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Bridging Real-Time Data and Adaptive Management: Case Study Report

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Bridging Real-Time Data and Adaptive Management in International Development

Final Case Study Report

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Executive Summary

Introduction

The challenges and problems faced by international development and humanitarian agencies have long been acknowledged as some of the most complex and uncertain in the world. Calls for a more responsible and flexible approach to development are coming from many different quarters. This report looks at how real-time data initiatives in different sectors and contexts might help to underpin and strengthen adaptive management approaches in development programs and operations. Although the two movements are distinct—real-time data systems are tools and adaptive management is a management approach—examples of crossovers and overlaps exist. But exactly how these might be bridged in practice—with what strengths, weaknesses, challenges, and opportunities—is not well understood. As a result, the genuine synergies between the movements are yet to be delineated and realized. The overarching aim of this report is to address the following research question: *When, where, and how can real-time data systems contribute to adaptive management practices?* An evidence-based approach is needed to answer this question, drawing on literature, interviews with experts, workshops, and four country case studies.

Key concepts

For the purpose of this study, real-time data initiatives are defined as follows:

> *Real-time data initiatives are those that employ digital technologies (computers, tablets, mobile phones, sensors, etc.) and specialized software applications to enable and accelerate the collection, sharing, management, analysis, and reporting of data with the aim of informing more rapid and timely decision making.*

It is important to distinguish among real-time data, real-time data systems, and real-time data initiatives. Specifically:

- *Real-time data* is the information generated by the different technologies.
- *Real-time data systems* are the specific combinations of technologies and processes designed to generate, share, and manage real-time data.
- *Real-time data initiatives* are projects or programs of work that seek to apply real-time data systems within specific contexts. For the purposes of this study, these contexts are development and humanitarian efforts in developing countries.

Adaptive management can be defined as follows:

> *Adaptive management (or adaptive programming) relates to a broad combination of approaches, tools, techniques, and processes that enable responsive, flexible, and novel decisions and approaches to development interventions—at both the tactical level and the strategic level. The premise of adaptive management is that decisions and actions can be adjusted as contexts and problems are better understood through a process of "learning by doing."*

Real-time data and adaptive management are potentially highly complementary. Both areas seek to achieve changes in how decisions are made in development programs and emphasize the importance of data, information, and learning. Examining the potential integration of real-time data and adaptive management reveals potential mutual benefits, with scope for addressing the problems faced in each field.

Methodology

The overall research project had five interconnected components, as follows:

1. **Review and synthesis of literature**: This covered 116 published reports, articles, agency grey literature, opinion pieces, and evaluations sourced from a number of sectors including international development, business, and military.

2. **Key informant interviews**: Forty-eight interviews were conducted with key international development experts to explore the intersection of real-time data and adaptive management in different contexts.

3. **Case study survey and analysis**: A survey (developed and disseminated through a number of widely used platforms) generated over 60 responses from development practicioners, which were then filtered and resulted in a long list of 20 case studies.

4. **Initial case study interviews**: Interviews were conducted with key informants working on or representing specific initiatives using an analytical framework derived from findings in components 1 and 2. This informed decision making about the selection of countries and case studies. Four case studies were selected for in-depth study—two in Indonesia and two in Tanzania.

5. **In-depth case study research**: Research on the four case studies was guided by the team's conceptual framework on the use of real-time data for adaptive management. Across the case studies, the team conducted 82 interviews, held 8 workshops, and reviewed over 100 documents.

Case Study Overview
The selected case studies relate to four distinct areas of development work:

Service delivery: Mobile nutrition through M-Posyandu in Indonesia.
The **M-Posyandu** system in Indonesia focuses on the use of real-time mobile data to improve the efficiency and quality of nutrition service decision making in health posts and enhance achievement of national nutritional goals.

Sustainability and resilience: Urban flood resilience through PetaJakarta in Indonesia.
PetaJakarta in Indonesia is a real-time data system for enabling crowdsourcing of citizen-generated data to support disaster management in urban Jakarta, focusing on flood management.

Economy and productivity: Agricultural marketing and knowledge through the Listening Project in Tanzania.
The **Listening Post** project in Tanzania is a pilot initiative undertaken by Farm Radio International (FRI) to incorporate real-time mobile data systems in their existing radio-based methodology for collecting unfiltered feedback from farmers.

Citizenship and governance: Birth registration through the UNICEF–Registration Insolvency and Trusteeship Agency (RITA) *project in Tanzania.*
The **Scaling Up Birth Registration Program** in Tanzania uses mobile real-time data systems to enable faster, cheaper, and more comprehensive child birth registration.

The activities as described in this case study report were not USAID-funded but PetaBencana, which replaced PetaJakarta, did later receive USAID funding.

The case study findings can be categorized under four areas:

- **Systems:** how real-time data systems are designed and developed and how they are implemented and operationalized

- **Data:** how real-time data is collected, aggregated, and verified and how it is analyzed and shared
- **Contexts:** how real-time systems and real-time data are shaped by capacities, relationships and incentives
- **Decisions:** how all the above enable or inhibit adaptive decisions, at both tactical and strategic levels

Findings: Systems

- Successful real-time data initiatives require a recognition of opportunities and challenges, enthusiasm for the potential of technology, and availability of resources
- Real-time data systems involve high levels of “combinatorial innovation”
- Technological considerations span data, applications, hardware, networks, and infrastructure
- Technological choices do not always take account of issues of access and representation
- Design efforts place greatest emphasis on data collection and least on data use
- Implementation approaches are diverse
- Operational challenges are both technical and social
- Financial issues severely limit operational viability and sustainability
- Effective operations require an agile approach to system deployment

Findings: Data

- Collecting data is not enough—it must be cleaned and verified and this takes time
- Cleaning and verification takes place at different levels of the system
- Aggregation and collation need to combine automated and human processes
- Most analyses undertaken by real-time data initiatives are automated due to lack of human capacity
- Automated data analysis tends to focus on simpler, easy to measure indicators of the underlying problem
- More sophisticated analysis of data are not always economically feasible or technically viable
- The demand for analysis is as important as supply and has both technical and human dimensions
- Dashboards are widely deployed for data sharing and are as useful for advocacy as for decision making—typically in combination with other mechanisms for data management and sharing

Findings: Context

- Multi-level relationship development is essential but political challenges emerge at every level
- Constant engagement and winning over champions is key to effective relationship development and takes considerable amounts of time, energy, and negotiation skills
- Data processes are only as good as the relationships in which they are embedded
- Incentives and disincentives play out in unpredictable ways
- Wider institutional and political factors play a critical role in data systems and decisions
- Human capacities and technological innovation need equal attention

Findings: Decisions

- Real-time data systems contribute to frontline tactical decisions for case management and process optimization
- The greater the scope of the decision, and the further from frontline case management, the greater the need for RTD to be complemented with other sources

of data
- The value of real-time data systems for strategic adaptation lies in expanding the space of possibilities for wider changes
- Strategic adaptations require involving decision makers in design of systems
- Real-time data systems are not always intended influence strategic adaptations
- Real-time data systems can often be perceived as imcomplete or of low quality, which places limits on strategic utility
- Many practical barriers to strategic adaptations are not addressed by the speed or quality of data

Summary of Lessons and Conclusions

The case study findings suggest that more integrated approaches to real-time data initiatives and adaptive management efforts hold potential value. Specifically, in response to the core research question of when, where, and how real-time data can contribute to adaptive management, the research findings suggest the following:

Conclusion 1: Real-time data systems can generate data that directly informs immediate operational adaptations to specific "case-based" challenges faced by frontline workers. These adaptations can happen more-or-less at the point the system is used.

Conclusion 2: Real-time data systems can generate data that, in combination with other data and information sources, informs higher-level tactical adaptation decisions about resource allocation, individual and organizational performance management, rollout of initiatives, and progress of specific interventions.

Conclusion 3: Real-time data systems can provide data that, when aggregated in meaningful and comparable ways, provide useful inputs into strategic dialogue and discussions—as part of a broader strategic information management system.

Conclusion 4: Real-time data initiatives can open up individual and collective space to explore wider implications of the system for other related areas of development policy and practice.

Research across the case studies helped articulate a set of common lessons about critical enabling factors for bridging real-time data and adaptive management in a more systematic and sustained fashion:

- Lesson 1: Design holistically for adaptation
- Lesson 2: Design for decision makers' needs and interests
- Lesson 3: Emphasize right-time data over real-time data
- Lesson 4: Ensure quality and coverage to build trust among diverse stakeholders
- Lesson 5: Build real-time data into overarching strategic information systems
- Lesson 6: Invest in capacity of individuals and teams to be "data ready"
  And approaches
- Lesson 7: Focus as much on the social as the technical life of data
- Lesson 8: Ensure appropriate, agile, and accessible technologies
- Lesson 9: Work to strengthen data culture and data leadership
- Lesson 10: Develop realistic ambitions—start from where you are

The case studies show that real-time data systems can, in the right circumstances and with the right enabling conditions, enable adaptive management. In settings where there are no political or institutional constraints to adaptation—and where the timeliness of information is the binding constraint on strategic and operational improvements—real-time data systems can underpin and catalyze *data-driven tactical adjustments* and *data-enabled strategic adaptations*.

For this to take place, the goals and scope of real-time data initiatives must evolve and include a focus on how to inspire and enable innovative and novel development practices. Adaptive management approaches must also change—and recognize the potential that real-time and digital data systems hold for providing necessary evidence for improvements in programs, policies, and practices. Ultimately, a willingness and openness to go into the unknown is needed. A number of shifts must take place: from data-driven optimization to data-led innovation; and from implicit, “invisible” adaptive decision-making approaches to explicit, transparent ones. In short, each field holds untapped value and benefits for the other. Development actors should continue to work to better understand and realize this value practically.

Ultimately, the use of real-time data systems for adaptive management is not about technology—it is about a strategic and cultural environment that enables technology to be utilized as a driver of organizational decision making and of institutional transformation. While technology can certainly raise questions and opportunities, it cannot open the door to this kind of transformation—either within programs or more broadly in organizations and alliances. As with other forms of evidence utilization, the key factors are political, institutional, and individual will.

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1. Introduction

1.1 Background and context

The challenges and problems faced by international development and humanitarian agencies have long been acknowledged as some of the most complex and uncertain in the world.[1] Since at least the 1960s, development experts and practitioners have called for a move away from top-down, over-designed interventions towards more anticipatory, adaptive, and networked approaches.[2] Today, such approaches are seen as essential for addressing many different development challenges, including enabling governance reforms, responding to epidemics, achieving universal basic education, providing vaccine coverage for all—the list goes on and on.

Calls for a more responsible and flexible approach to development are coming from many different quarters. Long seen as overly conservative, rigid, and risk-averse, the development sector has experienced an explosion in new ideas, theories, methods, approaches, and movements. Political scientists are making the case for strategic and operational approaches that are more evidence-based, institutionally grounded, and flexible. Systems- and complexity-thinkers argue for new computational frameworks to understand and navigate thorny and evolving problems. Behavioral scientists suggest addressing psychological and cultural norms that shape and underpin development processes. Digital innovators want more agile approaches—not only for new technological development, but for development efforts as a whole. While the origins and philosophies of these trends are diverse, proponents share a hope for transformative change in how the development sector operates by enhancing the evidence base, grounding programs in context, and increasing program flexibility.

The *Real-Time Data for Adaptive Management* research project, of which this report is one part, focuses on whether and how two movements might work in tandem to bring about such change. Specifically, this report looks at how **real-time data initiatives** in different sectors and contexts might help to underpin and strengthen **adaptive management approaches** in development programs and operations.

The first of these movements is ubiquitous, with origins and impacts well beyond the development sector. Enabled by advances in information and communication technologies, data is bigger, faster, more diverse, and more detailed than ever before. The data revolution has numerous strands, which are usefully summarized by the eponymous United Nations group as follows:

> [The data revolution] refers to the transformative actions needed to respond to the demands of a complex development agenda; improvements in how data is produced and used; closing data gaps to prevent discrimination; building capacity and data literacy in “small data” and big data analytics; modernizing systems of data collection; liberating data to promote transparency and accountability; and developing new targets and indicators.[3]

Development organizations have responded to the data revolution by committing to “data driven development” and to being “digital by default” by seeking to exploit the commonly referenced V’s of volume, variety, and velocity and by signing on to a set of principles that guide their digital development efforts.[4] Although the V’s are not exclusive categories, this report and the overall project focuses on development data systems that emphasize

[1] Ellerman, 2003 in Roper and Pettit
[2] HFP
[3] http://www.undatarevolution.org/data-revolution/
[4] http://digitalprinciples.org

velocity—namely, real-time data. Systems providing more dynamic data are being utilized in many different development contexts and sectors including health, agriculture, disaster management, environmental sustainability, governance, and citizenship.

The second movement is much less ubiquitous and fast moving than the digital revolution. Ideas of "adaptive management" are reasonably popular in a number of other fields including business, environment, sustainability, public administration, and military planning. Calls for more adaptive approaches to development date back as far as the 1960s, with the ideas re-emerging regularly ever since. These approaches have gained renewed attention thanks to concerted efforts across a loose network of academics, donors, policy think tanks, and implementing organizations. Recent years have seen much more emphasis on adaptive management—taking the ideas and applying them in practice within programs and across entire organizations. Many of those involved in these efforts have argued for the need to "do development differently" and are signatories to the related manifesto of Harvard University and the Overseas Development Institute (ODI).[5]

1.2 Rationale and aims of the report

The present report, and the broader study of which it is one part, focuses on the interface between real-time data and adaptive management. Although the two movements are distinct, they have areas of synergy. For example, actors making the case for adaptive management have cited agile approaches to software development to help legitimize more flexible delivery approaches. At the same time, proponents of real-time data initiatives have cited its potential benefits as including better, faster, more responsive decision making. To date, practical linkages between the two have been recorded only anecdotally. The most that can be said is that real-time data might theoretically contribute to adaptive management, and adaptive management might theoretically benefit from real-time data systems. But exactly how this might work in practice—with what strengths, weaknesses, challenges, and opportunities—has been poorly understood. As a result, the genuine synergies between the movements have yet to be delineated and realized.

