons in both web and Android clients.	Visuals (graphs, charts, maps) can be scaled to any level (national, district, facility) on any IT equipment (smartphone or computer). Visuals and dashboards can be configured and shared at any level or on user/ user group based. Dashboards are optimized to render in mobile devices and work offline. DHIS2 visualizations integrate data from its native clients (web and mobile Android app). It can also integrate data from third party software sent through the Web API. The DHIS2 Android application renders local analytics, which are a simple version of the web analytics based on the data saved to the mobile device. Mobile local analytics are automatically updated when data is collected in the device and do not require internet connection.	Business rules can be added to dashboards to flag whether actions are needed. Summary bulletines can be sent by email and SMS. Automatic feedback can be sent via email such as daily summaries of coverage or alert.	Yes	Yes	Partial. DHIS2 web is meant to work online, but performs well with unstable connections and, in the case of dashboards, has the ability to work offline. Full offline support for data collection and analytics is supported through the DHIS2 Android app.

Note: *These were the most frequently used tools identified from focus-group interviews with several countries. It is likely that other tools (such as Tableau for data visualization) have been considered and used, but these were those that countries generally referred to when discussing RTM for campaigns. Most of the use cases involved monitoring for preparedness and supervisory checklists, RCAs, and post-campaign surveys. Another tool used for campaigns is Survey123, which is similar to the ODK-based tools in that it is primarily designed for data collection.*

Table 7: continued

Software used for RTM of SIAs	Essential elements of an RTM System			Considerations		
	Data Collection	Data analysis and visualization	Communicating/ discussing findings and decisions	Open Source Y/N	Fee Liscnece Y/N	Works Online Y/N
Rapid Pro	Data submission is done via SMS, voice, Android app, or social media messaging apps (like Facebook, WhatsApp, Line, etc.). Can use a 'dumb phone' (i.e., a basic mobile phone that lacks the functionality and Internet capacity of a smartphone) or a smartphone. GPS coordinates, photos, video, and audio can be collected with many channel types.	Data can be pushed to dashboards that are accessible on the web or are used in conjunction with data visualization platforms, i.e., Power BI and other.	Automatic feedback can be sent via SMS or social media, such as daily summaries of coverage. Can also send automated reminders or messages to field staff. Email reports and event-driven webhook APIs can be configured for additional notification and reporting integrations.	Yes	Yes	Yes
WhatsApp	Usable for qualitative data (pictures and descriptions of incidents/issues). Not recommended for quantitative form-like data. Has been used in Pakistan as a temporary workaround for submitting a limited number of quantitative updates (target and number vaccinated) from village to district level, to track coverage that was entered in an information system manually at a higher level. Requires smartphones.	Cannot compile data. Cannot generate charts, tables or other visuals and data summaries. These would need to be done manually.	Great for discussion, public accountability, coordination and sharing of best practices and updates. Field staff are familiar with this tool and no training is needed. Many SIAs already use WhatsApp groups to coordinate. *WhatsApp should not be used to transmit confidential information.*	No	No	No

Open Data Kit (ODK)–based platforms (KoBo Collect, OnaData)

ODK-based platforms were designed for survey data collection. Free of cost, they allow cell phone users to fill out and submit forms easily. The ease with which forms created in Excel can be uploaded and turned into cell phone forms on ODK is appealing for country programme staff. Although historically used for collecting quantitative data, there is some flexibility as well. Uganda, which uses ODK, has added open-ended questions on its forms to capture qualitative narratives on reasons for over- or underperformance while also capturing quantitative information on reasons why children were missed during an vaccination campaign. ODK-based platforms can also collect GPS and timestamp data to monitor when and where data were collected and submitted.

However, ODK-based platforms lack user-friendly visuals (they cannot be viewed easily on a phone), and the visuals cannot be drilled down to local levels (they show only national-level summaries). Other challenges include timeouts due to large volumes of data, the inability to resubmit data in case of mistakes, and the loss of data due to high server load during peak hours of reporting. Stress-testing ODK and other data capture systems (such as the new DHIS2 Android app) might help IT and programme teams prevent similar issues in the future. Lastly, ODK-based platforms were not designed to provide feedback or facilitate communication among data users. The WHO Regional Office for Africa (AFRO) can provide technical support for these types of tools.

DHIS2 (District Health Information Software 2)

DHIS2 is a free, open-source software with web-based capabilities used as the HMIS in 73 low- and middle-income countries. It can store data and provide visualizations that allow policymakers and managers to generate analyses in real time. It is adaptable and extendable through its ability to interface with web application programmes and can be used for both health and non-health sectors. DHIS2 can be installed, configured, and used for free and can be hosted on the cloud or locally. A professionally managed and installed instance in the cloud takes care of the backup, security, monitoring and high-speed connectivity aspects of the deployment. This requires expertise in server configuration, maintenance and updates of DHIS2.

Users entering data into the system need little training, but users configuring and maintaining it do need training; it is a long-term investment. There is a large community of DHIS2 developers worldwide. DHIS2 software development is a global collaboration managed by the HISP Centre at the University of Oslo (UiO). HISP is a global network comprised of 17 in-country and regional organizations, providing day-in-day-out direct support to Ministries and local implementers of DHIS2.

DHIS2 can receive and host data from different sources and share data with other systems and reporting mechanisms. It has been adopted as a data warehouse in a number of countries, as well as supporting integrations between DHIS2 and logistics, surveillance data, population and other information systems, including RapidPro.

DHIS2 Android Capture App

The DHIS2 Android Capture App is a mobile application designed to function seamlessly with a DHIS2 instance. The Android app supports data capture across all DHIS2 data models, including aggregate and individual-level data for Tracker and Event programs. The app functions in both online and offline mode, and data and metadata are automatically synchronized whenever there is internet access.

Power BI

Power BI is a Microsoft data visualization tool with rich reporting and dashboard capabilities. It can be integrated to work with data-collection platforms like ODK-based platforms and can also be integrated with data from ArcGIS (for mapping) and DHIS2 (HMIS). Special care will be needed to ensure the right licences are obtained and that the intended users will be able to access it. Large organizations may have trouble coordinating with the licence holder of institutional accounts to get all the access they need. Global and regional partners can provide technical support for Power BI.

RapidPro

apidPro has both data-collection and data-visualization capacity, and data can be automatically pushed to dashboards to eliminate a step required when using separate data-collection and data-visualization tools. It integrates well with SMS, voice messaging and social media. RapidPro is interoperable with DHIS2. A 'dumb phone' can be used for data collection. Prompts allow for two-way feedback. A short code is recommended for RapidPro. Alternatively, RapidPro Surveyor can be used (it does not require a short code and can work offline) and it can send photos, videos, and GPS locations. UNICEF Headquarters and regional and country offices can provide substantial technical support for RapidPro and RapidPro Surveyor.

WhatsApp

WhatsApp provides free, cross-platform messaging. It allows users to send text messages and voice messages, make voice and video calls, and share images, documents, user locations and other media. It is very popular around the world and many people already have it on their phone so do not need to be taught how to use it. It is not designed for data reporting, so quantitative data shared through it must be manually inputted into another tool; therefore, it is not recommended as the primary tool for large-scale quantitative data collection. Qualitative data, such as photographs and observations from fieldwork, can be easily shared through this channel. Similarly, results from data products and response/actions needed can be disseminated. It is widely used for coordination and sharing of best practices during the field implementation of health activities. WhatsApp groups can also serve as a platform for boosting morale and accountability among members. The 'WhatsApp Broadcast' function can be used to message multiple contacts with the same message at once, but separately and without the need to create a group. There will likely be situations where WhatsApp information will need to be formally reported (such as AEFIs), and campaign guidelines should make these situations clear.

Note: The software tools above are based on thise used by countries mainly for monitoring administrative coverage and conduct of campaign activities. Countries may wish to review the logistics management information systems in use (particularly if there is a vaccine component, and if routine and campaign vaccines use the same transportation and cold-chain monitoring systems) as part of their situation analysis.