This report is an initial attempt to understand this potential interface in a more thorough and evidence-based way. It is part of a wider study that seeks to illuminate and better understand whether and how one specific aspect of digital development, namely real-time data, can contribute to adaptive management efforts. This report is the most substantial output of a year-long program of work undertaken by a consortium of four leading research, learning, and design organizations focusing on development and humanitarian issues.[6]

The overarching aim of the consortium was to design and implement a program of research and learning focused on the following research question:

> *How, in what ways, and with what benefits do real-time data systems contribute to adaptive management?*

The consortium took an evidence-based approach to answering this question, drawing on literature, interviews with experts, workshops, and case studies. It looked across a number of different case studies operating in different countries and sectors. In doing so, the consortium sought to provide a more detailed and systematic understanding of the strengths, weaknesses, opportunities, and challenges that lie at the interface between real-time data and adaptive management.

1.2 Approach to the case study research

[5] http://doingdevelopmentdifferently.com
[6] The Institute of Development Studies, the Overseas Development Institute, Feedback Labs, and Reboot, Inc.

In order to understand these emergent and embryonic fields in a more systematic and coherent fashion, the research was undertaken by a project team comprising specialists in real-time data systems, adaptive management, digital technologies, and feedback systems. The overall work program included three components (see section 3 on methodology for more details). An extensive literature review, together with key informant interviews, helped to clarify the analytical lens for understanding the potential intersection of real-time data and adaptive management. This research also provided a framework for exploring the case studies. Each case study was analyzed in detail to identify common themes and issues systematically.

This report presents the synthesis of lessons across the four case study investigations. It first sets out *key concepts and ideas* before explaining the *methodology* in more detail. After providing an overview of the *case studies,* it presents *findings* in four parts (*systems*, *data*, *contexts,* and *decisions)*. It ends with a summary of *findings, lessons and conclusions*.

2. Key concepts and ideas: What is Real-Time Data, What is Adaptive Management, and How can They be Bridged?

This section draws on research undertaken to date to present key concepts, ideas, and broad definitions relating to real-time data, adaptive management, and their potential interface. The section is intended to provide readers with a platform for engaging with and understanding the case study material that follows.

2.1 What is real-time data?

According to research published in the Harvard Business Review, real-time data is "the continuous processing of events and data to gain instantaneous insight and take instantaneous action."[7] The rise of real-time data systems in business corresponds to the wider interest in big data—and specifically in the growing desire to tap into the enhanced volume, variety, and velocity of data enabled by digital technologies.

Several distinct business models have been enabled and underpinned by real-time data systems:

- *Rapid response systems* that integrate fast response data collection, analysis, and action (e.g., Uber, Airbnb, and Google cars)
- *Resource or network usage systems* that respond instantly based on product stock levels, resource utilization, user traffic, demand and activity volumes (e.g., Spotify and Facebook)
- *End user experience management systems* that analyze in real time large amounts of internet behavioral data about browsing history, search terms, purchases, and interactions to tailor and support self-service (e.g., Amazon and Netflix)

Real-time data in these settings is real time in an *absolute* sense. Data is literally presented as, or very soon after, it is collected. Many of the cases mentioned above also incorporate fully automated responses to the data. A good example is the continuous updating of products on shopping or consumer websites (such as Netflix and Amazon) to match the evolving profile of individual browsers. These systems, of course, still include human intervention at the overarching strategic level of design and implementation. But the real-time elements are largely, if not entirely, digitized.

Technology sector organizations employing such approaches have used them to challenge existing business models and realize competitive advantages. The successful ones have distinguished themselves from other players in this way. For example, "Uber knows where you are, where you're going, and how you will pay to get there because it can capture, analyze, and act on data in real time."[8]

For other businesses, such end-to-end digital approaches—in which the data gathering and decision making are fully automated—are not always feasible or desirable. In such contexts, digital and human capabilities must be integrated across the processes of data collection, analysis, and use. One memorable example from recent times is the Hong Kong venture capital firm that legally appointed an algorithm as a board member to contribute to investment decisions: the algorithm is provided data, and its judgments are incorporated into any final decisions.[9]

There are also many other, rather less fanciful, examples of humans and machines actively

[7] https://hbr.org/2015/02/your-data-should-be-faster-not-just-bigger
[8] (HBR, ibid)
[9] http://www.bbc.co.uk/news/technology-27426942

involved throughout the process of moving from data collection to decision making and action. Roaming sales people or mobile retail offices might upload performance and market information via mobile phones, enabling decision makers in regional hubs to direct and change resource allocation. Infrastructure staff working across different engineering sites might share information about asset quality and undertake the most urgent repairs. Market researchers can share survey information in real time, enabling decision makers to adapt advertising or retail strategies. Customers can share their views on products and services instantly, shortening the timeframes for adapting launches or campaigns.

In some cases, human intervention is required to interpret and collect data at the frontline, and human capabilities are often required throughout the process to make sense of and act upon data. Because such systems do not operate instantaneously, and are typically only partially automated, they are not equivalent to the *absolute* real-time data systems described earlier. However, they can be seen as *relatively* real-time, because the data streams are *more* real-time than traditional paper-based or analogue systems and can support a move from data to action in a more dynamic fashion. Relative real-time data systems can be demonstrably faster and more dynamic than pre-existing manual or analog data approaches. As such, they fit within the *velocity* aspect of the data revolution.

In the business world, the term *real-time* is often over used and subjective. This has led some analysts to suggest that a line be drawn between *real-time* and *near real-time (*which relate to instant, wholly automated data systems) and *right-time data* (which relates to hybrid digital–human systems equivalent to the *relative real-time* data systems described above).[10]

In international development circles, relatively few (if any) applications are genuinely real time or near real time. This is because few development programs can be fully automated. Instead, *real-time* is generally used as a kind of accepted shorthand for *relative real-time data systems*. When development actors talk about real-time data, they generally mean accelerated data processes and the improved decision-making processes these could potentially support.

Thomas Davenport, an influential scholar in information technology and data-driven businesses, has shown through a variety of case studies that firms are using technology and data to optimize supply chains (retail), pricing strategies (Amazon), and customer engagement (Netflix).[11] However, these are still largely anecdotal and based on self-assessments by the businesses in question rather than on objective analysis. They are more likely to be linked to the strategic marketing of the organization in question. Moreover, in highly competitive settings, it is hard to argue that data-driven approaches are an essential enabler of success, because those organizations that failed may have been using the same kinds of strategies. Noted digital scholars Erik Byrnjolffson and Andrew McAfee at the Massachusets Institute of Technology have demonstrated more generally that the use of data-driven approaches is linked to overall business productivity and performance. However, the specific processes and causal pathways for the contribution of data to success remain uncertain.[12]

Research by the Institute of Engineering at Cambridge University distinguishes usefully between the kinds of value that real-time data initiatives can *potentially* generate:

- Real-time data can be used for the incremental improvement of current business practices and services—through the optimization of existing processes, customer bases, relationships, employee interactions, partnerships, and systems.

[10] https://tdwi.org/~/media/8853F06E45A2458F8995A0FC495557C0.PDF
[11] https://hbr.org/2013/12/analytics-30
[12] https://hbr.org/2012/10/big-data-the-management-revolution

- Real-time data can also be used to enable, facilitate, and drive the creation of entirely novel products, services, processes, and business models.[13]

As we will see in the following section on adaptive management, this distinction has much in common with frameworks for learning. The literature review and key informant interviews conducted as background to this paper identified many ways in which real-time data initiatives are seen to contribute to decision making (see table 1).

Type of benefit	Explanation
Opening up to new understanding and voices	To gain understanding of events as they unfold, often from novel and disregarded perspectives and voices; for example, how populations might be mobilizing in response to a disease outbreak using real-time tracking of mobile phone call data
Enabling rapid and timely responses	Monitoring of specific indicators – asset quality, changes in performance, cases of diseases, behavioral changes – and using these to inform immediate decisions and responses
Optimizing resources	Tracking the use, level and location of critical resources – such as drug stocks, food levels, vehicle drivers – and using this information to manage operations more efficiently and effectively
Sharing collective learning and perceptions	Tracking in real time how people are reacting to or discussing specific phenomena – from responding to a new consumer product to learning how to deal with specific weather conditions, to generating perspectives on a new policy or the quality of a critical service such as education or health – and using this to inform decisions about policies and practices
Understanding and managing systems	Real-time data systems that provide a comprehensive system- or network-wide view of key challenges, processes or functions can enable systems stewardship. Widely used in the military and manufacturing, such systems are starting to be used in humanitarian operations, environmental management, and health and education systems-strengthening efforts
Adapting and scaling new business models	Real-time data systems can enable new business models for development organizations and businesses to emerge and be taken to scale. For example, the combination of mobile data capabilities with financial services has enabled more inclusive financial services for poor communities. Along similar lines, mobile money is now being used in combination with off-grid solar energy systems to expand energy services to poor communities
Anticipation and building resilience	A range of real-time data solutions have enabled decision makers to shift from reactive solutions to anticipatory approaches. For example, resilience-related systems are already in place in a number of settings that anticipate spikes in food prices, extreme weather or other events that could affect the lives of poor and vulnerable people. These can also be used within operations and logistical systems, such as food or supply delivery, to anticipate bottlenecks or other problems, and respond through contingency planning

Table 1: Benefits of real-time data systems[14]

The background research also documented risks associated with real-time data systems in the business context. These include: exclusion/marginalization of users and customers who lack digital access, reinforcement of internet monopolies, exclusion of important businesses and sectors that don't have data capacity, and over-simplification of human decision-making processes.[15]

For the purpose of this study, real-time data initiatives can be defined as follows:

[13] http://cambridgeservicealliance.eng.cam.ac.uk/resources/Downloads/Monthly%20Papers/2014_March_DataDrivenBusinessModels.pdf
[14] Source: Hernandez, K (2016) RTD4AM Literature Review, Unpublished Background Paper
[15] ibid

Real-time data initiatives are those that employ digital technologies (computers, tablets, mobile phones, sensors, etc.) and specialized software applications to enable and accelerate the collection, sharing, management, analysis, and reporting of data with the ultimate aim of informing more rapid, timely, and effective decision making

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- *Real-time data initiatives* are projects or programs of work that seek to apply real-time data systems within specific contexts. For the purposes of this study, these contexts are development and humanitarian efforts in developing countries.

2.2 What is adaptive management?

The basic assumption behind adaptive management is that organizations, teams, and individuals must be able to respond to changing contexts, emerging problems, and new opportunities. Responsiveness cannot be random or arbitrary, but rather based on ongoing and continuous processes of learning and feedback. Under an adaptive management regime, projects, programs, principles, policies, and practices are all developed anticipating that they will be adjusted and iterated over time. As this explanation suggests, the heart of adaptive management is a process of evidence-based learning and feedback.

Table 2 shows how the data foundations of adaptive management can be contrasted with other common approaches to data gathering and use.

Program mode	**How data is gathered**	**How data is verified**	**Organizational mentality**	**Mode of utilization**
Laboratory experimentation	Controlled observation to infer cause	Replicated to assure reliability	To enable design, control, and prediction	Research summaries and theory development
Standard monitoring and evaluation	Goal-oriented observation and data gathering	Multiple sources of information to verify progress	To mitigate implementation problems	Improve management / allocation / evaluation decisions
Unmonitored experience	Casual and unsystematic observation	Applied anecdotally	Politically oriented programs and projects	Selective use of information and evidence, can be arbitrary and politicized
Adaptive management	Systematic monitoring to detect changes, emergence, and novelty	Collective assessment to build knowledge of systemic phenomena	To inform better models, theories of change, and idea generation	Interpretation and learning

Table 2: Comparing the data foundations of adaptive management to different program

modes[16]

Adaptive management has become increasingly popular in development and in other fields due to a growing awareness that reductionist, silver bullet approaches are seldom appropriate for the problems faced in the real world. Done right, the argument goes, adaptive management leads to organizations, teams, and individuals who can better recognize and navigate uncertainty and complexity. Typically, adaptive management is not presented as an end, but rather as a means to more effective decisions and enhanced outcomes.

Many scholars and practitioners link adaptive management to advances in the 1970s in the areas of ecology and natural resource management, especially through the work of Buzz Holling.[17] However Holling's seminal work makes clear that these ideas have a long intellectual and practical history spanning business strategy, public administration, engineering, decision theory, organizational behavior, and a host of other disciplines. With strong interdisciplinary roots, adaptive management has moved from a response to specific kinds of problems to a set of principles that are increasingly being used to rethink and change how entire organizations are managed and structured.

Adaptive management is typically framed as a cyclical process involving assessment of problems, program design, implementation, monitoring, evaluation, and adjustment (see figure 1). The cycle is seen as underpinned by purposefully collected information.[18]

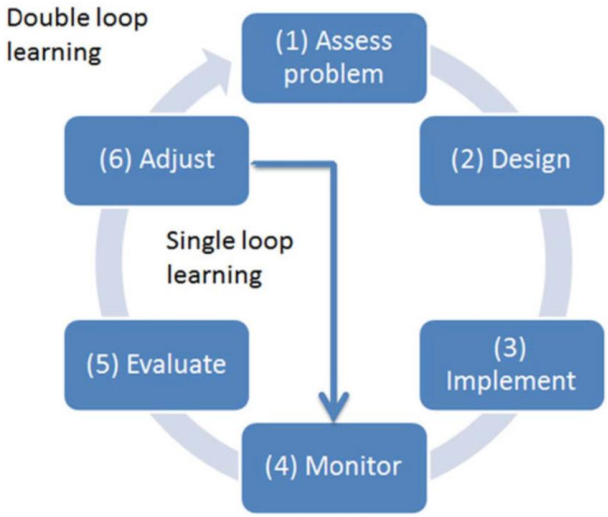


Figure 1: The adaptive management cycle[19]

Within this basic cycle, two distinct levels of learning and feedback can be distinguished, characterizing different levels of adaptation. Specifically, *single-loop learning* supports

[16] Adapted from Lee (1999) and NAP https://www.nap.edu/read/10972/chapter/4#21
[17] Holling, C. S. (ed.). 1978. Adaptive Environmental Assessment and Management. New York, NY: John Wiley and Sons.
[18] Walters & Holling 1990
[19] Adapted from http://onlinelibrary.wiley.com/store/10.1111/conl.12189/asset/conl12189.pdf;jsessionid=6D5F608EBDBEA0A3DC28370C7E451BB3.f04t04?v=1&t=j304ajio&s=5658576e8a78e7ded5904785ab69318d3339db47

tactical adaptation. This refers to adjusting ongoing interventions in response to monitoring information or feedback. Tactical adaptation—responses to single loop learning—means *learning to do things right*. In these adaptations, the overall problem definition and program design-related assumptions do not change. Responses focus on improving the system or initiative that is already in place—using existing assessments, designs, and assumptions.

Strategic adaptation refers to more in-depth and profound course corrections in response to learning or feedback that questions the appropriateness of (for example) the project outcomes, target group, or locations. Such changes often require deep reflection, consideration of a variety of information sources, and deliberations to identify relevant responses. Strategic adaptations are responses to double-loop learning and involve *learning to do the right things.* Here there is a need to, and scope for, adjusting fundamental problem definitions, program design, objectives, and assumptions.

Of particular relevance to the present research is the distinction between tactical and strategic adaptations regarding issues of *time*.[20] While some processes and outcomes can be observed and understood quickly (e.g., treating acute malnutrition among under-fives) many complex problems involve data collection that does not immediately lead to analysis, understanding, insight, and action (e.g., enhancing agricultural development). Strategic adaptations often require careful reflection and time, rather than simply more rapid information to make faster decisions. For certain kinds of problems, faster course-corrections are not necessarily better course corrections. One can easily imagine cases in which changing an overall approach too quickly might lead to processes that are inappropriate over the medium to long term.

It is also important to note that in the majority of contexts, strategic adaptation, or double-loop learning, has proved elusive. In the development sector, for example, a historical analysis (in 2005) of how the U.N. High Commission on Refugees used evidence and data as a basis for learning showed that changes aligned with existing organizational frameworks (and focused on optimizing the delivery system of known outcomes) were much easier to foster and support. By contrast, changes that challenged the organizational status quo were resisted and ultimately "seen off."[21] A 2002 cross-organizational review of how organizational learning was applied across 13 international agencies (both donors and implementers) found that knowledge and learning tools were used more for tactical than for strategic purposes: "…there is little evidence of fundamental re-organization based on knowledge and learning principles."[22]

Adaptive management has been extensively applied in the areas of ecosystem and natural resource management; numerous studies show how challenging strategic adaptation can be in practice. In some cases, adaptive management efforts end up focusing entirely on tactical adjustments, do not take account of the wider ecosystem processes that are seen as essential for effective natural resource management, and therefore do not move programs to a more strategic footing.[23] However, the literature also documents shifts from tactical to more strategic approaches to adaptive management,[24] with many cases highlighting the considerable amount of time and resources required for such transitions.

The shifts from tactical to strategic adaptive management are typically underpinned by a number of factors including:

- acceptance of the complexity and uncertainty of the challenge

[20] https://www.bond.org.uk/sites/default/files/resource-documents/adaptive_management_-_what_it_means_for_csos_0.pdf
[21] ALNAP, 2002
[22] Ramalingam, 2005
[23] http://onlinelibrary.wiley.com/doi/10.1111/faf.12111/full
[24] https://www.ecologyandsociety.org/vol19/iss3/art25/

- emergence of crises, disputes, and setbacks
- scope for slow, unforced change and patience to allow co-learning, commitment, and trust
- credible relationships resulting in a willingness to change behaviors in the interest of a common vision
- purposeful delays in decision making allowing understanding to grow as the system reveals more of its nature
- recognition of imperfect understanding and limited knowledge and the need for experimentation and prototyping
- leadership and committed agents of change at different levels of the system
- individual and institutional flexibility including a willingness to learn and change and to let go of preconceived assumptions

Consistent with these findings, a host of studies have shown that the human and social factors in adaptive management are essential. These include: effective relationships based on trust and mutual accountability to organizations, teams, and individuals who "have the capacity to listen and learn, the confidence to manage unpredictability, and the willingness to challenge and change conventional thinking and practice."[25] Also critical is the need for agency and empowerment of decision makers at multiple levels of an adaptive system.

The principles of adaptive management have been tested in a number of flagship development programs and have also been utilized in reform initiatives among both donors and operational organizations. These efforts have been framed as a means to address longstanding issues of development effectiveness, rigid accountability, and lack of responsiveness to context. For the most part, adaptive management efforts are in an embryonic stage in the development sector—producing more discussion and debate than evidence of what works and what doesn't. Because of this lack of practical evidence, some fear that the adaptive management movement will fall prey to conceptual blurring and "me too" bandwagons, with many organizations simply re-labeling their existing conventional efforts as "adaptive."

At the same time, numerous lessons have emerged from efforts in the development sector. Perhaps the most important overarching finding is that adaptive management cannot simply be an add-on, but needs to be incorporated into results frameworks, procurement processes, technical leadership, operational management, staff competencies and attitudes, commercial considerations, financial arrangements, context monitoring and analysis, organizational learning, experimentation, relationship management, and leadership. Adaptive management is also widely seen as inherently positive, but there are numerous assumptions and ideas about its impact down the "aid chain," especially on those people who are the intended beneficiaries of development efforts.

For the purpose of our study, adaptive management can be defined as follows:

> *Adaptive management (or adaptive programing) relates to a broad combination of approaches, tools, techniques, and processes that enable responsive, flexible, and novel decisions about emergent phenomena and approaches to development interventions, both at the tactical level and the strategic level. The premise of adaptive management is that decisions and actions can be adjusted as contexts and problems are better understood through a process of "learning by doing."*

2.3 Bridging real-time data and adaptive management: from concept to practice

[25] http://www.laserdev.org/media/1171/11-laser_savi_report-online-version-final-120816pdf.pdf

To date there have been few if any attempts to bridge, let alone actively integrate, real-time data and adaptive management in international development. In their origins, real-time data and adaptive management seek to address distinct but overlapping problems in international development.

Real-time data efforts address performance gaps with a focus on improving the availability and use of data to track a range of different challenges. Real-time data initiatives are designed to enable more effective and efficient decisions in different contexts. For the most part, real-time data efforts have focused on the digitization of data collection, sharing, and use to track information about a variety of different challenges and issues.

Adaptive management has emerged in response to the idea that development programs are inherently rigid and inflexible and that there should be scope to adjust as operational realities emerge. Its central goal in the development arena has been to bring about a more experimental and flexible approach. By definition, this means starting out with a specific set of approaches and processes and seeking to adapt and refine these over time to make them more appropriate to context. This requires an effective system for monitoring internal and external changes in response to a given intervention—and making necessary changes.

Real-time data systems and adaptive management processes are potentially highly complementary. Both support changes in how decisions are made and emphasize the importance of data, information, and learning. Examining the potential integration of real-time data and adaptive management reveals potential mutual benefits, with scope for addressing the problems faced in each field respectively.

On the real-time data side, and more generally in data systems, the *use* of data has been challenging. Much more emphasis has been placed on improving data collection and presentation than on ensuring its utilization. For the most part, there is more data than there are data-driven decisions. Many initiatives and systems that seek to provide data have focused on enhancing the supply of data with relatively less consideration of demand-side factors. This is not unique to data, or to real-time data, but is common in attempts to bring greater information, evidence, and learning into decision making. On the adaptive management side, there can be a perception that flexibility and program changes are based on hearsay and instinct rather than on evidence and data. What should be a platform for robust and reflective action can descend into vague, uncritical, and ungrounded meanderings. Engaging with complexity brings the risk of working without accountability.

To sum up, the challenge for real-time data initiatives is to focus beyond sensing on acting, and the challenge for adaptive management is to focus beyond action on sensing. These are issues of which many in the data and the adaptive management communities are aware. The solutions are increasingly accepted as managerial and organizational, rather than technical.

In recent years, there have been some preliminary and small-scale efforts to try to address these challenges in an integrated fashion, perhaps notably as part of a workshop led by the United States Agency for International Development and the Institute of Development Studies (IDS) on the information, knowledge, and learning basis for adaptive management. The workshop write-up concludes:

> …Effective adaptive programs are those with a strong focus on data and information and how these are used in ongoing cycles of decisions… there is a need for openness in relation to data sources and types, discipline and clarity in their selection, and intelligence in their use. This raises issues of balancing data quality and speed, to ensure this matches the decision-making needs around the problem in

> question. This will of course vary from program to program: data collection, management, and use will need to be contextually relevant and fit for purpose. There is also a need to invest in resources to make sense of data as it emerges, and to empower different actors to make use of data in different ways. Ultimately, better data should lead to more timely, relevant, and accurate decisions for the program as a whole. However, it is also important to acknowledge that data use behaviors are diverse, and different individuals and teams will engage in different ways…[26]

The ideas and concepts presented in this section underpin the core question addressed by the Real-time Data for Adaptive Management Research Project. Specifically:

> *How, in what ways, and with what benefits do real-time data systems contribute to adaptive management?*

By answering this question in a thorough and evidence-based fashion, it is hoped that this study will enhance understanding of the value of real-time data systems and inform better, more evidence-based adaptive management practices.[27]

[26] https://www.globalinnovationexchange.org/learning-adapt

[27] It is worth noting that the potential dual benefits from this project has also posed challenges to the research team on how best to undertake formative research on the intersection of two emerging fields.

3. Methodology and Approach to Case Studies Research

The overall research project consisted of five interconnected components:

1. Review and synthesis of literature
2. Key informant interviews
3. Case study survey and analysis
4. Initial case study interviews
5. In-depth case study research

Each component is explained in detail below.

3.1 Review and synthesis of literature

The research project was initiated in April 2016 with a literature review on real-time data and adaptive management in development and other sectors. The review included 116 published reports, articles, agency grey literature, opinion pieces, and evaluations. Each document was reviewed in accordance with a set of standard research questions. The aim of the review was to synthesize a broad range of available evidence on the intersection of real-time data and adaptive management.

3.2 Key informant interviews

Between May and September 2016, 48 interviews were conducted with key experts to explore the intersection of real-time data and adaptive management in different contexts. Key informants were selected to be broadly representative of both real-time data and adaptive management initiatives in different countries and sectors.

These first two components enabled articulation of a set of questions that could be explored in more depth in the case study research. The findings from these initial components were documented in a briefing paper published in June 2017. The paper included a framework of questions for further exploration in the case study research (see figure 2).

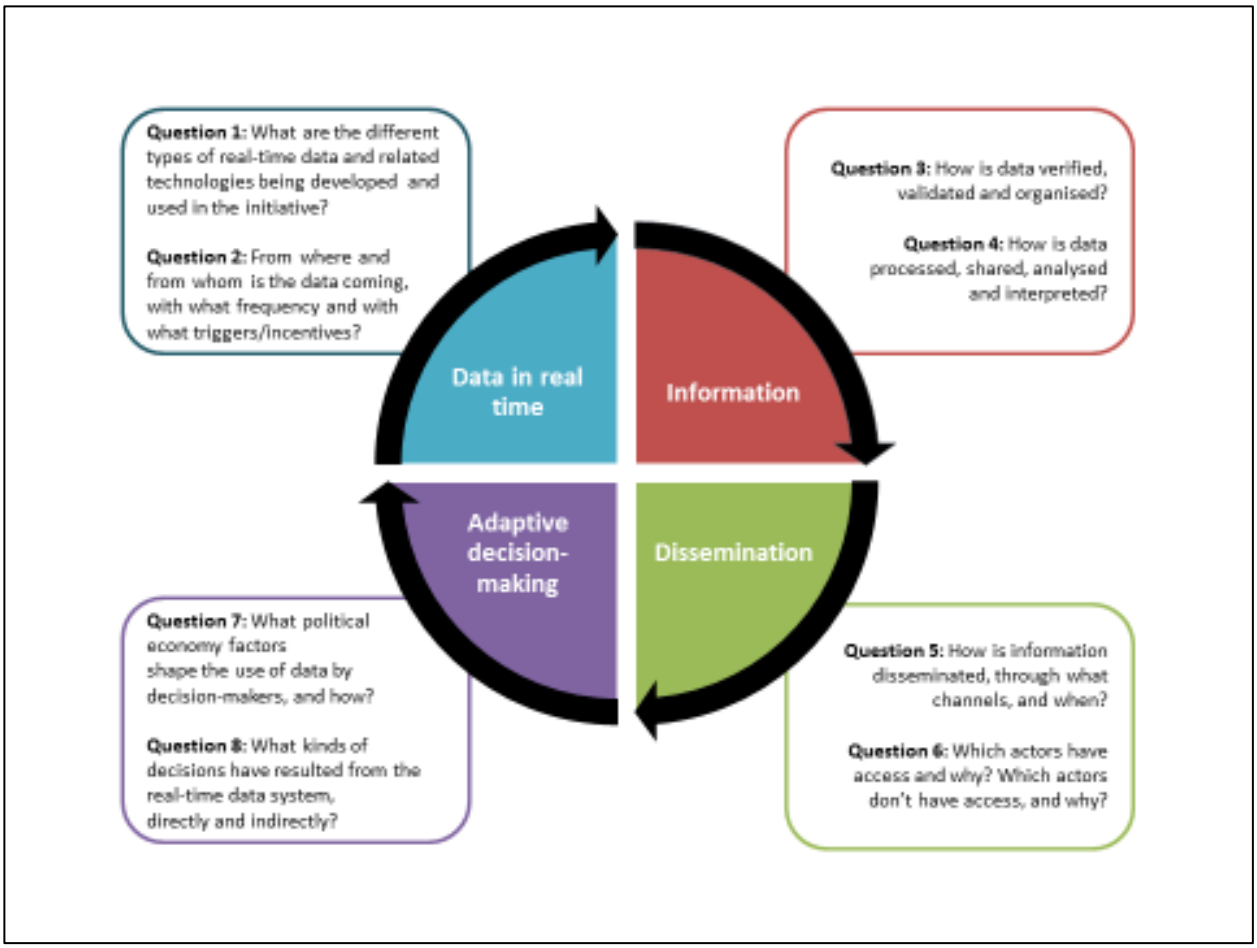


Figure 2: Conceptual framework on real-time data for adaptive management

3.3 Case study survey and analysis

As part of the first phase of research, a survey was developed and disseminated through a number of widely used information, communication, technology (ICT) and digital platforms in the development sector—including ICTworks, Twitter, and Facebook accounts of participating organizations and widely read blog pages. The survey sought to gather examples of real-time data initiatives that had contributed to decision making over time. The intention was to use the survey to gather a long list of case studies, which were then supplemented by further case studies provided by the client teams, consortium members, and through the initial key informant interviews. Over 60 responses were received, which were then analyzed by country and sector. These were shared with the Global Development Lab team and collectively filtered. This generated a "shorter long list" of some 20 case studies that were most promising for the present task.