Criteria that were top of mind for countries that have used RTM during initial software selection included:

- Whether the platform was currently in use by national partners
- Interoperability of the RTM platform with existing national systems
- Whether it is open source (to reduce costs of licensing and to facilitate interoperability)
- Extent to which it can work offline
- Past positive experiences/use with the software in country
- Ease of developing data entry forms
- Types of data it could collect timestamps, GPS coordinates, photos, open-ended narratives, types of survey form data (multiple-choice, ranked)
- Ability to conduct automated analyses
- Ability to provide automated feedback
- Quality of the mobile user experience for viewing reports and dashboards (if districts are expected to use mobile phones to view data)

Short codes are short digit sequences, significantly shorter than telephone numbers, that are used to address messages in the Multimedia Messaging System (MMS) and short message service (SMS) systems of mobile network operators..

Indonesia

RapidPro was designed and introduced as a convenient and straightforward SMS question-and-answer tool during an MR campaign. It had a limited number of simple questions and required minimal training for health workers to complete. It also provided health workers and districts with daily feedback on coverage attained that day, via SMS messages. Users also received daily morning greetings and, once a week, a congratulatory and motivational message for their hard work. District, national and provincial levels had access to dashboards with interactive, coloured maps allowing users to identify underperforming facilities, districts and provinces. Notifications of low coverage and facilities not reporting prompted managers to take follow-up action. Users generally reported high satisfaction with using RapidPro. However, it was perceived that the limited information supplied via RapidPro (facility code, location and total number of children vaccinated) was insufficient for problem identification and corrective action; it was recommended that additional information be collected in the future.

Pakistan

WhatsApp groups were widely in place among campaign staff in Pakistan; the platform was used to coordinate and share pictures and anecdotes of issues and best practices found in the field. These types of qualitative findings were used to take prompt action, such as managing AEFIs and rumours and rectifying incorrect vaccinator practices.

There was one unique instance of WhatsApp's use for quantitative data collection. Although field staff were collecting data through KoBo Collect and RapidPro Surveyor, the information was not viewable by or accessible to most users until the next day (after it had been cleaned and reviewed at the national level). This was not rapid enough for decision makers in Sindh Province, who wanted to be able to access data in time for evening review meetings during a typhoid campaign. A parallel, short-term workaround was instituted whereby field monitors submitted key information via WhatsApp every day in addition to submitting data through KoBo or RapidPro. This information was manually aggregated and passed on to the next level by appointed focal people.

How to choose a mobile data collection platform

Consider data needs. The first step is to understand and agree with partners on what kinds of data and how many data elements are needed to support programme implementation and M&E. In one case, defined data need may prompt a search for a mobile data collection platform that can allow for easy collection of GPS coordinates and has integrated mapping features. Another consideration is whether personal or sensitive data will be collected. In such cases, the platform must have the necessary data privacy and security features and attendant operational mechanisms to safeguard the privacy of user data.

Consider the ecosystem. Ecosystem factors such as infrastructure, security and the technology market, should be considered when selecting a mobile data collection platform. For example, is a stable Internet connection available or will a tool that works offline be required? In high-risk or conflict-affected areas, consider if or what mobile devices would be safe for a data collector to carry. If the data collection plan includes having health workers or monitors submit data using their own devices, ensure that you understand the devices commonly used at the national and subnational level, and that the technology is compatible with those devices. Also consider if or how individuals will be able to connect to a mobile or Internet connection suitable for uploading collected data. If Internet connections will be slow, it may be best to consider collecting 'light' data that do not include large files like images and audio.

Identify and prioritize selection criteria. In addition to data needs and ecosystem considerations, several other factors could influence selection of a mobile data collection (MDC) platform:

- **Short-term and long-term costs**: What is the budget? Understand licence, device, maintenance, support and training costs associated with the MDC platform.
- **Number of users, surveys and items**: How many people will be using the MDC application? How many data variables will be uploaded? On how many items will data be collected? Some MDC platforms provide licences for an unlimited number of users and unlimited number of surveys uploaded to the server, while others offer a per-user licensing model. For a lengthy questionnaire, an SMS-based system may not be ideal, as data entry can be time consuming.
- **Devices and data requirements for enumerators:** What devices will data collectors be using? Some MDC tools work best on tablets, but others work only on certain operating systems, such as Android. If data collectors will be using devices that they, or their organizations, already own, ensure they are compatible with the platform selected. Also consider what the minimum standards would be for an airtime or data plan needed to operate the MDC platform. For example, if collectors have only basic phones, it would be best to use a platform that collects data via SMS or Unstructured Supplementary Service Data (USSD). If procuring new devices, consider devices that have sufficient battery life, so they do not need charging during a long day of data collection. Also consider how much training or technical support will be needed given the device selected.
- **Security and privacy compliance:** What data security standards and procedures does the organization follow? Does the country of operation have national data protection regulations that must be complied with? How does each tool

protect user data, hide personally identifiable information, and so on? Is it desirable to track location information, either through GPS or GIS embedded in images? For example, a tool may be needed that encrypts or anonymizes data as they are entered. This will be important if a device is stolen and if any information that could be recovered would be sensitive or would compromise the safety, security or privacy of respondents. This is also an important consideration if a data-collection device is shared within an organization or if it is an individual's personal device that family members might also use.

- **Integration with other technology:** Are any platforms for data analysis, reporting or mapping already in use? For example, does the organization use a company-wide platform for reporting on common indicators? Consider whether the data-collection platform can easily work with the desired analysis and reporting platform or if significant time or steps would be required to transfer data.
- **Offline collection:** Is Internet connectivity limited in the programme area? Is it important that people can enter data when they do not have an Internet or mobile broadband connection?
- **SMS integration:** Do users need SMS or push notifications? Will they be submitting data via SMS? Some platform providers will help set up an SMS short code (a four- or five-digit number is often easier to remember than a full phone number), making it easier for users to submit data, or reverse billing so that sending SMS messages is free for the user.
- **USSD integration:** Beyond SMS, USSD can provide a way for users to submit data when they do not have smartphones. USSD is the system used to add mobile credit to an account and is prompted by dialling *number#.
- **Authentication and user roles:** Who is collecting data? Some tools allow anyone to download an app or access a link and start submitting data. This is useful for citizen data-collection efforts. Other tools allow an administrator to assign privileges and survey instruments to specific people. This is useful if a cohort of trained enumerators will enter data but do not need to edit the survey or view aggregated data.
- **Skip logic and data parameters:** Is there a need to customize survey questions based on previous answers or restrict types of data entered? Some tools allow skip logic, meaning certain answer choices will prompt enumerators to skip several questions or a whole section, while other tools allow questions to be programmed so that enumerators must enter a value within certain parameters, such as a range of numbers or dates
- **Data analysis:** Do results need to be displayed in real-time charts and graphs? Platforms vary as to whether and how they let users export and analyse data. Some platforms offer dashboards with charts and graphs that are immediately generated as data is collected. Others require data to be exported before it can be analysed or viewed.
- **GIS and mapping:** Do results need to be mapped? Some MDC platforms are built specifically to collect GPS coordinates for mapping.
- **Language:** What languages will be used by data collectors and respondents? Some MDC platforms have been developed only for certain major languages like English or French, and others are not compatible with non-Latin scripts like Arabic. Determine whether the platform is available in the required language. The survey's language could also affect what kind of data can be collected through SMS. For example, sometimes phones owned by average users support only Latin scripts. Text messages in some languages are also restricted to 70 characters, rather than the 160-character standard for Latin scripts.
- **Photos, audio and video:** Will media need to be captured, or video or audio played as part of the survey instrument? If so, this will increase the size of data files and will require sufficient bandwidth to be uploaded. Also consider how to gather informed consent from participants before taking photographs, video or audio.
- **Ease of set-up and use:** How sophisticated are the users? How much technical support is available? MDC tools vary in terms of the interface and processes for building survey instruments, entering data, exporting data and uploading data to a cloud server. Some are very intuitive, while others may require more extensive training and support.
- **Cost of acquisition vs. total costs of ownership**. Consider the total costs over the life of the tool, including deployment and maintenance, not just the initial acquisition costs

Hardware and network connectivity

Hardware typically used for RTM systems includes mobile telephones, tablets, computers and smart TVs. Smartphones and tablets have been commonly used for data collection and all the above devices have been used to varying degrees for data visualization, data access and data management. In places where smartphones use is low, combining 'dumb phones' with the RapidPro software has worked well (as in Indonesia), because data can be collected using SMS. Programmes will often not provide phones for data collection but will adopt a 'bring your own device' approach, so it is important the chosen software is compatible with the phones owned by health care workers and other key stakeholders involved in data collection and analysis.