We initially aimed to select four case studies in a single country, in part because of resource and timing constraints. Following discussions between the consortium members and donor/ client about representativeness and generalizability of findings, the target was changed to four case studies across two countries.

The teams also worked together to identify several specific criteria for the final list of case studies and a range of "fall-back" projects if needed. The case study criteria included the following:

- diversity of projects across different thematic areas
- potential to undertake case studies in available time frame
- availability of evidence and research
- ongoing activities of relevance

A long list of potential case studies was developed based on these criteria including programs in Bangladesh, Indonesia, Mozambique, and Tanzania. A short list of five to seven case studies was identified in each country for further analysis.

3.4 Initial case study interviews

The research team contacted key informants working on or representing each of the programs in this initial selection. Interview questions were based on the framework developed with information from components 1 and 2, as well as on the criteria set out in component 3 (above). Particular focus was put on whether the initiative was ongoing, on the availability of evidence and data about each case study, and on the willingness of case study representatives to be involved in the research.

The preliminary case study selections were discussed at length with the donor/clients; further consultations were then held with the key informants connected to the respective initiatives. Based on this, two case studies were selected in Indonesia and two in Tanzania.

3.5 In-depth case study research

Research on the four case studies was also guided by the conceptual framework developed by the team on the use of real-time data for adaptive management (figure 2). The framework breaks down this process into four steps:

1. real-time data collection
2. translation of data into actionable information
3. dissemination of the information
4. up-take and use of the information to inform decision-making

For each step, the team developed a list of questions to direct in-depth examination of challenges and contextual factors that can act as enablers, barriers, or opportunities. As mentioned, the framework informed the overall sample selection, guided the data collection and analysis for each case study, and provided a basis for analyzing and synthesizing findings. The study used a comparative case study approach to enhance generalizability of findings.

Data collection for the case studies was conducted between September and December of 2016 in Jakarta, Indonesia, and in different locations in Tanzania. Stakeholders for each case study were interviewed at different levels and included community members, volunteers, frontline workers, district authorities, national authorities, implementing organizations, and donors. A semi-structured interview guide (based on the conceptual framework) was adapted for the specific areas of expertise of each stakeholder. Interviews lasted 45–60 minutes and were held at an interviewee's work place or home. In some cases, key informants were interviewed in groups to stimulate critical discussion. Interviews were conducted in local languages (Indonesian, Swahili, Chaga) and English, with the support of research assistant/translators.

Across the case studies, the team conducted 82 interviews, held 8 focus group discussions, and reviewed over 100 documents. The lead researchers conducted manual content analysis of the combined notes and emerging findings were discussed with the case study

representatives. These discussions helped to further elaborate and triangulate the findings. The four case study researchers then worked with the principle investigator to determine common themes and undertake a synthesis across the case studies.

All stakeholders consented to be interviewed, although several key informants asked not to be directly quoted. Primary data collection and access to key stakeholders was facilitated by the initial case study contacts, which introduced a risk of positive bias. However, based on the researchers' experience in the field, the risk was deemed to be small, because all the teams exhibited an interest in critical reflection and learning on their work.

4. Case Studies Overview

The selected case studies related to four distinct areas of development work as follows:

- *Service delivery*: Mobile nutrition (M-Posyandu in Indonesia)
- *Sustainability and resilience*: Urban flood resilience (PetaJakarta in Indonesia)
- *Economy and productivity*: Agricultural marketing and knowledge (the Listening Project in Tanzania)
- *Citizenship and governance*: Birth registration (the UNICEF–RITA project in Tanzania)

The following section provides details about each of the case studies.

4.1 Mobile nutrition in Indonesia through M-Posyandu

The **M-Posyandu** system in Indonesia (later referred to in this paper as the "mobile nutrition case") focuses on the use of real-time mobile data to improve the efficiency and quality of nutrition service decision making in village health posts and to enhance achievement of national nutrition goals. M-Posyandu is a mobile phone platform developed by World Vision International (WVI), with support from the Bill & Melinda Gates Foundation (BMGF), using the CommCare platform developed by software firm Dimagi. Using real-time data systems and processes, WVI and its partners have sought to accelerate and improve nutrition status data collection and use at community, sub-district, district, and national levels.

The M-Posyandu system supports nutrition counselors to assess children and provide nutrition counseling at posyandus (health posts, staffed by volunteers) and at the homes of those unable to travel to the health posts. Using a smartphone app, counselors can input information about children and automatically process growth measurements. The system also flags nutritional risk—allowing counselors to tailor health messages for parents in real time. All measurements are stored in electronic health records that are available in real time or nearly real time at sub-district and district levels—where it triggers responses by health care officials and NGO staff.

The data is also used to inform budget decisions, advocacy, and program planning. M-Posyandu began with 14 sites, but following its initial success, was recently been rolled out to 500 additional sites. WVI supported a rigorous independent evaluation of the pilot sites. It found that counselors who used mobile phones were more likely to provide feedback on their sessions and that the system accelerated the process of nutrition data collection and improved data accuracy by 80 percent.

4.2 Urban resilience in Indonesia through PetaJakarta

PetaJakarta in Indonesia (later referred to in this document as the "urban resilience case") is a real-time data system that enables crowdsourcing of citizen-generated data to support disaster management (focusing on flood management) in urban Jakarta.

Up-to-date information is critical for response efforts to be targeted and effective. Combining information about the extent and locations of disasters, such as floods, is key to reducing harm and maximizing resilience. Such efforts are especially challenging in an urban setting such as Jakarta, which experiences severe flooding on an annual basis. Locating instances of flooding used to be very time consuming, requiring responders in different parts of the city to collect information manually, followed by centralized processing and analysis.

PetaJakarta comprises a digital mapping tool that allows users to see flooding events across

the city in real time. The system combines different kinds of data—from social media, citizen reporting, government flood alerts, and physical sensor data—to provide an integrated source of information for decision making by residents, local and national agencies, and international responders. The data is collected, validated, and relayed in real-time, and the entire system—the map, the software, and the actual data—is shared openly, enabling integration into different decision-making systems and protocols.

PetaJakarta has recently been integrated into the Jakarta Emergency Management Services, and a new platform, PetaBencana, has been developed for use in Java. The American Federal Communications Commission recently recommended PetaJakarta as a model for crowdsourcing real-time disaster response information in the United States.

4.3 Agricultural learning in Tanzania through the Listening Post

The **Listening Post** project in Tanzania (later referred to as the **"**agricultural learning case") is a pilot initiative undertaken by Farm Radio International (FRI) to incorporate real-time mobile data systems in their existing radio-based methodology for collecting unfiltered feedback from farmers.

By bringing new digital technologies to the listening methodology, FRI has sought to facilitate rapid feedback and learning, helping to ensure that agricultural development projects are based on the needs and priorities of farmers.

The project was initially developed as a pilot with funding from BMGF to strengthen the responsiveness and accountability of agricultural development actors to farmers. It provides an interactive rural radio platform that combines specialized farm radio broadcasts with Uliza—a tool created by FRI to gather and analyze mobile phone-based feedback and questions from audience members, particularly farmers. Uliza is built on an interactive voice response (IVR) system developed by Voto Mobile that enables listeners to vote in polls, leave messages, and request information.

Listening Post programs have included radio mini-series on specific topics, with listeners invited to participate in polls, ask questions, and offer opinions. An underlying aim is to empower farmers to send honest opinions to development partners.

In late 2016, IDS conducted a detailed research study exploring whether and how the Listening Post could support adaptive management processes.[28] The research found significant evidence that the Listening Post model could act as a conduit for adaptive civic action, if attention is paid to key issues including data processes and engagement of stakeholders, farmers, and local actors.

4.4 Birth registration in Tanzania through the Scaling Up Birth Registration program

The **Scaling Up Birth Registration program** in Tanzania (later referred to as the "birth registration case") uses mobile real-time data systems to enable faster, cheaper, and more comprehensive registration of child births.

Birth registration in Tanzania involves three steps: notification, registration, and certification. Traditionally, *notification* happens at the birth of a child or at first contact with a health facility—which then leads to *registration* of details in a log book. This log book is shared with the district registrar, and the birth is then registered on payment of a fee. A trip must then be made to collect the *certificate*. The whole process is slow, inefficient, and expensive; it has

[28] https://opendocs.ids.ac.uk/opendocs/bitstream/handle/123456789/12770/FRI%20Listening%20Post%20research%20report%20for%20MAVC%2021-Feb-17.pdf

led Tanzania to have one of the lowest levels of birth registration in Africa.[29]

An SMS-based birth registration system was developed by the Government of Tanzania, UNICEF, and TIGO, with support from VSO. Nurses or village/ward officers can enter information about births or so-far-unregistered children (up to the age of five) into a mobile application and send it instantly via SMS to a centralized server hosting a database. The mobile application has evolved over time. It was initially designed for basic mobile phones, and registrars inputted the required information by following a series of prompts. When complete, the application compiled the data into discrete SMS messages and sent it to an SMS gateway server which, in turn, forwarded these to a central server. Once the central server decoded the messages and stored the birth record in the central database, a confirmation message was immediately sent to the mobile device, notifying the registrar that he or she could issue a birth certificate to the child. The current application was developed to work on a smartphone-based system, providing a more secure, user-friendly interface and the capacity to work across multiple network providers. It enables registrars to issue certificates to parents or caregivers on the same day as registration. The real-time data availability is also used for planning and budgeting at numerous levels within several departments—including health, education, and social protection.

The initiative is working to embed the new system in legislation and the institutional framework and build the capacity of the Registration Insolvency and Trusteeship Agency (RITA) at the national level—as well as the relevant local government officers at regional and local levels—to manage, monitor, and effectively scale up the system. It is currently operating in ten regions of Tanzania, and there are plans to scale it up. Research published by GSMA shows that the registration rate of children under five increased from 8 percent to 45 percent within six months of the mobile registration system being introduced. The system successfully registered more than a million births in its first year of operation.[30]

4.5 Overview of case studies: commonalities and differences

As already noted, the different case studies were selected to reflect a range of contexts in which real-time data efforts have been (and are being) implemented. By applying consistent analytical approaches and questions, the case study findings addressed a range of common themes and issues across these diverse contexts and challenges. By combining desk reviews, interviews, and dialogue workshops with stakeholders both directly involved in and supporting the initiative, the researchers could develop a rich picture of how each real-time initiatives worked, the challenges they faced, and the ways in which the real-time data has contributed (or has not) to different levels and forms of adaptive management.

The case studies shared several features, facilitating comparative analysis:

- All the initiatives qualified as examples of good practice in real-time data systems, providing the opportunity to learn from examples with demonstrated success.
- All the initiatives had undergone some formal evaluation or research-based assessment, providing a more detailed empirical platform for the current research.
- All of case projects were ongoing, allowing ready access to current staff members and stakeholders.
- All involved an initial interview or interviews with key stakeholders, providing researchers the opportunity to gauge their interest in being involved in the research project.
- All projects collected and transferred real-time data through mobile phones; in some

[29] http://www.millicom.com/media/3789925/Scaling-up-Birth-Registration-in-Tanzania-2015-2020.pdf
[30] https://www.gsma.com/mobilefordevelopment/wp-content/uploads/2016/07/Birth-Registration-in-Tanzania_Tigos-support-of-the-new-mobile-birth-registration-system.pdf

cases, they utilized multiple information and communication technologies to collect, analyze, and use real-time data.

The programs also exhibited some important differences, namely:

- The case study initiatives were deliberately selected to represent different areas of development work.
- The geographic scale of projects varied considerably, from working with online urban populations to clusters of rural villages.
- Target populations for decision making based on the real-time systems varied from the community level up to national government and international partners.
- The data sources and forms of analysis varied—from analysis of data provided passively and indirectly on social media to real-time information directly solicited and actively submitted by volunteers or frontline staff.
- The extent to which donors or implementing organizations supported or shaped the nature of initiatives varied.

The four cases focused on how real-time data initiatives and related systems generated data that could be used in different ways to support program adaptation at tactical and strategic levels. None of the projects was explicitly designed as an *adaptive management intervention.* However, they all did seek to bring about adaptive management based on data. At the crux of the case study investigations was an examination of the kinds of decisions that were enabled by the data systems, and the kinds of adaptations that resulted.