When planning the hardware elements of the RTM system, it is important to keep the following in mind[28]:

- Is there sufficient electricity supply and electricity coverage in the areas where these devices will be used?
- Is there sufficient network capacity and coverage in those areas?
- Are vendors/mechanisms for purchasing phone credit or data widely available?
- Are there technical support facilities and vendors for maintaining and replacing these devices in country? What are the costs for repair and replacement?
- What are the estimated ongoing operational costs (electricity, airtime and data credit)?

Even during a relatively short campaign, maintenance will be required and should be factored into budgets.

Mobile device management

The use of mobile devices and applications for programme delivery is becoming increasingly prevalent. Devices are being used for communication and networking, for data collection and as learning devices in the health sector. Many partners are not trained to configure the devices and, given increasing remote working modalities, it may be difficult to receive onsite support from technicians in centrally located teams.

Mobile device management (MDM) includes tasks from basic setup and configuration to troubleshooting, upgrading of apps/operating system and setting up security policies, etc. to ensure devices remain secure and in good working condition, all while allowing for adequate data protection and effective, efficient, and scalable programme delivery.

The ability to provide device support and maintenance remotely has become integral to the support and scale of real time monitoring approaches. MDM is the process of enhancing data security by monitoring, managing and securing mobile devices such as laptops, smartphones and tablets that are used in organizations, and by government. MDM solutions allow IT teams and administrators to control and distribute security policies to the mobile devices accessing sensitive corporate data in their organizations, ensuring the safety and security of the network as well as data in the devices.

Zambia and Uganda

Smart TV screens are used at the Emergency Operations Centre to visualize data so the emergency response team can discuss what is happening and where to intervene. Users at the district level can access dashboards on cell phone browsers.

28. Odendaal WA, Anstey Watkins J, Leon Net.al.. Health workers' perceptions and experiences of using mHealth technologies to deliver primary healthcare services: a qualitative evidence synthesis. Cochrane Database Syst Rev. 2020 Mar 26;3(3):CD011942.

Technical support assistance for digital tools and systems

Technical support assistance needs for the deployment and use of digital tools and systems related to the vaccination campaign should be planned and budgeted for before they arise. Technical support can take several forms: assistance with setting up the software and hardware; ensuring interoperability between systems and server management; stress testing to ensure the software and the server can handle the demands of a large-scale campaign; user testing and revisions based on user feedback; development of training materials; and troubleshooting during campaign implementation.

It is important to engage technical (IT and software development) support persons as early as possible in the RTM planning process. Contracting could be a lengthy process; it may even be the biggest bottleneck to the timely availability of an RTM system. It should be planned for well in advance – about eight to nine months, although some countries have started contracting three months before and noted this was insufficient. These individuals may have useful inputs on what kinds of set-up are appropriate and feasible and can ensure that quality control activities (like stress testing) are appropriately included in the overall timeline and planning process, saving time and effort for the rest of the task force/planning team. Moreover, IT/software contractors will likely have multiple contracts/projects at the same time so engaging them early can help ensure the best qualified individuals can prioritize their time and be available to support the campaign. Finally, it will be useful to look at the scale of the campaign and plan to have adequate technical support (or protocols, SOPs and training materials) for all levels.

Uganda

The Health Information Systems Programme, the country's leading DHIS2 developer, provided IT and software development assistance with the DHIS2-based RTM system during an MR campaign. In addition to setting up and testing the RTM system, they procured and set up routers and a smart TV screen for the national command centre and helped train staff. Moreover, a team of three IT specialists was stationed at the national command centre for troubleshooting during the campaign itself. Staff at national and subnational levels received in-person or remote support from this team. Given the short time frame of the campaign, access to this kind of support alleviated frustrations for campaign staff and facilitated learnings on necessary IT adaptations to the platform for future campaigns.

Mobile network operators and aggregators

MNOs will likely play a significant role in the SIA campaign. Their networks are used to promote the campaign, coordinate with field staff and submit RTM data. It is important to know the network coverage and strength of the MNOs operating in areas where SIAs will be conducted and to establish contracts with these vendors. Depending on the scale of the campaigns planned, the EPI programme can bring substantial business to these vendors and may be able to negotiate advantageous contracts.

Flexible long-term agreements are ideal because campaign timelines often shift, and it is not always possible to tell where mop-up or corrective ACSM activities are needed. Moreover, some campaigns need to be organized within short time frames (such as a reactive polio campaign), so having these contracts in place will help ensure the RTM system can be used. In some instances, it may even be possible for international partners to contract and manage international MNOs or aggregators, so contracting would not need to be done in every country.

Programmes may find it helpful to engage with mobile aggregators, or third-party companies that work with multiple MNOs on their clients' behalf. Working with mobile aggregators instead of individual MNOs can reduce the complexity, cost and duration of setting up agreements, and help reduce complications in implementation. Benefits include:

- **Less contracting:** Instead of needing to negotiate and contract with every MNO, programmes can save time and effort by working with one aggregator.
- **Better pricing:** Aggregators can negotiate on behalf of multiple clients, helping them secure better pricing with MNOs
- **Single point of contact:** Aggregators represent a single point of contact for several MNOs, reducing coordination complexity.
- **Analytics:** Some aggregators may be able to provide additional services, like the ability to analyse MNO data to better characterize the types of cell phone users in each area. This would be useful for programmes that use SMS-based reporting or cell phones for development activities.

Pakistan

Viamo was UNICEF's partner for robocalls and SMS outreach for the 2018 measles and 2019 typhoid campaigns. Their staff used to work for MNOs, so they were able to leverage those professional relationships for contract negotiations. They were able to access data on how long recipients stayed on robocalls on average and helped with obtaining and analysing user data to inform campaign ACSM activities.

Indonesia

Using a government shortcode for RapidPro to cut costs was discussed, but it was not feasible for various reasons. Instead, UNICEF contracted an aggregator to deal with multiple MNOs to provide RapidPro cost-free so users would not be charged for airtime.

Data-collection forms, reports and data use processes

Data-collection forms

Development of electronic forms

Countries that have used RTM generally adapt existing SIA paper forms for electronic data entry. These forms include supervision checklists, RCA forms, and pre- and post-campaign surveys. Common forms, like supervision checklists and RCA forms, are often based on forms included with WHO guidance.

Electronic forms should have built-in data quality controls to minimize the amount of manual data cleaning needed. Examples include:

- Making some fields required before the data collector can move on to the next page;
- Appropriate skip patterns;
- Range checks – upper and lower limits for numbers;
- Look-up lists/drop-down boxes for common variables such as the name of the health facility, community, district, province, and categories (such as gender). As much as possible, these lists should match those being used for the broader HMIS, to facilitate interoperability and analysis;
- Multiple-choice and checkboxes over open-ended responses;
- Collection of metadata such as GPS coordinates and timestamps. This information can help confirm that forms were completed at the right times and places;
- Checking for duplicate submissions

Some countries have also selectively included open-ended questions to collect information that might not otherwise be captured, such as challenges implementing that day's activities. However, these are also paired with a similar quantitative question to help with categorizing responses. Other countries have also included submission of photographs. Although useful, photos can take up considerable bandwidth and should be avoided in places where the network is weak.