4.6 Case study findings: an explanatory framework

The case study researchers produced stand-along summaries of findings from investigations into each of the respective initiatives. These were then analyzed with the support of the case study team to draw out common lessons and messages. For organizational purposes, the framework used to analyze findings varied slightly from that used initially to select case studies and gather data (i.e., the one outlined in figure 2). The revised framework (shown in figure 3 below) emphasizes four categories for analysis:

- **Systems:** how *real-time data systems* are designed and developed and how they are implemented and operationalized
- **Data:** how *real-time data* is collected, aggregated, and verified and how it is analyzed and shared
- **Contexts:** how real-time systems and real-time data are shaped by *capacities, relationships, and incentives*
- **Decisions:** how all the above enable or inhibit adaptive *decisions* at *both tactical and strategic* levels

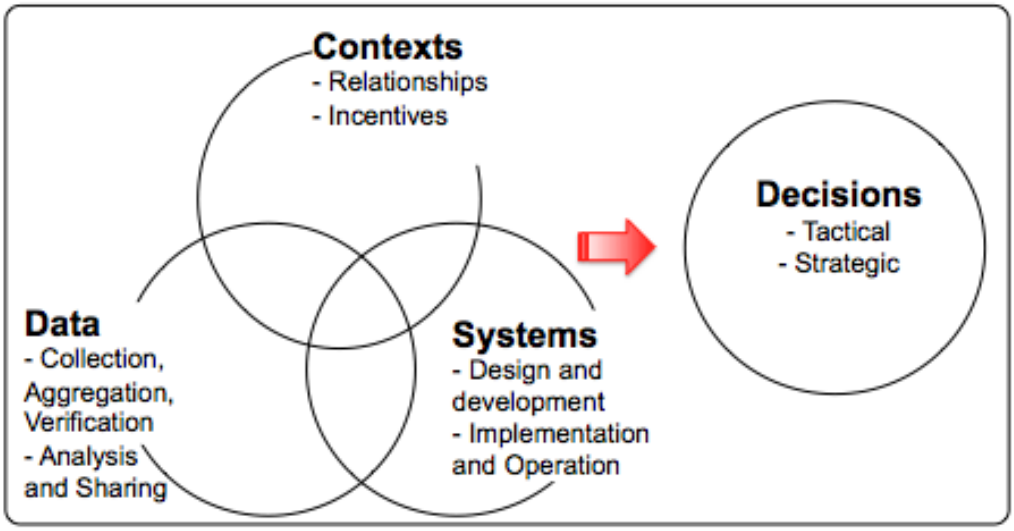
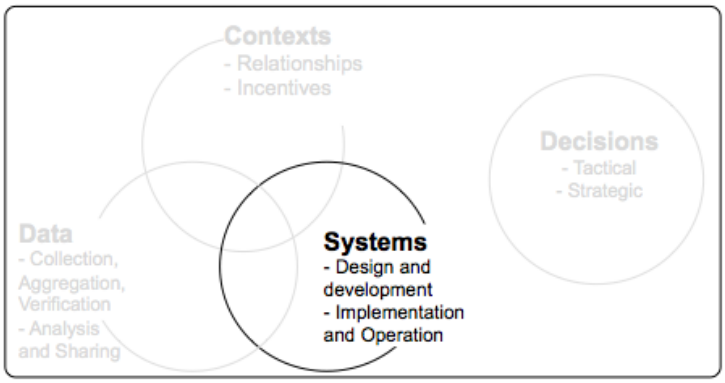


Figure 3: Framework for case study findings

The next section of the report summarizes findings from the case studies, organized in line with the framework in figure 3.

5. Findings: Systems



5.1 Systems—design and development

5.1.1 New real-time data initiatives require a fusion of recognition, enthusiasm, and availability

The four case studies addressed a wide range of development sectors, from health to agriculture, illustrating the diversity of areas in which real-time data systems can be deployed. At the same time, certain common underlying problems helped to catalyze the development of the systems. Across all the case studies, there was a degree of *recognition* of the opportunity and/or need for real-time data systems. Thanks, either to knowledge of similar applications in other settings, or to the vision of certain initiating actors, all the systems were premised on the idea that faster data could help address a specific development problem or challenge.

In all the cases, the rationale for the proposed real-time data systems was two-fold: operational and strategic (or policy level). In terms of operational issues—the M-Posyandu app was justified in the Indonesia nutrition case study because it would improve nutritional decision making among frontline health workers in poor communities, while the Tanzanian birth registration system was seen as contributing to greater levels of child birth registration among traditionally excluded groups.

At the level of strategy and policy goals, each of these two systems was also seen as helping to advance high-level goals related to a given issue. In the mobile nutrition case, this meant positioning the real-time data system as helping to fulfill national and international commitments to tackle undernutrition through data and evidence. Similarly, the Tanzania birth registration case focused on using technology to expand implementation of the national policy of birth registration and citizen identity.

The introduction of the new technologies was typically based on some form of assessment of the underlying problem or challenge that included comparison of the existing (typically manual) approach to information gathering with a possible data-driven approach. For the most part, challenges were framed in terms of poor and inadequate information processes.

- For example, stakeholders justified the PetaJakarta system in Indonesia by highlighting the inability of disaster management agencies to respond to floods in real time due to the slow speed of existing manual data gathering. A digital process building on crowdsourcing and combining different data sources would address this.

- The Listening Post project in Tanzania was built because of concern about insufficient real-time feedback from farmers. Such feedback could, in combination with radio broadcasts, help to better understand and respond to farmer interests and priorities.

Of course, recognition of a problem in these cases was not itself sufficient to make any of the initiatives transition from idea to reality. This required a degree of *enthusiasm* for the potential of the technology in question. Enthusiasm might be manifested at the individual level or team level. It might also have been based on institutional interest—for example, among donors who prioritized certain kinds of data-driven investments or were keen to advance specific kinds of technologies.

The initiatives of course also relied on the *availability* of software tools, technologies, resources, and capacities that could be deployed. These three factors—*recognition*, *enthusiasm,* and *availability*—played out in novel and interesting ways across the case studies. For example, in the birth registration and the mobile nutrition case studies, recognition and enthusiasm led to developing initial pilots with available mobile technologies (typically using basic phones), which were then found lacking, leading to further iterations involving more sophisticated technologies (typically smartphones).

5.1.2 *Real-time data systems involve high levels of "combinatorial innovation"*

Having made the case and mobilized support and resources for real-time systems, the four intiatives moved forward thanks to a process of *inventing* and *developing* technological solutions to address the given development challenges. In all the cases, pre-existing data solutions, systems, tools, and techniques could be adapted to the specific problem.

Some of these solutions had already been developed for similar challenges, while others were developed for the specific initiative. However, none of the systems were either 100 percent "off-the-shelf" or 100 percent bespoke, customized solutions. Some programs integrated existing real-time data systems into newly designed data processes, while others created new systems and processes to capture real-time data effectively.

In the Indonesia mobile nutrition case, for example, the CommCare suite by Dimagi is one of the most widely used platforms for mobile health programs in developing countries. However, CommCare was adapted to the specific requirements of Indonesian nutrition service provision.

In the Indonesia urban resilience case, the PetaJakarta developers used a customized smart cities software platform called Cognicity to configure Twitter data and information from other existing platforms into a format and system already in use by city government. PetaJakarta made data available using existing urban mapping software and built the information architecture—integrating several different platforms—to support decision making by city-wide agencies. The Tanzania agricultural learning initiative combined a range of different technical solutions, including the radio broadcasts, phone calls, IVR, and a dashboard to integrate and manage all the data.

These examples highlight that developing a system suited to the needs of specific challenges and stakeholders required high levels of "combinatorial innovation." The creative combination and re-combination of existing and new elements in a technological system to develop new solutions to existing problems is increasingly popular in innovation circles. To put it another way, real-time data systems are generally made up of many different modules, some new and some old, and the critical challenge is as much one of selection and integration of existing tools as it is development of new tools.

5.1.3 Technological considerations span data, applications, hardware, networks, and infrastructure

The design of each system in these four case studies involved considering five critical layers of technological design:

1. data, e.g. system of indicators for collection, data architecture;
2. applications, e.g. MOTECH suite, IVR;
3. hardware, e.g. smart phones, basic phones and other technology;
4. networks and connectivity, e.g. provision of airtime and coverage;
5. other infrastructure, e.g. radio networks, health facilities, and broadband.

The importance of, and attention paid to, each layer differed among the cases. In addition, choices about specific layers were made in an iterative and sequenced fashion rather than all at once at the start of the initiative.

As noted above, both the Indonesia mobile nutrition and the Tanzania birth registration cases eventually involved the deployment of smart phones; how the choice was made varied between the cases. In the nutrition case, the national NGO team initially proposed using basic phones. But the initiative transitioned to smartphones due to both donor requests and technical requirements. In the Tanzania birth registration work, the limited capacity of basic phones became apparent during the pilot phase, leading to a switch to smart-phones. In both cases, Android phones were distributed across the different networks of facilities and subsequently used by frontline workers to gather and share data. Both initiatives also provided free air-time to enable user connectivity.

The Tanzania agricultural learning case and the Indonesia urban resilience case both used a blend of technologies to gather data. The Listening Post integrated radio and basic phones because the target stakeholders were rural farmers who were much less likely to have access to smart phones. FRI was technologically oriented, so introduction of the digital element built on their existing experience and competence. Their mobile phone-based system combined text messaging and IVR in tandem with a schedule of radio programs, which was a highly trusted medium among the farmers. Low literacy levels in the target audience created concern that many, especially the older farmers, would be more likely to use phones to make calls than to text. The system utilized a variety of ways of “listening” to the farmers, including mobile-based questionnaires and polls, open-ended questions, requests for information by farmers, and a hotline system for calls. This made the real-time data system more episodic than systems in the other case studies—with data collected in a series of six-week blocks over several years.

Perhaps the most sophisticated technological system among the cases was that developed for the urban flood management case. Operating on a city-wide level, PetaJakarta combined data from multiple sources including crowdsourced Twitter data streams, real-time data streams, and internal databases used by government agencies. This was achieved through data mining and machine learning processes.

At a broad level, it is apparent that many of these factors were heavily shaped by national context.The level of infrastructure development in a given country will dictate what specific factors must be considered and how.

5.1.4 Technological choices did not always take account of issues of access and representation

It is important to flag how issues of technology access and coverage were addressed across the case studies. In the mobile nutrition, urban resilience, and birth registration cases, the decision to use smart phones was made by the implementing organizations and their stakeholders, including donors. This led to some operational challenges around availability, cost, and capacity that were not fully addressed during the initial design phase..

PeteJakarta (urban resilience case) collects data mostly from Twitter users, who are unlikely to be representative of the city’s population—especially the vulnerable, who may have to depend on others to input data for them or may not have access to the system at

all. A smart phone is also needed to contribute to or view the PetaJakarta map, but less than 50 percent of the population has access to this technology. Data use also incurs costs, so only those with disposable income can contribute to and make use of the system. These amount to sharp inequities in who can use the system, when, and how—which have implications for the disaster events that are reported, or not. People who are unable to contribute to map-making, for lack of a smart phone, lack of an affordable data-plan, or lack of familiarity with or use of apps, risk being technologically invisible in the initiative's maps. Given that the maps are tied to disaster response, resource allocation, and support to address long-term vulnerability, this lack of accessibility poses serious questions.The best system design in the world cannot overcome inattention to issues of access and coverage among the most vulnerable and poor groups.

5.1.5 Design efforts placed greatest emphasis on data collection and least on data use

For the most part, the system design and development efforts emphasized the front-end work of raw data collection. In many cases, this detracted from a focus on downstream sharing, analysis, and use of that data. Across the case studies, use of data and implications for decision making were not explicitly considered in the design stages.. Instead, the systems were shaped by a number of implicit assumptions. The common mentality seemed to be one of "build it and it will be used," leading to numerous downstream issues. The exception was PetaJakarta Indonesia. Efforts were made to synthesize and make data available in the form of usable maps. Feedback was captured on data usage from both institutional and civilian users, which was then used to adjust information categories and tags used for data gathering to support different user needs.

Across the systems, the design phases involved prioritizing specific forms and types of data to be collected, collated, and incorporated into analysis. The selection of specific indicators and/or questions inevitably narrows how a given problem is framed. This then affects the kinds of decisions that might be taken up based on the system. For example, the quantitative, indicator-based systems for the mobile nutrition and birth registration initiatives stand in contrast to the mixed methods, mixed data systems used in the farmer learning and urban resilience initiatives. The former involved pre-defined thresholds, standardized responses, and detailed guidance on the specific kinds of actions that could be triggered. The systems were based on pre-defined ideas about what malnutrition and birth registration looked like, what relevant indicators would be tracked, and what could be done about specific incidents and overall patterns in the data.

For the more qualitative, mixed methods and data source approaches of the urban resilience and agricultural learning systems, information required greater levels of aggregation and interpretation and triggered learning and reflection among potential responding actors. This could then lead to specific actions, but these were not as narrowly defined as they generally were in the mobile nutrition and birth registration programs. The urban resilience and agricultural learning programs captured more open-ended information and led to greater human involvement in interpreting the data and determining possible actions.

Box 1: Key messages for systems—design and development

Three key messages
1. Design for data *use* from the outset and build decision-making considerations into the overall system goals and objectives.
2. Go beyond the data system to consider the social and behavioral systems that determine how data is interpreted and understood.
3. Consider which users are included and which are excluded and develop an approach that addresses rather than reinforces persistent inequities.

Implications for bridging real-time data and adaptive management
For real-time data systems and adaptive management to be effectively bridged, use of data for adaptive programming must be a strategic design orientation from the outset. Meeting the potential for program adaptation means considering the different ways data can be utilized for decisions and allowing for stakeholders to have agency to act on emerging learnings.

Efforts should be made to "design for adaptation" at both tactical and strategic levels and to build this into system objectives. This means thinking about both the data system and the broader systems in which they are embedded. The ways in which these systems trigger program adaptations are not inherent in the systems *per se* but largely reside in the protocols for how they are used.

For example, a nutrition indicator-based system could highlight that child undernutrition has suddenly increased in many target communities. Similarly, a farmer learning system could flag the need many farmers have for better marketing information about specific resources, such as seeds or fertilizer. Whether such inputs from the system trigger novel decision making is based on whether and how this data is verified, by whom, and with what implications. Nutrition program decision makers might be prompted to send investigative teams to communities and, based on their findings, might adapt policies guiding nutrition service delivery through community health posts. Agricultural NGOs might verify received information through exercises with farmers and then adapt their programs. In each case, the real-time system would provide a key trigger—but a whole chain of information flows and follow-on decisions would be required to result in strategic adaptations, rather than simply tactical changes.

The distinction between tactical and strategic adaptation is also linked to the types of data available. Quantitative data, for pre-defined indicators, provide helpful input for tactical adaptations and for aggregation that can inform strategic adaptations. Qualitative data may not have clear implications for tactical adaptations but may be essential for strategic adaptations—depending on the capacity, intent, and agency of data users.

5.2 Systems—implementation and operations

5.2.1 Implementation approaches were very diverse
Two of the initiatives incorporate real-time systems into their work through frontline workers (mobile nutrition, birth registration). A third operationalizes data collection processes through a radio program (agricultural learning). And the fourth analyzes social media data streams in combination with stationary city data (urban resilience). This diversity of implementation approaches corresponds to the breadth of data sources to be found in real-time data

systems in the development sector.[31]

In the mobile nutrition and birth registration case studies, systems were rolled out through existing infrastructure, facilities, and personnel. Data for both initiatives is generated by frontline personnel (or volunteers/ward officers) inputting data about clients (based on visits to health posts or outreach to homes). With each visit acting as a potential trigger for data entry, information can be uploaded as appropriate.

By contrast, the urban resilience PetaJakarta system is based on an automated process of collecting and sorting social media data streams and converting them through a backend information system into actionable information dashboards. These dashboards are largely organized through real-time maps. PetaJakarta relies mostly on Twitter data uploaded voluntarily by social media users in Jakarta. Twitter bots designed by the team continuously mine social media for flood-related keywords, such as *banjir* (or "flood" in Bahasa). Other automated processes collect and verify additional flood-relevant information. All of this takes place continuously and the frequency of data collection can be increased or decreased depending on the urgency of the issue and ongoing events—as deemed appropriate by users. The system combines and triangulates the Twitter data with other real-time data systems used by government agencies including a 311-style feedback system and government agency databases. For this reason, the PetaJakarta team sees itself as "the glue bringing together otherwise fragmented data."

The agricultural learning system is literally episodic—generated as part of a series of radio programs that createsg windows of opportunity for digitally mediated engagement with farmers. Engagement is voluntary, with farmers listening to scheduled Listening Post programs. Most of the data has been collected from basic phones through voice and polls via IVR. Data collection is triggered by responses from farmers, who can participate before, during, or in the week following a radio show. This then leads to responses from FRI and their operational partners (including NGOs delivering agricultural programs to the farmers and private sector organizations providing them necessary goods and services).

5.2.2 Operational challenges were both technical and social

In a sense, initial implementation of these data systems served as "learning probes" that helped generate lessons about the opportunities and limitations of the technical systems and processes deployed. These initial efforts also served to highlight the human, social, and economic contexts within which the systems were embedded. In some instances, the lessons that emerged proved critical for the effective working of the systems.

For example, the mobile nutrition and the birth registration systems both deployed smartphone applications with the capability to upload data in real-time. While the choice of smartphones created the potential for real-time data flows, the choice also generated some problems for users. Some staff using the birth registration system had to travel to different locations to upload data due to lack of connectivity and coverage in their community. In the mobile nutrition case, power outages and insufficient airtime for users led to delays in data transmission, thereby diminishing timeliness and potential utility.

The agricultural learning program attempted to be sensitive to the effect of contextual factors on device usage—for example, by designing systems based on technology that was available to farmers. However, the Listening Posts were also affected by lack of connectivity and signal and issues of battery-life.

Institutional and behavioral issues also came into play during initial implementation of the mobile nutrition system. The system was designed and implemented in a way that led to

[31] http://www.ids.ac.uk/publication/real-time-monitoring-in-disease-outbreaks-strengths-weaknesses-and-future-potential

conflicts between the flow of real-time data and existing organizational hierarchies. Specifically, data quality from the M-Posyandu system was used as a means of judging individual clinic performance. As a result, senior volunteers with responsibility for the overall performance of the health posts would seek to verify all data generated by individual workers before it was shared with the aggregating system. Although this checking for data errors and gaps was important from a hierarchy perspective and valuable for quality control, it also slowed the data flow considerably. While the technological system was theoretically real-time and data was indeed collected real time, the nature of the social system within which the system was embedded meant that data could not be shared in real time.

More generally, while there may be political will at higher levels of the system to use real-time data for decision making, there may not always be political will or buy-in lower down to support the "datafication" of existing processes. As was noted by stakeholders in the birth registration case, "Even if you put all the systems in place, if there is no political support you can do very little [that is sustainable]."

5.2.3 Financial issues severely limit operational viability and sustainability

As the M-Posyandu case illustrates, real-time data systems require both up-front and ongoing investments in financial and human capacity to work effectively. The financial implications of implementation need to be considered up-front, to ensure operational viability in the short term and sustainability over the medium to long term—as set out in the Principles for Digital Development. However, as with issues of data use, these implications were not considered upfront in most of the initiatives.

A common issue was that subsidized or pro-bono private sector involvement in pilot phases could potentially—and in one case actually did—lead to escalating costs as the programs started to scale up. More generally, programs could eventually be closed down because they were not economically viable beyond the pilot stage.

Sources of funding also had a bearing on the systems in question. All four systems were initially reliant on international donors for financial support, raising questions of sustainability and how best to build ownership and capacity to run them without external support.

5.2.4 Effective operations require an agile approach to system deployment

Making choices about system development issues in a strategic and agile fashion is vital. In some of these cases, this lesson was learned the hard way. Often, more attention was paid to the "hard" layers in the design process (typically data and software, and often to the exclusion of connectivity), and the "soft" challenges (e.g., capacity to use technology, hierarchies, perceptions, ownership, and buy-in) emerged at the time of implementation.

The most detailed articulation of these challenges was in the birth registration case study, where a range of agile decisions were identified and classified as follows:

- **Technical changes** (identifying where phones weren't working; upgrading "dumbphones" to smart phones after realizing the former could not easily be used for data entry and texting; improving the app to deal with "time outs" and providing unique identifiers to each data entry point; surfacing connectivity issues due to poor signal coverage)
- **Operational changes** (expanding the registration points to include ward executive offices; identifying areas where there were low rates and undertaking further campaigning to drive registration)
- **Capacity changes** (identifying areas where staff were too busy to use the system and then investing in additional staff resources—increasing training from two to three days)
- **Communication changes** (realizing that key messages about children's ages had been misunderstood and changing the messaging accordingly; changing campaign channels

to target mosques and churches and promotional channels such as radio and entertainment groups)
- **Behavioral changes** (using the dashboard “leaderboard” as a way to incentivize better performance; creating a climate of friendly competition and peer pressure between different villages, wards, and regions)

In some cases, these changes were supported and enabled by data generated by the registration system. In other words, real-time data contributed to decision making of a tactical nature. The data system triggered signals of a potential issue and a need for adaptation. For example, the need for “operational change” was signaled by the failure of registration rates to rise in specific target areas. The system itself provided the signal that there was a problem. However, the system did not collect granular information about why there was an issue. Depending on the context, causes were related to phones not working, connectivity issues, or overburdened staff. As such, the system has made a necessary but not sufficient contribution to improving the program. More in-depth work and analysis was needed to understand and interpret the signals, explain the implications, and support appropriate decisions.

The urban resilience system in Jakarta incorporates a system for verifying contributions, helping move toward this kind of in-depth decision support. All civilian contributions are verified using geotags, photos, keywords, or any combination of the three. All contributions are posted to the real-time map and labeled “unverified” or “verified” and tagged with several other pieces of relevant information. Potential decision makers are then able use this ”thick data” to make their own decisions about the validity and value of information posted.

Box 2: Key messages for systems—implementation and operation

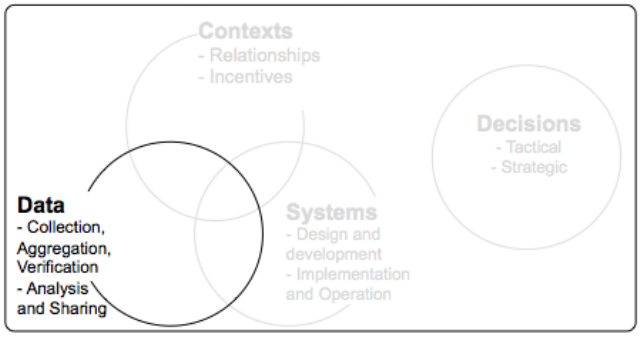
Three key messages
1. Real-time data systems need to address technical, social, and economic considerations if they are going to be meaningfully real-time.
2. Real-time data systems can be perceived by frontline workers as an additional means of accountability rather than as a source of learning.
3. Real-time data systems (in combination with other data sources and reflection processes) can help trigger project learning to improve implementation. Real-time data systems provide signals about whether a problem or opportunity might exist, and these can be analyzed and used in decision making. In this way, real-time data might be supportive of an adaptive management approach.

Implications for bridging real-time data systems and adaptive management
Effective implementation of real-time data systems requires technical, social, and financial systems to work in close harmony. While this is true for all data systems, the time-critical nature of real-time data means that poor management of cross-system interactions can undermine the entire premise and rationale of the system. Across the case studies, these distinct technological-social and economic systems were not always considered in an integrated and holistic fashion. This meant that in several situations, the systems were only real-time in theory.

Care must be taken to ensure that real-time data systems do not create an added burden on frontline workers—limiting their autonomy and ability to be flexible and responsive. Making data demands on individuals and groups who have less power than the stakeholders who design the system can easily lead to disempowerment. In the worst cases, this can lead real-time data systems to be perceived as a means of accountability rather than of learning, which seldom creates the space for adaptation and flexibility.

The real-time data systems in question did in some cases generate information that enabled agile decision making about the implementation of the systems themselves. While such *technological agility is* not the primary focus of this study, these examples do highlight the broader contribution of real-time data. Specifically, the systems can serve to generate signals about potential challenges or opportunities for agile decision making. However, the system cannot verify that challenge or opportunity or the specific actions that might be taken in response. Even for internal decision making, such adaptations require additional processes of learning and reflection that can be beyond the scope of the system.

6. Findings: Data



6.1 Data—collection, verification, and aggregation

6.1.1 Human capacities and technological innovation require equal attention

Capacity is a running theme among the four case studies. This report has already highlighted that the capacities of users and the wider constellation of actors had a strong influence on how each of the four real-time data systems were designed and operationalized. This is also true for how the data systems function, hour-by-hour and day-by-day.

Two of the cases, birth registration and mobile nutrition, share some features in terms of how and where they work. Both involve collection of data from visitors to health posts/facilities, registering new clients, and collecting pre-defined and standardized data. In both cases, the gathering and inputting of data was introduced as an additional task for health workers—without any additional pay or time allowance. When staff or volunteers are already overstretched, and where there is already a high turnover rate, simply adding real-time data responsibilities carries both risks and burdens. The time and resources required to conduct data-related tasks—and the way they fit into existing processes and commitments—are critical aspects of real-time data systems.

Some of these risks and burdens are inherent to the real-time nature of systems. For example, although the M-Posyandu system is in theory real-time, at the busiest of times, volunteers often suspend digital data collection—capturing data manually and then uploading it at the end of shifts or the next day. This means that one specific real-time benefit (the system is designed to provide rapid feedback to caregivers on children's nutritional status and allow health workers to provide referrals or schedule appointments on the spot) cannot be realized at precisely those times when the service is busiest and when such referrals might be most needed.

Any reliance of real-time data sources on frontline workers and community members means that, where there are more formal sources of data, these are likely to be more trusted. This is especially the case in areas such as nutrition, where epidemiologists and nutritionists will undervalue information that comes from the community, seeking to place their faith instead in more official and formal data sources.

This raises a kind of "catch 22" issue. Because frontline workers don't have capacity, data can often be poor quality. Because the data is poor quality, users with power often ignore it and won't then invest in data capacity strengthening because they don't see the point. Addressing the catch 22 requires leaders to understand and invest in the potential of data systems to drive improvements.

6.1.2 Collecting data is not enough—it must be cleaned and verified and this takes

time
Across the initiatives, a range of tools have been employed to ensure data collection is systematic and high quality. Some systems are deployed at the point of data gathering and are automated. For example, the mobile nutrition and birth registration applications automatically refuse data that does not fit in certain predefined parameters. The nutrition app also makes it impossible to skip data fields, thus ensuring data is always complete. Both the nutrition and the birth registration systems include features such as dropdown menus for questions that can only have predefined answers (e.g., male/female), calendars for dates, and other commonly utilized software development practices**.**

Similarly, the farmer learning system uses mechanisms to reduce duplication of data entry by an individual. If the system detects the same mobile number connecting and inputting data, it automatically picks up where the data input process left off in the previous call, instead of starting over.

The different initiatives have also made efforts to strengthen human capacity for data collection and cleaning. For example, the birth registration initiative invested in training registration coordinators to review inputted data; this has become part of their standard tasks. In the mobile nutrition case, all health volunteers received refresher training on how to take anthropometric measurements. A common quality assurance process is double checking of data by more senior facility staff. Posyandu heads are especially likely to review data because the quality and completeness of data is assessed.

However, as noted earlier, this can sometimes slow down the data sharing processes. The data and completeness of entires is used to rank posyandus. The data is also used to make annual funding decisions. Both of these anticipated uses give posyandu heads an incentive to closely review the gathered data, leading to potential delays in submission. Interestingly, the WVI data was not initially editable, but requests were made by posyandu volunteers during the pilot phase to be able to update and change data, which led to adaptations to the system. Volunteers proved reluctant to use the real-time data submission option because they could not be remain in control of the data (and mitigate against any negative repercussions down the road).

6.1.3 Cleaning and verification take place at different levels of the system
Both the mobile nutrition and the birth registration intiatives utilize higher levels of data verification and checks. After nutritional data is verified by the head of the posyandu, it is verified by WVI staff and sub-district health officials. In the birth registration case, registration coordinators were trained to review data as a part of their standard tasks and to reach out to offices with any concerns. The registration agency regional office also receives the paper and electronic versions of each registration. Regional staff review and scan the copy for accuracy and can make corrections directly in the system as needed. The IT team at the registration agency has a further system to track where registrations come from and use this to track repeated errors or strange patterns. They contact field offices directly to address any anomalies. Finally, all data is reviewed a final time before being archived at RITA headquarters.

This combination of automated and manual checks and verifications is also a feature of the agricultural learning project. FRI worked with the Voto mobile system—which had several built-in quality control measures. FRI staff also spend time checking through response databases to ensure that the overall initiative is on track.

In the urban resilience initiative, the fusion of digital systems and human input has been undertaken in a technically sophisticated fashion. Twitter bots initially identify flood-relevant language and interact with Twitter users. The same bots then seek additional information related to areas of flooding, including confirmation of location and request for photos. This

overcomes the problem of relying solely on human knowledge and proactive use of the platform in collecting timely and reliable information.

6.1.4 Aggregation and collation need to utilize automated and human processes

Simply collecting data does not ensure that it is in a suitable form for analysis. Information aggregation and collation processes bring multiple kinds of data together in meaningful ways. Aggregation processes might need to work with the same kinds of data from different sources (e.g., nutrition data from different locations) or with different kinds of data (e.g., Twitter feeds and government agency data).

Meaningful analysis requires data to be aggregated into a structured form. In the four case studies, aggregation has mainly been achieved through automation. For example, in the mobile nutrition case, WVI aggregates data for different stakeholders and administrative levels, collating data relevant for these groups to make decisions. They have also conducted case-by-case collation of data on specific issues or challenges, or from specific locations. In the first Listening Project programs, the FRI staff would put together a summary of the responses and questions each week and then send these to the radio station and the participating organization for their use. In the later Listening Posts, the radio station made decisions about the data and what should be used. Operational partners, including those from the private sector, were also given access and could dig into and analyze the information in real time (including for their own marketing and business development purposes).