One of the principles of Responsible Data for Children is purpose-driven. Only data that is needed should be collected, and stakeholders should specify how the data will improve children's lives. If there is no clear benefit, the data should not be collected, stored, shared or analysed. When designing data-collection forms, referencing this principle is useful to decide what data is helpful and what is not needed.

The software tools listed above typically allow for offline data collection for places where network connectivity is poor. The data can be uploaded to the server once the device is on the network. Having GPS and timestamp data should not be dependent on cell phone or Wi-Fi network access. Devices can record time regardless of their location, and they should be able to connect to GPS satellites, except in the occasional place where the configuration of buildings and geographic landmarks blocks such signals.

Digital data entry can reduce the work associated with data collection and data cleaning. However, careful curation of electronic data collection forms is still required. Lengthy

forms can mean staff spend more time on data collection, actual supervision, data use and service provision. The content of forms should be developed and vetted by key stakeholders for technical value, then electronically tested by potential data collectors for bugs and time burden.

Role of paper-based reporting

Generally, it is not recommended that programmes submit paper-based reports as a 'backup' to electronic data submission. Filling out both paper and electronic forms burdens staff and takes time away from core tasks like supervision and service provision.

There are, however, circumstances in which some paper-based reporting makes sense. For example, paper reports can be reserved for providing in-depth information on serious/key incidents, while providers may wish to keep individual-level patient data on file at facilities.

Eliminating or reducing the use of paper forms can be a difficult decision; where possible, it may be best to plan for a gradual transition. Building support for reduced paper-based reporting may be done through promoting the data quality, security and access measures being taken with digital data and sharing the results of routine checks on the accuracy, timeliness and completeness of both digital and paper data.

Nepal

Nepal piloted the use of mobile phones for rapid convenience monitoring (RCM) in 10 districts during a 2016 MR campaign. Six months after the completion of the SIA, no RCM reports had been received at the central level from the 33 districts using paper-based RCM. In contrast, 94 per cent of reports were received from 98 per cent (196 of 200) of village development committees where digital RCM was conducted, and 87 per cent (328 of 377) of these reports were received on the same day the data was collected.[29]

Indonesia

Indonesia used RapidPro (SMS-based reporting) for its 2018 MR campaign. Health facilities submitted a very limited amount of data through RapidPro and only aggregated information (the total number of children vaccinated that day). At the same time, health facility staff recorded individual-level data on paper forms and submitted aggregated data to the next level on paper reports. During the pilot phase, the paper-based data and RapidPro data were compared. Less than 5 per cent variance between the two data sources was found, suggesting that RapidPro could be deployed at scale.[30]

Reports and dashboards

Although more efficient data collection is of valuable benefit, much of RTM's potential lies in its ability to produce timely, automated reports that can facilitate easy analysis and decision-making. RTM can be a cost-effective investment if it diverts staff time and energy from downloading, cleaning and analysing data towards identifying corrective actions. In addition to minimizing data aggregation and cleaning, the system should call attention to implementation bottlenecks. In other words, problem alerts would be easily flagged to decision makers, rather than requiring them to analyse raw data and look for problems.

Types of reports

Reports can include graphs, maps, summary statistics, and tables or lists (such as a list of missed settlements). These can be used to support the analysis and dissemination components of the RTM system. They can take many forms:

- **Real-time, interactive dashboards**: These emphasize only a few key indicators and clearly signal when action is needed. Too much content on a dashboard can result in information overload

29. Oh DH, Dabbagh A, Goodson JL, et al. Real-Time Monitoring of Vaccination Campaign Performance Using Mobile Phones — Nepal, 2016. MMWR Morb Mortal Wkly Rep 2016;65:1072–1076. DOI: http://dx.doi.org/10.15585/mmwr.mm6539a5
30. Jusril H, Ariawan I, Damayanti R, et al. Digital health for real-time monitoring of a national immunisation campaign in Indonesia: a large-scale effectiveness evaluation. BMJ Open 2020;10:e038282. doi: 10.1136/bmjopen-2020-038282

and fail to prompt timely action. Ideally, dashboards are interactive, allowing for the exploration of the data without having to download and analyse it. Dashboards should be visually attractive and convey information easily.

- **Supplemental tables and lists:** Ideally, the system would be able to generate additional details to support the data on dashboards. For example, a list of missed settlements could be populated to complement the map shown on a dashboard.

- **Summaries:** Busy individuals in the field may not have the time, network bandwidth or computer access to explore dashboard data. Some staff are also responsible for only a small component of the overall SIA programme and may not find it helpful to see all the data available. Such individuals may find it more valuable to receive summaries of progress towards a target, or key issues and locations requiring corrective actions. In Indonesia, for example, health facility staff and programme managers received an automated SMS at the end of each day with feedback on progress towards local coverage targets (e.g., "As of today, you have achieved X per cent of coverage in this district").[31]

  SMS alerts: SMS alerts can be used to quickly communicate that there is a problem, an outlier, or a situation that needs to be resolved).

- **Technical reports:** Training reports or post-SIA technical reports usually combine qualitative descriptions with quantitative data. Although RTM data can contribute to a technical report, the report is produced too late to be used to improve the current campaign.

Process for defining report/ dashboard requirements

The RTM planning process involve stakeholders during dashboard development at the beginning, to define dashboard requirements and later, after the dashboard has been implemented. During the latter stage, the focus should be on: a) testing its ability to connect to the database and present the data correctly; and b) ease of user comprehension. It is more time- and cost-effective to include stakeholders in the planning stage than to revise the dashboard after it has taken shape in the application.

The design of reports and dashboards should begin with a review of the key objective or purpose: 'What do we want to be able to do with the data?' As noted in the Theory of Change presented previously, RTM approaches can be used for many purposes before, during and after a campaign.

The governance task force/advisory group should work with stakeholders and potential users to define the following key data to be included in the dashboard:

- The purposes of the RTM system;
- Which indicators should be included, and why;
- The level of aggregation at which each indicator data can be made available (geographic: national, province, district, subdistrict, health facility catchment area, vaccination post, community; age groups; vaccination strategy, etc.);
- Thresholds for identifying problems, and the form that 'triggers' or alerts would take. Nepal, for example, used the colour green on maps to indicate which communities had passed RCM ('no action needed'). These communities were coded red if they failed ('action needed').[32]
- Who needs to see the information?
- The form this information should take;
- The type of report that will be accessed by different users;
- Planning a response for cases where the initial data is incorrect;
- Identifying roles such as who has authority to comment on issues, address errors or speak to the press

Pakistan

Issues with adhering to SOPs were detected across multiple provinces: vaccines were frozen instead of cooled and the wrong gauge needles were used. Qualitative information and photographs were shared by local and district level teams with national level. These issues were reported, and messages and guidance were immediately distributed to correct them.

31. Jusril H, Ariawan I, Damayanti R, et al. Digital health for real-time monitoring of a national immunisation campaign in Indonesia: a large-scale effectiveness evaluation. BMJ Open 2020;10:e038282. doi: 10.1136/bmjopen-2020-038282
32. Oh DH, Dabbagh A, Goodson JL, et al. Real-Time Monitoring of Vaccination Campaign Performance Using Mobile Phones — Nepal, 2016. MMWR Morb Mortal Wkly Rep 2016;65:1072–1076. DOI: http://dx.doi.org/10.15585/mmwr.mm6539a5

Zambia

Zambia uses two dashboards, one for intra- and one for post-campaign activities. Indicators served multiple purposes, tracking implementation inputs and processes, team performance and administrative coverage. Both dashboards were generated by Power BI.

These were indicators captured in the 2020 polio SIA's intra-campaign dashboard:

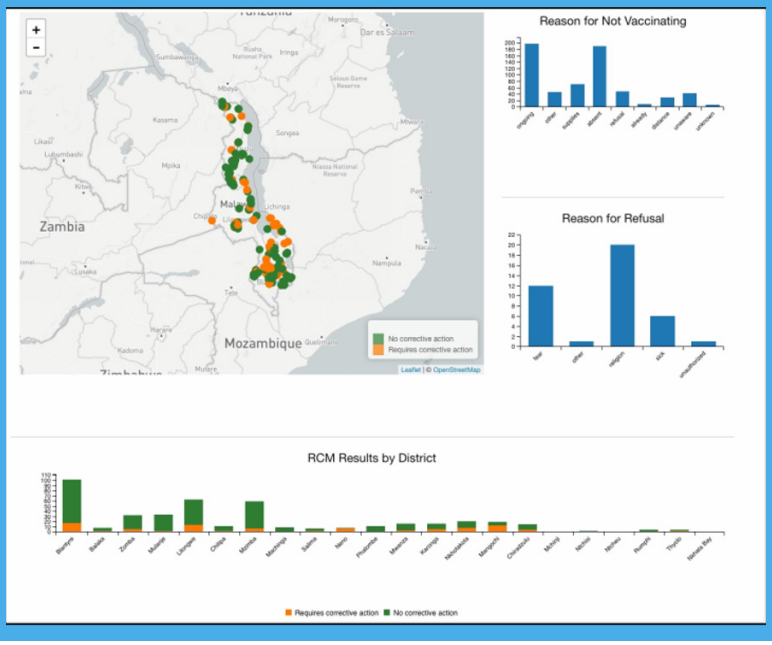
Performance of team supervision	Quality of SIA implementation
1. Vaccine vial monitor knowledge. 2. Number of children missed 3. Daily sufficiency of logistics and supplies 4. Team movement plans 5. Type of teams (local or not) 6. Surveillance knowledge (reporting on suspected acute flaccid paralysis areas)	1. Household visits 2. Number of children seen 3. Number of children finger-marked 4. Number of children missed 5. Reasons for not vaccinated 6. Geographical coverage through GI

Finally, the following indicators were used in the **post-campaign dashboard** (for the end-process activity to validate administrative coverage).

- Number of households sampled
- Number of households visited by the vaccination team
- Number of households missed by the vaccination tea
- Number of children checked

Malawi

Below is an example of how RCM data was visualized on a web-based dashboard. It shows only a few key indicators useful for identifying major problems. Triggers/alerts are defined; areas requiring corrective action are flagged in orange. More detailed information would ideally be accessible as users interact with the dashboard. This dashboard was developed with assistance from the American Red Cross's GIS team during the 2017 MR campaign.



In addition to receiving input from in-country stakeholders and users, technical assistance from people with skills in statistics, GIS, informatics and data visualization may also be useful during the design of the RTM platform. Most countries already have forms and checklists that can be uploaded into data-collection platforms, but further support for strategically thinking through how to automate the analytics, visualization and decision-making portions of the platform will be critical for increasing data use.

Several countries (Malawi, Haiti, Nepal and Nigeria) have successfully built RTM platforms with the help of mapping and informatics staff drawn from various partners such as the U.S. Centers for Disease Control and Prevention, the American Red Cross, universities, and the WHO AFRO GIS Information Centre. Some of these organizations have their own grants and resources to support other countries.

Data use and formats

Even the most sophisticated real-time data platform would fall short of its potential if it was not accompanied by processes and skills to share and interpret the incoming data. Table 8 below includes examples of RTM data users and some of the formats in which they have been able to access, share, review and use data.

Table 8. Data users and formats for sharing and using data

Users	Potential formats for reviewing and using data
National emergency operations centre	• Dashboards • WhatsApp group messages • Daily review meetings
Minister of health, international NGOs, donors	• Daily situation reports • Dashboards
Provincial and district managers	• Dashboards • WhatsApp group messages • Daily review meetings
Health facility staff and field supervisors	• Automated feedback SMS • Daily review meetings • Leaderboards showing performance or results relative to peers/comparable areas
Multilevel (national to health facility/field staff)	• Conference calls with representatives from multiple levels to discuss issues identified
Local officials and traditional leaders	• Meetings to review campaign plans and advocate for local officials' support for resolving bottlenecks or accessing local resources, or to obtain public endorsement
Media	• Media briefings to supply journalists with key findings based on local data, to generate headlines and facilitate public conversations. These can be used to increase awareness and acceptance of the campaign

By far the most common platform for data use at all levels has been a daily review meeting where SIA staff review progress and tailor plans for the following day. For RTM data to be available on the same day, a balance between quality and speed must be met. Data quality measures and methods of accessing data will need to be as automated as possible.

One approach to automation includes the use of interactive dashboards. However, careful planning and consultation is required to ensure these are used below the national level, where access to computers, smart TVs, electricity and the internet is more feasible. Although users at subnational levels (district, subdistrict, health facility, etc.) sometimes have access to dashboards through smartphones, some software applications had dashboards that could show only national-level data (not disaggregated for subnational levels). Some countries have used workarounds like sending dashboard results/snapshots to districts (e.g., Malawi)[33] or SMS summaries (e.g., Indonesia);[34] some of the software tools listed in Table 7 also provide the ability to view results at the desired scale/level.

33. Eros, E. and A. Schmeltzer, 'Stop the Spots: Measles vaccination in Malawi', Missing Maps, 10 August 2017, accessed 1 December 2020.
34. Jusril H, Ariawan I, Damayanti R, et al. Digital health for real-time monitoring of a national immunisation campaign in Indonesia: a large-scale effectiveness evaluation. BMJ Open 2020;10:e038282. doi: 10.1136/bmjopen-2020-038282

Experience shows that granular-level information (such as a community or immunization post) helps to pinpoint problems, particularly as it allows local leaders to immediately take corrective action based on available data. In a campaign context, where the time to correct issues is short, this information will make a difference. Making dashboards interactive, and not requiring users to download and analyse data, will also make data use easier.

One of the benefits of early and sustained engagement with government ministries is the ability to strengthen trust in RTM systems. It will be helpful to cultivate an explicit understanding that the data being made viewable in real-time is 'interim', not 'official' data. 'Official' data can be made available once reviewed by the appropriate parties, while 'interim' data ensures campaign staff can review SIA data daily and take corrective actions promptly. Another way to boost trust is to openly discuss the data quality and security measures incorporated into the system.

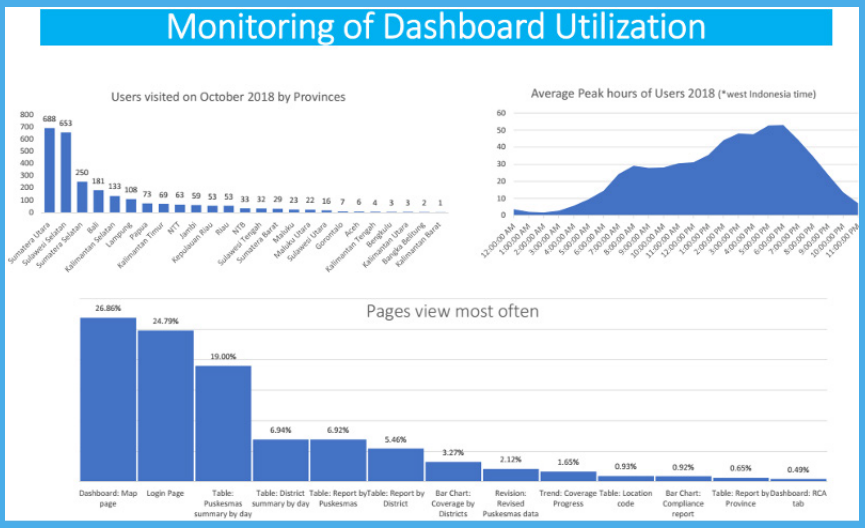
WhatsApp groups have been popularly used to facilitate communication and coordination among campaign staff. Qualitative data, such as photographs and observations from fieldwork, can be easily shared through this channel. Similarly, results from data products and response/actions needed can be disseminated. There will likely be situations where WhatsApp information will need to be formally reported (such as AEFIs) and campaign guidelines should make these situations clear.