With the Indonesia urban resilience case, the emphasis is placed on integrating Twitter and social media data streams with other data sources related to disaster management. This aggregation takes place across more than seven different digital platforms and is undertaken through a variety of technical processes. PetaJakarta has spent time building application programming interfaces (APIs) that integrate a range of different apps and information sources in which people report on or talk about floods, or that the government uses to identify flood risk areas. The aggregation of data is a major source of the initiative's added value. Integrating real-time data streams with more stationary data (land-use, urban hydrology, government gathered statistics) helps to identify problem spots, outliers, or potential causes and trends in flood areas. This was widely seen as making the PetaJakarta data stream useful for both short-term and long-term decisions. Various other institutions have tapped into this centralized platform including the World Bank and other state agencies.

Automation of aggregation and integration processes has, however, brought challenges. Issues that fall outside the specific scope of what algorithms can read, or what programs are tasked to capture, can easily disappear in the process of "structuring" and "cleaning" data. For example, if flooding-related comments include serious concerns about housing, the app does not necessarily process the housing-related information, despite the inter-connectedness of the problem. This is another illustration of the need for any real-time data system to place clear boundaries on what is 'in" and what is "out"—which in turn relies on certain pre-defined framings of an underlying problem.

Box 3: Key messages for data—collection, verification, and aggregation

Four key messages
1. Capacity constraints on data collection cannot be underestimated.

2. Real-time data systems by their very nature (and source of the data) are likely to be trusted less by decision makers as a direct guide to action.

3. Quality and speed need to be balanced in real-time data systems.

4. Data aggregation and collation are essential for analysis and ideally combine both digital and human processes.

Implications for bridging real-time data and adaptive management
Real-time data systems, like all data systems, are only as good as what goes into them. The best, most sophisticated technological data system in the world is only good as the individual, group, and organizational capacities that facilitate the gathering, sharing, and use of data. These capacities in turn cannot be effectively mobilized in support of data-driven decision processes without appropriate behaviors, processes, supporting cultural norms, and values—and perhaps most importantly, resources (not just in terms of money, but also in terms of time and space).

There are clear trade-offs between the real-time nature of data and quality management. Raw data needs to be cleaned and verified if it is to be of value. At the same time, this can slow the flow of data and lessen its potential value. Speed is not the sole characteristic of valuable data. The case studies here highlighted the value of right-time, quality data over data that is simply real time in absolute terms. In part, this is because data is most useful when it is contextually specific. It is also because of the absence of data-driven processes, norms, and values that can take advantage of data innovations.

The real-time data streams looked at here depend on the direct involvement of individuals and groups who have ongoing access to the populations or the challenges in question. This generally means frontline workers, volunteer community members, citizen reporters, or beneficiary groups themselves. The legitimacy of such data may be doubted by decision makers, even with mechanisms for cleaning and verification, and therefore less likely to be taken seriously as a basis for decision making. The accountability-oriented nature of some of the systems can also mean that that these actors are not empowered by the systems in question, but rather are more closely monitored.

Meaningful analysis of data depends first on checking data quality, but also aggregating and integrating it. While this can be undertaken in an automated fashion, human involvement is also necessary to make sense of the data and to interpret patterns that may exceed the analytic capacity of the digital system.

6.2 Data—analysis and sharing

6.2.1 Most analyses undertaken by the RTD initiatives were automated due to lack of human capacity

Effective analysis and interpretation of data is essential for timely dissemination and use by potential decision makers. Across the case studies, limited human capacity to analyze data in any significant way led to a reliance on automated processes—utilizing analysis, visualization, and reporting tools built into the systems. This was both a feature of the

systems employed and a pragmatic choice made in the face minimal human and financial resources. Limited data literacy, analytic capacity, and technical understanding has meant that for the most part analysis *must* be automated if and when needed.

For example, in the mobile nutrition case study, data collected during the posyandu clinics is submitted to a cloud-based, password-protected server hosted by Dimagi/CommCare. WVI and any other invited stakeholders can access and track data entry via a web-based dashboard (described further in the next section). Simple descriptive statistics can be calculated and presentation of data in charts is relatively straightforward. Volunteers receive z-scores, nutritional status, and growth velocity information immediately after inputting data, which they can then use to counsel parents. The system also generates summary reports based on this data.

The data system for the birth registration program is also highly automated, with a dashboard that presents aggregated, analyzed data on all registrations using pie charts, bar charts, and explanatory text in formats that can be accessed and reviewed by decision makers at different levels.

6.2.2 Automated data analysis tends to focus on simpler, easy to measure indicators of the underlying problem

In these cases, both the analysis and the advice provided are based on pre-defined thresholds. The analyses address challenges that can be readily mapped. (*Is a child underweight? Was a birth registered in good time?*) This same principle applies to the anticipated range of actions that can be taken—which tend to be clear and unambiguous guidance along the lines of "If data says X, then do Y."

All other things being equal, it is going to be easier to automate for phenomena that either occur or do not, or that are easily quantified/measured. (*Was a child born or not? Did a flood happen or not? Is a child underweight or not?)* By contrast, measures of phenomena that are more complex are more challenging to analyze. (*How underweight is a child in one district relative to other districts and why? How interested are farmers in better prices for fertilizers versus better prices for seeds?)* The need to automate might create pressure to define problems in more simple and straightforward ways, so that decision options can be predefined. While this is entirely appropriate for some contexts, it can also limit both the perceived need and the scope for adaptive decision making concerning the analysis generated. Taking an adaptive approach from the outset should therefore focus on developing scenarios of what kinds of problem definitions and questions *can* be integrated into real-time data systems and what the implications are for the kinds of insights and decisions that can be made downstream.

6.2.3 More sophisticated analysis of the data was not always economically feasible or technically viable

While there were some efforts reported in these cases to include human analysis in the respective systems, resources were sometimes required that were not typically available. In the agricultural learning case study, analysis of farmer responses was initially undertaken by Listening Post staff. This involved determining which questions were asked most frequently and sharing these with the broadcasters. Subsequently this analysis was automated. But prioritizing questions for the radio is still done by the broadcasters, who also determine how to direct questions and responses. The aggregate data from each Listening Project is analyzed and interpreted in different ways. Analysis undertaken by partners was generally based on how useful it was to them in terms of their overall investment in the Listening Post, while the analysis undertaken by FRI is focused on understanding overall engagement levels, utility, and value.

In the mobile nutrition case study, the Dimagi and CommCare private sector partners needed to use their proprietary systems to carry out more in-depth or tailored/sophisticated

real-time or ex-post analysis. The implementing team viewed this as a mixed blessing. On the one hand, the team did not have the technical expertise and time to conduct analysis of the real-time data in a timely manner. On the other hand, CommCare-directed analysis proved costly due to consultant rates; inflexible, because it was limited to the given suite of analytical tools; and time consuming, because of the multiple steps involved in requesting and receiving analysis.

In addition to the standard automated aggregated reporting, the national WVI team occasionally conducts more-in-depth analysis. At one point, WVI focused in some detail on data related to a specific posyandu—to assist with programming decisions at that site. However, this process could not be replicated at the regional level because of capacity issues. Data literacy was also a challenge for specific groups who might otherwise have been involved in analysis—such as midwives and sub-district and district health officers. WVI is currently considering employing a real-time data analytics expert for the scale-up phase of M-Posyandu. This could help address some, but clearly not all, of these challenges.

As already noted, the PetaJakarta urban resilience system is the most sophisticated technologically in terms of gathering information; such sophistication is also evidenced in data analysis. The core analytical application draws on the crowd sourced Twitter data streams, a variety of other civic crowdsourcing applications, as well hydrological information systems, urban infrastructure data, and food security management systems and response and mitigation information. These are used to create maps, and the data is then verified and structured to inform specific decision makers. Having real-time data streams verified and structured for specific kinds of decisions through the mapping/visualization process was seen as increasing uptake by users.

6.2.4 The demand for analysis is as important as supply and has both technical and human dimensions

In these initiatives, more sophisticated analysis was not limited only by available resources—which shapes the *supply* of analysis. Both the technical and human sides of *demand* must also be considered. On the technical side, there was a need to think about which decision makers are making what kinds of decisions and with what kinds of information. For example, for the mobile nutrition case study to be useful to district-level decision makers, analytical systems must allow them to compare specific data trends with data from previous time frames and contexts. Such comparative analytics are vital for discerning “big picture” trends. As with the urban floods case, the analytical systems in question need to enable users to move upstream of the data, to better understand the underlying drivers and related factors. The ideal would be not just to look at aggregate changes in nutritional status, for example, but also at weather patterns, disease incidence, price of grains, and so on. Analytical sophistication is not only about a getting a more nuanced and dynamic view of the problem in question but of the bigger systems picture. This demands a mind-set and culture of looking at the bigger picture in terms of data and reports—one that focuses on the accuracy and quality of data as well as on approaches to collectively interpret and make sense of the data.

A focus on the human side meant considering the social context of the data, which helps to shape its relevance and pertinence as well as to underpin processes of sense making and interpretation. To be effective, real-time data systems need to be effectivey socialized so that the target is not individual decision makers, but networks of decision makers who are able to come together to make sense of what is happening, look at opportunities, and make shared decisions. As highlighted in a number of the cases, data analysis can be challenging due to staff capacity but also due to the culture of the teams, organizations, and networks that seek to make use of the analysis.

6.2.5 Dashboards were widely deployed for data sharing and proved as useful for advocacy as for decision making

All four initiatives focused on dashboards and reports as the primary tools for sharing information with decision makers. Password-protected web-based dashboards are made accessible to authorized partners and personnel with necessary log-in details. These dashboards provide access to relevant charts, visuals, and texts that are the front end of the analytical systems described above.

In some of the initiatives, the dashboards have seen limited use due to poor data literacy, lack of interest, conflicting priorities, limited capacity, and time pressures. For example, while WVI shared the access code for the M-Posyandu dashboard with local midwives and sub-district and district health officers, actual access to and use of the dashboard has been very limited. Some real-time features of the dashboard system were also seen as unnecessary and as potentially adding pressure to staff and were not utilized.

The Dimagi/CommCare system allows the program to track in real time data collected in posyandus, see how volunteers are using the system, understand how long they take to complete forms, and so on. However, the evaluation commissioned by WVI found that these functions were not seen as helpful by stakeholders, and the data was not taken up at the sub-district or district levels. Instead, decision makers generally placed more value on aggregated reports generated by the system. These were more general, just-in-time reports. The WVI team shares monthly summary reports to relevant stakeholders via email, as printed hardcopy, or in person. Such active dissemination requires time and makes use of a dedicated m-Health officer who is located at the WVI headquarters. In an attempt to increase data uptake, WVI sends data reports to government officials shortly before monthly meetings. This targeted and strategic approach is widely seen as more effective than the automated, passive, and continuous dashboard-based systems.

That said, the M-Posyandu dashboard has been perceived as valuable. This is less about continuous use by decision makers and more about potential as a powerful visual advocacy tool. Presentations about the nutrition system frequently begin with an overview of the dashboard as a way of showcasing the power of the system and capturing audience attention and imagination.

The birth registration case story has had a more balanced story. Direct access to the data dashboard is provided to government officials, registration coordinators, UNICEF, and TIGO and has proved popular among these users. The initiative uses its data to generate reports to share with donors, which has helped to underpin specific actions. Along with the dashboard and reports, the initiative disseminates data via screenshots, emails, and WhatsApp groups—with different channels targeting different decision makers. The dashboard is seen as a critical means of dissemination, sharing information and data with decision makers at different levels, and triggering specific actions.

Box 4: Key messages for data—analysis and sharing

Four key messages
1. Ensuring data quality requires a mix of technical measures and human capacities.

2. Turning raw real-time data into actionable information requires human and financial resources that go well beyond those typically invested in real-time data systems.

3. Having the ability to gather and analyze real-time data streams is of limited value if potential users cannot access the analysis. Ultimately, decision makers need to be provided with the result sof analysis in the right form, at the right time, and in the right place, to guide actions.

4. A blend of approaches for creating actionable knowledge—through dashboards and reports—are needed to meet the interests of and needs of decision makers.

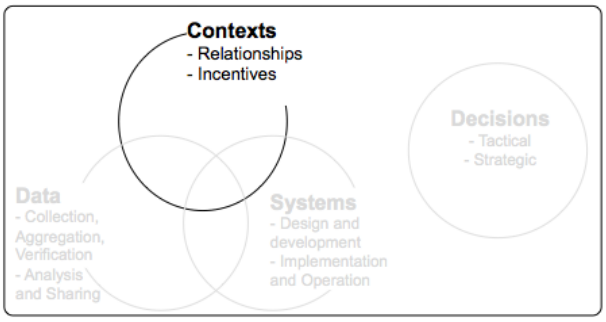
Implications for bridging real-time data and adaptive management
The types of analysis that can be undertaken, and how, depend on the nature of the problem, the type of and scope of data collected, and the nature of the system being run. For the most part, the initiatives looked at here examined relatively simple aspects of the respective underlying problems. This meant that analysis could be automated and could be used to provide specific triggers for action at the local level and by frontline workers. Aggregating this information for decision makers at different levels proved more challenging and happened less frequently and systematically.

The kinds of analysis required to support adaptive decision making contrast with the kinds of analysis carried out automatically in these case studies. Lack of resources and capacities limited the scope for generating a better understanding of granular, multi-variable, and multi-level phenomena. While aggregating information patterns from the given data sources was technically feasible, it was not a feature of the systems and would generally have been too expensive to do frequently.

For technical reasons, such systems would be challenging to maintain in real time as data volumes grow. Secondly, it is not always possible to anticipate what wider contextual information and signals would be and what supplementary information should be included. Rather, for these four programs, specific triggers from the core real-time data streams could catalyze further, deeper investigation of supplementary and supporting information.