Zambia

The data was reviewed daily at the national emergency operations centre to identify coverage gaps and organize interventions. Dashboard data could be scaled to show information at various levels, and cross-level conference calls (between health facility staff, district, province and national, etc.) were occasionally held to discuss identified issues. The surveillance office prepared daily situation reports for high-level officials at the Ministry of Health, WHO and the Centers for Disease Control and Prevention using service coverage and social data to share campaign highlights.

Indonesia

During the 2018 MR campaign, programme managers monitored utilization of the RapidPro dashboard. Dashboard utilization statistics were also available to view on the dashboard. The following graphs show that In October 2018, dashboard use was highest in two provinces, but about eight provinces barely used it. The most commonly viewed pages were daily health facility summaries and the map page. This information provides helpful information on what types of users were more likely to use dashboards, and for what purpose. In addition to dashboards, automatic SMS feedback summaries for health facility and programme staff at various levels were also sent on a daily basis.



User testing and piloting

The implementation stage of a health information system includes user testing and piloting, revisions and deployment. Piloting can include testing both the technology and the associated implementation processes (e.g., data use processes) in a real-life but small-scale programme. Piloting reveals any hurdles before the official launch, such as any bugs with the technology or a report output or data use process that is unclear. Testing in a smaller area allows for learning with lower stakes; this is less stressful and potentially less costly than fixing errors incurred during a national campaign.

During user testing, the RTM system can be assessed for user satisfaction and fit with users' workflow and accountabilities. It is important to be clear on the governance: who has the authority for corrective action? For example, who can review or change SOPs, who has the responsibility to troubleshoot, etc.? User testing will also help determine how much of a learning curve may be involved in deployment of the digital tools, and to see how many performance errors and information flow adjustments may need to be introduced.[35]

Throughout this process, sustainability and scale-up considerations should be kept in mind. Multiple rounds of monitoring and evaluation activities, in the form of user feedback sessions and review of RTM use data, may be needed to ensure that learnings are being collected and factored into revisions. Methods can be informal and inexpensive (focus groups, key informant interviews, review of existing data) particularly for the user-testing phase. Formal and more expensive evaluations may be more useful for assessing situations where deployments have been at larger scale. .

Conclusion

Digital data collection and automated analyses can reduce staff workload. On the other hand, planning an RTM system can take up time and resources, especially at the outset. However, redirecting staff time from data collection and data cleaning to improved planning and data use should ensure a more successful campaign.

35. Monitoring and evaluating digital health interventions: a practical guide to conducting research and assessment. Geneva: World Health Organization; 2016. https://www.who.int/reproductivehealth/publications/mhealth/digital-health-interventions/en/

Appendices

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Appendix 1. Common problems from country experiences with RTM

Below is a list of issues that have arisen in countries implementing RTM for SIAs, and recommendations for mitigating them. Importantly, these problems highlight the vital role of careful planning, particularly of understanding users' and stakeholders' needs and in understanding and testing the data use components of the RTM system.

Problems experienced by countries that have used RTM for vaccination campaigns

Problems Experienced	Solutions
Some stakeholders, particularly at local levels, do not receive the data in time for timely decision-making.	Build in automatic data validation and data entry checks so most data does not need to be manually downloaded and cleaned. Set up data quality audit pass/fail checks to identify any issues that do have to be addressed manually. Make sure dashboards can drill down to local levels, so that field teams do not feel they must download and manipulate data themselves. Set up the software to 'push' results in the form of visual snapshots or SMS notifications to subnational levels, rather than requiring manual approval/sending. Cultivate a shared understanding that the data being made viewable in real-time is 'interim', not 'official' data. 'Official' data will be available once reviewed by the appropriate parties, but access to 'interim' data is necessary to ensure campaign staff can take corrective actions promptly. This approach provides a balance between quality assurance and timely action.*
The digital platform is developed at the last minute, leading to insufficient time spent on user testing and training.	RTM planning should begin six to nine months ahead of the campaign to ensure sufficient stakeholder engagement, user-friendly data collection and analysis design, and development of training materials.
Multiple forms and platforms are being used at the same time; platforms are being deployed and used once (rather than for multiple SIAs).	When planning for a campaign, two early steps are crucial: • Conduct a landscape analysis to understand the stakeholders, past experiences, government policies and structures, and existing platforms. • An advisory committee/task force should develop a shared understanding of the specifications required.
Data is available digitally, but the necessary corrective actions are not immediately clear. Valuable staff time is spent on data cleaning rather than on reviewing data and making decisions.	Digital data collection is not the same as RTM. Data collection needs to be accompanied by automated systems for rapid analysis and decision-making. The advisory committee/task force should identify thresholds for key indicators where action might be needed. These analytics can be automated so dashboards can immediately flag problems, e.g., colour code them in red, or generate a list of top issues, or settlements or teams that failed the pass/fail benchmarks for certain indicators.
There is under-utilization of pre- and post-campaign data.	Campaigns that use RTM generally do a good job of using RTM for RCAs during the implementation phase, but few campaigns use RTM for the pre- and post-campaign phases. RTM data can be used before the campaign to monitor microplans, logistics and trainings, and after the campaign to monitor payments, closeout and evaluations.
Data is collected using digital methods and are accessible in real time, but not used for decision-making until much later, such as after the campaign.	This is just real-time data collection, which may be sufficient for some types of data but may represent a missed opportunity for other types. Be clear as to what data should be used for RTM and train staff on these specific methods and expectations.

* Moreover, it should be kept in mind that administrative coverage data from RCAs are not the same as official coverage data; official coverage statistics are typically obtained through post-campaign coverage surveys, which use appropriate sampling methods.

Appendix 2. Digital health situation analysis, data needs and readiness assessment checklist

Digital policy environment

- What digital policies exist in the country? For example, is there a digital health policy?
- How do these policies affect the RTM system?
- Are there restrictions on where data should be stored?
- Are there standards for interoperability?
- How are past and current initiatives navigating these requirements?

Existing digital health programmes for immunization and data collection

- Is there a strategy to integrate the RTM system for SIAs within existing electronic health information systems?
- Are there existing health information systems being used for SIAs already, particularly for RTM? What about for routine immunization?
- Are existing health information systems being used for other campaign-like activities, such as mosquito net distributions, mass drug administration, or deworming?
- Has RTM ever been used for performance/activity reporting, logistics management, supervision, etc., for the above? What about for routine immunization?
- What aspects of these digital systems have worked well and are appropriate for adaptation or adoption for SIAs? Why? What aspects would not work for SIAs? Why not?

Existing digital health programmes for immunization and data collection

- Who has been responsible for designing and implementing these digital systems?
- Are there implementing partners, software developers, government focal persons, and other resource people in the country who can provide expertise for the planned RTM system?

Financial resources and planning cycles

- How have these past and current initiatives been planned and funded?
- When does the planning process begin, and how does it work?

Coordination and oversight of SIAs

- Who are the implementing partners and government agencies involved in SIAs at each level?
- What are their roles?
- How frequently do they meet?
- What campaigns are planned in the next two to three years?

Network connectivity and devices

- Consider the types of users (health workers, field monitors, district management health teams). What kinds of mobile devices do they own?
- What per cent of the country has network coverage?
- Which areas are 'black' or have little coverage?

Defining priority data and information needs

- What information and data is needed and for what purpose?
- How will real-time data inform decision making and corrective action?
- What data is needed and with what frequency at local, district and national levels?

Information flows and data use practices/needs

- How is immunization data (both routine and campaign) currently collected?
- What types of data is collected and what is the quality?
- Which stakeholders are involved?
- How frequently is data shared?
- What are the formats for sharing, review and use of data?
- Are there any challenges or missed opportunities?
- What data is needed at local levels for decision-making?
- How can the data be accessed by users?

Ways to improve the use of data

- What kinds of data is collected before/during/after campaigns?
- Who are the different partners involved? What are their roles? What kinds of data do they need? (If one partner is involved in community mobilizing and another is involved in logistics, they will need access to different types of data).
- What tools are used? How is the data collected? By whom? How long does it take? Are there any challenges in data collection currently?
- How is it compiled? How is it analysed? By whom? How long does it take? Are there any challenges in data analysis currently?
- What processes are used to share information? How often do these meetings/exchanges occur? Who shares the information with whom? What kinds of decisions are made with the information?
- How well do existing information-sharing systems work? Are there any challenges in accessing and sharing information currently? Are dashboards being used at the national/province/district/subdistrict, etc., level? Why or why not? How do people handle these challenges?
- Is all of the information collected used? What types of information are used more? What types of information are infrequently used? Are there ways to make better use of the data? Which of these uses are the most important?
- What are the expectations regarding paper-based reporting? Which types of information must be submitted by paper, and why?
- To what extent did past/current initiatives alleviate or increase staff workload?

Challenges and opportunities

- What elements of the campaign (microplanning, training, logistics, supervision, AEFI, ACSM, payments, etc.) needed improvement during the last few campaigns?
- Generally, what parts of the campaign are the most challenging and time-consuming to implement and oversee?
- How might RTM make those processes easier?
- Were there missed opportunities to use pre- and post-implementation data?

Implementation

- Training:
  - How was training conducted in the past?
  - Who was trained?
  - What were the topics?
  - How much emphasis was there on data collection? On data use?
  - What is the level of digital literacy among the field workers who will collect data, and managers and supervisors who will support them in data use?
  - Looking back, in what areas do users and stakeholders wish they had better skills or information?
  - What further interventions are needed to ensure adequate skill levels are present at the beginning of the intervention and maintained?
- Maintenance:
  - Who is responsible for maintaining the software and hardware used in the current/past system?
  - How were issues with data entry forms, dashboards, permissions/data access, and data quality detected and corrected?
  - How were data plans issued and recharged?
- Supervision
  - What kind of data has been used to monitor staff performance? Obtain examples of how the data have been used.
  - How might RTM make supervision easier? (If needed, share examples from this document and assess level of interest/need in adopting those methods).
- Supporting environment:
  - If the RTM system will be designed to improve certain aspects of SIAs (such as identifying gaps in ACSM activities, or monitoring adherence to SOPs at vaccine posts), is the broader programme prepared to support the additional corrective actions the RTM system may detect? In other words, have provisions been made for funding or staffing for corrective actions?

Appendix 3. Illustrative considerations to mitigate data management risks [36]

Overview

1. What type of data is being collected? Are the data de-identified?
2. What entity is responsible for the system?
3. Where and how is the data being managed and stored?

Before data collection

1. Who is responsible and accountable for determining the purposes of data collection for this implementation or determining what personal data to collect from whom? Please provide the name(s) of the entity/entities (separated by semicolons), which may assist legal with updating any agreements.
2. What is the purpose of collecting personal data, and is it truly necessary?
3. Will the personal data collected during the implementation serve multiple purposes (such as contact management and fundraising, assessment of eligibility for benefits and research)?
4. Who are the personal data about?
5. Who will supply the data?
6. What kind of personal data will you be collecting?
7. Will you be collecting any of these categories of special data?
    a. Association data (religious, political, trade association)
    b. Racial or ethnic data
    c. Biometric data
    d. Genetic data
    e. Criminal or disciplinary history
    f. Health data
    g. Sexual orientation, gender identity or sexual activity data
8. Will any of the personal data be about key populations (e.g., commercial sex workers, people who inject drugs, or LGBTQIA people) or other specific population groups, such as children and adolescents?
9. Could the data realistically identify specific individuals, alone or in combination with other data sources?
10. Would collection of these data put certain individuals or groups of individuals at risk of harm?
11. Does your implementation involve any of the following technologies or any other technologies that appear to present a high risk to the rights of data subjects?
    a. Innovative technology like artificial intelligence
    b. Automated processing of benefits
    c. Social media networks or other online services for children
    d. Large-scale profiling of data subjects
    e. Biometric data, UNICEF's guidance on biometrics: https://data.unicef.org/resources/biometrics/
    f. Genetic data (this type of data is highly sensitive and should go through a legal office)
    g. Data matching from multiple data sources
    h. Invisible processing (processing significant amounts of data not obtained from the data subjects or their representatives)
    i. Tracking data (IP or geolocation)
12. What technical and organizational measures ensure a level of security appropriate to the risk? The following questions guide you through the process to protect information, as indicated in the Data Security section.
    a. Organizational measures on information security:
        i. Have you classified the information collected, managed, and stored under the scope of this system?
        ii. Do you follow a special protocol for personal or sensitive data?
        iii. Do you follow the national regulation, policies, standards and procedures on information security and data protection?
        iv. Do you have an updated inventory of the assets under the scope of this system?

36. World Health Organization, Digital implementation investment guide: integrating digital interventions into health programmes, WHO, 2020, <https://apps.who.int/iris/bitstream/handle/10665/334306/9789240010567-eng.pdf>.

b. Risk management:
    i. Have you performed a risk analysis in the planning phase?
    ii. Do you carry out a risk management process?
c. Data protection by design and default:
    i. Do you include the security requirements at the beginning of the analysis?
    ii. Do you apply a recognized development methodology that considers security aspects throughout the entire life cycle?
    iii. Have you carried out a security assurance test using international and best practices in security, such as OWASP?
d. Authentication and authorization:
    i. Do you authorize access for users following 'the need to know' principle?
    ii. Has each entity (user and/or process) that accesses the system been assigned a unique identifier?
    iii. Is each user who accesses the system assigned a unique identifier, depending on each of their roles?
    iv. Are users aware of their responsibility to protect assigned credentials, diligent custody, protection of confidentiality and immediate reporting in case of loss?
    v. Are accounts disabled or removed immediately when users do not work under the scope of this system?
    vi. Are there processes in place to monitor, assign, and revoke privileged users?
    vii. If passwords are used, do they comply with quality rules?
    viii. Is multifactor authenticator employed for users, especially for privileged users such as system administrators?
e. Secure infrastructure:
    i. Are the following processes defined and configured with the recent updates: processes to secure networks (perimetral, internal, administration), authorized control access, antimalware processes, spamming prevention, filtering software, end-point protection?
    ii. Do you implement mechanisms to prevent and react to harmful code, such as viruses, worms, Trojans, spyware, and 'malware' in general?
    iii. Have you defined and configured a secure process for remote access?
    iv. Do administrators access and configure the systems in a separate logical segment?
    v. Is a procedure identified and configured to fortify or strengthen systems before they go into operation? In other words:
        - only services and network ports necessary for efficient operation are up and running
        - all application code is patched and kept up to date, and
        - limiting the accounts and removing, changing or disabling default accounts and passwords
    vi. Are computer servers and network devices where data is managed and stored properly secured by a locked mechanism and control access?
    vii. Is a vulnerability process identified to address risk?
    viii. Are the assets updated with the latest software and antimalware releases?
    ix. Is a control changes process identified whenever changes affect the security of your information?
f. Encryption sensitive information to protect data in transit, in temporal caches and storage:
    i. Is cryptography utilizing strong, robust and updated algorithms in use?
    i. Do all the servers connections encrypt their communication using TLS that supports the latest protocol versions?
    i. Is sensitive information stored in the infrastructure encrypted, including backups?
g. Availability:
    » Do backups allow for the recovery of accidentally or intentionally lost data?
    » Have physical/logical methods been defined to ensure security continuity management, and to protect your information and facilities from the damage that malicious attacks can cause, or during a disaster or crisis situation?
h. Deletion of confidential/personal data:
    » Is it verified that all sensitive data has been removed or securely overwritten so that it cannot be reconstructed once the data is not needed?

i. Security testing:
    i. Is a process defined for regularly testing, assessing, and evaluating the effectiveness of technical and organizational measures to ensure information security?
    ii. Do you perform vulnerability assessments?
    iii. Do you perform penetration testing or other security testing?
    iv. Do you conduct audits? What kind: ISO, SOC-2, SOC-3, others?
j. Monitoring and auditing process:
    i. Does the system generate, collect, and monitor records/logs/events for success/failures in system access information, especially access to personal data?
    ii. Are there processes in place to monitor, assign, and revoke privilege to privileged users?
    iii. Are the records/logs/events protected from manipulation and unauthorized access?
    iv. Do you use network monitoring and packet-sniffing applications, as well as data traffic to detect installation of unauthorized hardware and/or software applications (i.e., monitor protocol violations, bandwidth-intensive applications, etc.)?
    v. Are host-based firewalls, virus, intruder detection, and network monitoring software installed?
k. Security incident management:
    i. Do you follow a procedure to report security incidents, including formally documenting notification and escalation?
    ii. Is different time response considered for security incidents depending on severity and classification?
    iii. Are the users notified if there is a personal data incident that affects them?
l. Awareness and training on information security:
    i. Do users who have access to the system receive training on information security and, system-specific risks?

During data collection

1. How will you obtain and store the personal data?
2. Where will personal data be stored?
3. What measures will be taken to obtain informed consent?
4. Who will own the data? Will the data subjects have access to their own data?
5. What are the data protection measures?
6. Who has access to the various types of data?

After data collectlion

1. Do you expect the personal data to move internationally? How will the data be processed? (This may possibly require information notice or determine need for particular legal clauses.)
2. Who will have access to personal data? Who will the data be shared with? How will the data be shared? (This may possibly require information notice or may determine new required legal agreements. Any sharing of personal data with additional entities/organizations is likely to require a non-disclosure agreement or other form of legal agreement.)
3. For how many years do you currently anticipate keeping the personal data? (For guidance, refer to UNICEF's Personal Data Protection.)

Appendix 4. Illustrative questions on how to monitor and evaluate a RTM system for vaccination campaigns

How to monitor the RTM system – questions to be asked and data required

Questions of interest and indicators	Data sources
Inputs: *What investments were made into the RTM component of this SIA?*	
• Financial expenditures, by type (planning meetings, software development, data hosting, training, IT support, mobile data plans, etc.) • Number of people trained on RTM, by type.	Expenditure data Training reports
Process/outputs: *To what extent did RTM roll-out go as planned?*	
Did data collectors submit data in real time? • Number of data collectors submitting reports • Timeliness of data (% of reports submitted by the deadline) • Completeness of data (% of communities/sites monitored with submitted data) • List of teams needing data quality supervision – teams with high rates of late data, incomplete data, high rates of duplicate entries, or missing GPS data (thresholds to be defined) Were the data accessible to users/decision makers in real time? • Number and % of users who accessed the dashboard daily during the campaign, by type (disaggregate between field, district, provincial and national supervisors) • Number and % of districts/provinces that received data summaries during each day of the campaign and mop-up period • Number and % of data collectors who received daily SMS reminders and/or performance feedback from the software (e.g., RapidPro) *User satisfaction with the data collection and data use process*	RTM software reports RTM software reports or reports from the national/province/ district emergency operations centres if the software is not programmed to automatically push/send reports to users SMS surveys, key informant interviews

How to evaluate the RTM system – Questions to be asked and data needed

Types of data and indicators collected	Data sources
Outcomes: *To what extent did RTM accomplish its intended sub-objectives?*	
*Did RTM data lead to prompt corrective actions **during** the campaign?* • Number of communities identified as requiring corrective actions • Number of corrective actions, by type • Number and % of communities requiring corrective actions that had any taken • % of corrective actions completed • Change in number of children missed, between intra- and post-campaign RCAs	RTM software reports
Did RTM data lead to improved performance from field staff? • Trend in mean performance scores from daily supervision checklists	RCA reports (can be summarized by the RTM software)
Other – did RTM lead to: • More timely identification and resolution of issues flagged through readiness checklists? • More accurate microplan maps and quantifications/denominators? • More timely completion of funds disbursement? • More timely rumour management? • Improved quality of trainings in subsequent rounds/provinces? • Improved sense of partnership and transparency during the campaign?	RTM software reports Review of programme documents After-action reviews with stakeholders at all levels; review of programme reports
(See Section 1 for a comprehensive list of possible uses for RTM.)	
Impact: *To what extent did RTM contribute to the goals of the campaign?*	
• Did RTM contribute to improved coverage? • Are the development and maintenance costs of RTM acceptable for future adoption, replication, and/or scale-up?	Quantitative analyses looking at the association and use of RTM data, controlling for factors such as pre-immunization readiness Qualitative interviews and use of monitoring data to map the ways in which RTM contributed to improved coverage Cost analysis comparing

Appendix 5. Illustrative dashboard examples

RTM objective: Monitor administrative coverage and identify where corrective action is needed

Data source	RTM analyses/indicators	Triggers for corrective action	Report and dashboard outputs
Daily vaccine tally sheet	Administrative coverage (daily and cumulative progress to target), by geographic area, population cohort, strategy and dose*	Red if below X% or above X%	Colour-coded graphs and maps to indicate pass/fail status List of communities needing corrective action, with column for most common reasons for non-vaccination
RCM forms	Number of houses (out of 15) with all SIA-eligible children vaccinated during SIA*	< 14 houses completely vaccinated*	Colour-coded graphs and maps to indicate pass/fail status List of communities needing corrective action with column for most common reasons for non-vaccination
	Percentage of SIA-eligible children identified during in-house monitoring who were vaccinated during this SIA*	< 90% vaccinated children*	
	Percentage of SIA-eligible children identified during out-of-house monitoring who were vaccinated during this SIA*	< 90% vaccinated children*	
Daily vaccine tally sheet and RCM forms	Compare RCM pass/fail results to administrative coverage*	Red if community's administrative coverage was > 100% but failed RCM	List of communities

RTM objective: Support routine immunization by identifying communities at risk for low routine immunization coverage

Data source	RTM analyses/indicators	Triggers for corrective action	Report and dashboard outputs
Daily vaccine tally sheet	Proportion of zero-dose children, where vaccine card retention is high* Communities where the proportion of children with vaccine cards is greater than X%	Red if above X%	Colour-coded graphs and maps List of communities

Starred (*) indicators and thresholds were suggested in the 2016 WHO measles SIA guidelines.

RTM objective: Check quality of administrative data

Data source	RTM analyses/indicators	Triggers for corrective action	Report and dashboard outputs
Daily vaccine tally sheet	Compare number of vaccinated children to vials opened (accounting for acceptable X% level of wastage)*	Red if consumption was less or greater than X%	Maps and list of sites requiring follow-up
Daily vaccine tally sheet	Compare number of vaccinated children to number of children of the same age group given other interventions for that age group (if multiple interventions were given during the SIA)*	Red if the number of vaccinated children is X% lower or higher compared with the number given other interventions	Maps and list of sites requiring follow-up

RTM objective: Supervision and accountability

Data source	RTM analyses needed	Triggers for corrective action	Report and dashboard outputs
Daily vaccine tally sheet	Per cent of teams submitting complete tally form data that day*	Red if less than X%	Names of districts with reporting rate below X%
Daily vaccine tally sheet	Per cent of teams visited by a supervisor that day*	Red if less than X%	Names of districts with supervision rate below X%
Supervision checklists	Calculate scores for adherence to SOPs by thematic area	Red if below X% for total score, or has at least one sub-score below X%	Table/list of teams requiring follow-up (with scores)
Any form	Calculate start and end time for completion of forms Percentage of forms with GPS coordinates	Red if time is X% below or above pooled average Red if less than X%	List of enumerators filling out forms too quickly or slowly List of enumerators not submitting GPS coordinates

Starred (*) indicators and thresholds were suggested in the 2016 WHO Measles SIA Guidelines.