In these cases, the continuous data streams enabled through dashboards and other systems common to real-time data systems did not always prove to be the most useful tools for supporting decision making. The systems may have enabled alerts to be generated and thresholds to be reported—and responses to be formulated. But simply providing tools without thinking carefully about how they will be used is no guarantee they will be used in decision making—adaptive or otherwise. Specifically, dashboards will only be used if there are strong incentives and rationale. A “build it and they will come” mentality does not seem to work. Dashboard features must be developed with users in mind, rather than be “off the shelf.” The tools that were more frequently used were less real-time and more right-time, including reports that aggregate relevant data at the right time in the right form for specific decision makers.

7. Findings: Contexts



7.1 Contexts—relationships

7.1.1 Multi-level relationship development is essential but political challenges emerge at every level

Across the four case studies, diverse networks of stakeholders emerged and collaborated in design and development. These included government and foundation donors (USAID, AUSAID, BMGF), private sector software developers (Dimagi, Voto, Cognicity), international organizations (UNICEF), international not-for profit organizations (WVI, FRI) and national governments (the Government of Tanzania and the Government of Indonesia at national and regional levels). In each of the cases, international development organizations and technology partners played lead roles in program initiation and inception, usually in consultation with national partners from government and civil society.

All of the cases faced the need to build relationships with actors at different levels to gain their engagement, acceptance, and commitment to collaborate on the initiatives. This relationship development process was vital: without it, no progress could be made, and all the initiatives would have remained theoretical. This lesson is of course not unique to technology or data projects, but it does have some specific implications for such projects.

Relationship-building was reportedly not easy. Issues and barriers emerged at many different levels of institutions and operations. The mobile nutrition case was proposed in the context of an Indonesian political leadership highly supportive of data-driven development and digital innovation. Both the President of Indonesia and Mayor of Jakarta are firm supporters. However, a digital agenda is not uniformly well received across the different levels and institutions in Jakarta and Indonesia more widely. Nor were the potential blockers apparent at the outset. Even effective engagement with the right stakeholders is not necessarily a guarantee that judgments and decisions will always be appropriate or that all possible problems can be anticipated. When rolling out new technologies—whether entirely new or new to the particular context—uncertainties will always exist.

As a result, even when one level of government buy-in seemed to be in place, lack of engagement and agreement by other key actors often emerged during implementation. This was a key part of the learning curve for the mobile nutrition case. For example, one head of a sub-district (who did not feel appropriately included or consulted) discouraged the use of the M-Posyandu application in his district. The program eventually failed in that sub-district, which in turn resulted in lower registration rates in the pilot site. Because this issue emerged during the pilot phase, it led government buy-in to become a major priority for the rollout phase.

This issue played out in a different way in the urban resilience case. Many different agencies with different functions (and often conflicting mandates and objectives) needed to cooperate. PetaJakarta had been used extensively by the local disaster management agency, which

was an important indicator of success. However, the urban planning agency, also an essential player, had not taken it up nor shared its own data with the initiative. The agency's data was widely viewed as more politicized and ownership issues as more territorial in nature than that of the local disaster management agencies. Moreover, the urban planning agency was also seen making many decisions with negative impact on urban resilience. While the issue of getting this agency to share data and engage with PetaJakarta could be framed as a technical challenge, in reality it was a political roadblock. Real-time data initiatives can highlight such issues, but it is hard to imagine that any would have the clout alone to be able to address them.

7.1.2 Constant engagement and winning over champions is key to effective relationship development and takes considerable amounts of time, energy, and negotiation skills

The real-time data systems in both the mobile nutrition and birth registration programs were designed to operate as part of formal service delivery and citizen accountability mechanisms. This meant buy-in and endorsement from different levels of official government was essential. Buy-in was necessary for endorsement of the systems themselves and also to ensure the systems would become trusted means through which policy and practice could be influenced.

The work of the mobile nutrition system highlighted the importance of getting buy-in and identifying champions across all relevant government players and from across different administrative layers. This ensured active participation and increased the potential for scale and sustainability. However, the process of getting such endorsement was very time-consuming. For WVI, this required constant engagement, time, and resources from the outset. In fact, WVI staff noted that getting government buy-in was the most time-consuming part of the project. Such a challenge can be a significant barrier to entry for organizations lacking the human resources and skills to undertake such work.

Some of the private sector partners in the FRI program felt that they had not really chosen to be a part of the initiative. As a result, they were not as committed to using the data for strategic purposes. These partners saw the initiative as an opportunity to market their goods and services to farmers, rather than as an opportunity to use data to inform their operational and strategic thinking. At first FRI did not feel comfortable working with one partner mainly interested in using the Listening Post for marketing purposes. FRI capitulated because this was the only way to get the partner to participate.

7.1.3 Data processes are only as good as the relationships in which they are embedded

Relationships must be considered across all the critical data processes. Stakeholders include those who collect data and those who provide data.

For all of the initiatives, frontline data collectors were critical for getting the right data into systems at the right times. Assumptions in some cases about these actors' willingness and capacity to participate did not match reality. For example, WVI sought to add more indicators in the mobile nutrition program in order to align M-Posyandu with the Indonesian Government's nutrition data requirements. But when WVI attempted to add these indicators in the system, community volunteers (who were already overstretched) refused to collect the data on each client. This proved problematic for the comprehensiveness of data, which in turn affected potential decision-making processes. The lesson is that programs cannot assume frontline staff or volunteers will simply take on additional tasks without given extra time or compensation.

Relationships are also essential when dealing with third party data providers. In the urban resilience case, PetaJakarta needed precise data from multiple different levels and

locations. This was not be feasible without a partnership agreement with Twitter and other data providers covering details about data sharing, security, management, and so on. PetaJakarta also created mechanisms for providing feedback and encouragement to those submitting data. This feedback loop has, according to the PetaJakarta team, prompted users to provide further data in their submissions.

Relationship and trust development efforts were also necessary with the stakeholders and communities about whose lives data was being collected. FRI could get farmers to participate in the Listening Project because they were a trusted channel. Moreover, the presence of expert farmers on the program made the initiative attractive to farmers. However, lack of effective communication with farmers meant users initially thought the system would use up their airtime, despite its freely available calls and texts. In the first trials, farmers therefore did not use the mobile phone system to the level expected.

Leaders of the birth registration initiative knew that work would be required to convince caregivers to show up at health facilities and get children registered. The initiative was launched with targeted public awareness campaigns about a child's right to be registered, the importance of registration, and its benefits. However, effective messaging was challenging and took time. During the first year of operations the varying quality of relationships with communities affected registration rates; some areas registered 98 percent of children, while others registered closer to 50 percent.

Box 5: Key messages for contexts—relationships

Three key messages

1. It is difficult if not impossible to anticipate who will oppose an initiative and why. The key is to apply a strategic stakeholder analysis lens to relationship development.

2. Developing relationships and identifying champions at different levels of a system is critical but usually takes much more time than is anticipated.

3. It is vital to consider the needs and interests of actors at the front line of the system and consider how to build their trust and commitment effectively.

Implications for bridging real-time data and adaptive management

It is tempting to think that real-time data systems can shortcut or accelerate the processes by which people make decisions. However, lessons from across the case studies suggest that these systems are subject to the same utilization challenges as those facing any other form of information, data, or evidence. Specifically, social relationships among those served by a system are among the most important, and most overlooked, factors shaping data collection, management, and use in decision making. Whether or not real-time data can contribute to adaptive management is profoundly shaped by how different decision makers have been bought into and trust the system. This in turn depends on how well initiatives have engaged with the actors in question and how well they have learned about and adapted to different actors' interests. This is true at all levels of the system, from the highest political level to the front line. Working to bridge real-time data and adaptive management is as much a social and human process as it is a technical one.

7.2 Contexts—incentives and institutions

7.2.1 Incentives and disincentives play out in unpredictable ways

Incentives and disincentives for different stakeholders to engage with, contribute to, and use the different real-time data systems were apparent at various levels of the operations and the overall initiatives. Interestingly, mechanisms that enabled effective data systems in one setting sometimes proved to be barriers in another.

For example, in both the birth registration and mobile nutrition cases, the data collecting facilities are rated on quality (e.g., missing data, data entry errors) and coverage of data (e.g., whether the target population is comprehensively captured). The resulting metrics are then fed into comparative league tables showing performance of different facilities and regions. This has proved to be a positive motivation for birth registration—incentivizing greater use of the real-time data system at local and regional levels. However, the same approach has hampered the real-time data process for the mobile nutrition program. Posyandu heads became concerned about the implications of sharing the quality of their data—fearing judgement and potential reprisals for poor performance. As such, they work to double check all data before it is submitted, creating a bottleneck and hampering the real-time nature of data transfer and uptake.

End-user incentives for participating in the system were initially important in the birth registration system. Marketing of birth registration to community members led to spikes in demand for the service, which in turn led to facilities providing the registration service faster and more efficiently.

In the mobile nutrition program, real-time feedback on nutrition status was also marketed to caregivers bringing children to the health posts. This was positive in one sense, because the M-Posyandu system helped increase caregivers' awareness and active involvement in their children's' nutritional well-being. However, the M-Posyandu staff felt under heavy pressure to provide real-time feedback, and this often led to service delays while providers waited for the system to respond. One interviewee said some caregivers would not leave until they were given their feedback, even if they had to wait up to 20 minutes during busy times. In this case, demand increased pressures on frontline service providers. Both the previous impact evaluation and interviews conducted for this research with volunteers and WVI staff found that the duration of child growth monitoring sessions in posyandus increased after the introduction of the mobile phone application because caregivers were actively requested to wait for real-time feedback—and they were motivated to do so. Promoting the system to caregivers thus had two unintended effects: slowing overall service (rather than accelerating it), and dis-incentivizing health workers from actually using the system.

With both PetaJakarta and FRI, incentives to participate were focused on citizen engagement with the technology and the potential rewards that could be generated. In the Listening Posts, farmers have the opportunity to have their questions answered by experts, to hear from other farmers, and to engage via the radio—which is a trusted source of communication and information. The PetaJakarta system provides users who input data with a visualization of their inputs on a map, giving them a sense of their contribution. It also allows the user to see the status of their contribution, so they can continue to follow it. As soon as a citizen adds to the platform, the contribution is mapped (even if unverified) and sent back with a hyperlink and a thank you for the contribution. This "feedback" validates user contributions and allows users to see how their information could be useful. Program stakeholders saw immediate feedback and visualization of individual contributions as driving increased use of the platform.

Incentives were primarily focused on how to get potential users to engage with the system and remain engaged. But system effectiveness is also based on underlying incentives and

disincentives associated with trust and legitimacy. If a real-time system is introduced into an organizational and institutional climate and culture shaped by fear of accountability and hierarchies, its use (or non-use) will inevitably be shaped by these wider considerations. On the other hand, if the climate is a positive one that encourages learning, then the system is more likely to be used and to further this climate and support a positive approach to the challenge being addressed.

7.2.2 Wider institutional and political factors play a critical role on data systems and decisions

The wider political and institutional climate profoundly shaped both the overall initiatives and their respective data processes. In Indonesia, the fact that data-based decision making was on the presidential agenda created an enabling context for real-time data initiatives. This may even have contributed to a proliferation of such initiatives, especially in the capital city. Similarly, the birth registration system benefited from high and visible political commitment. The government signaled its commitment to the initiative in a variety of ways. Perhaps the most significant was the raft of policy changes that linked birth registration with access to essential services. These included higher education, voting rights, and passports. The government also supported the initiative in more direct ways, through investment in training and in efforts to decentralize and simplify birth registration processes.

The wider context can also provide challenges and hindrances to the use of data by decision makers. In the mobile nutrition program, heavy regulations and government requirements have made decision making cumbersome. It has also made decision makers hesitant to use data due to fear of reprimands. Government regulations also directly affect the usefulness of the data collected in the m-Posyandu system. Certain nutrition indicators are legally required but are not necessarily the most useful to inform decision making. When WVI attempted to add more indicators, community workers—who were already overstretched—refused to collect even more data on each client and were more concerned with the legally required indicators than those that could be used for decision making.

The birth registration system has also faced regulatory issues; birth registration is regulated by a multitude of laws and acts in Tanzania that make program implementation confusing. To date, these laws have not been updated in a way that supports the rapid expansion of birth registration.

Box 6: Key messages for contexts—incentives and institutions

Three key messages
1. Incentives for using and engaging with real-time data systems can be effective, but how they play out will be shaped by the cultural and social climate around the challenge in question.

2. Building trust in the system is essential; so, also, is anticipating the unintended consequences of system-related targets and messages.

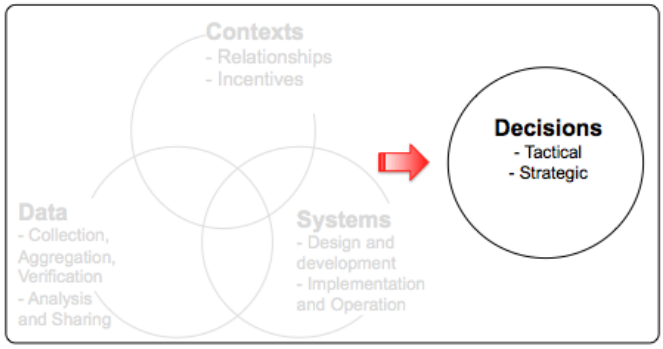
3. Political and institutional contexts can be major enablers or inhibitors of real-time data and its use in decision making.

Implications for bridging real-time data and adaptive management
All of these findings reinforce a common lesson—that absence of effective incentives and supportive institutions can seriously constrain the contribution of real-time data to adaptive management approaches.

The political context of a program or challenge has considerable influence over what data processes and adaptive decisions are possible. The best and most sophisticated technological solution can easily get stuck in a political quagmire.

Indeed, the political context shapes the way in which real-time data is thought about, collected, and used—just as it does for evidence more generally. The political context serves to define, shape, and influence investments in data—conferring or undermining legitimacy and supporting its use or non-use.

8. Findings: Decisions



8.1 Tactical decisions and learning processes

8.1.1 The real-time data systems contributed to frontline tactical decisions for case management and process optimization

The four case studies were based on a range of different goals and objectives. Their respective data systems therefore informed and influenced a wide range of different decisions and learning processes.

In the mobile nutrition program, the real-time data system was designed to inform more timely and effective decision making at both frontline and district levels. During community visits, volunteers used the real-time nutrition status calculations to provide feedback, and where necessary, provide nutrition counseling and referrals. When this process worked well (i.e., when used, the system did not cause additional delays, even with increased demand), the data helped frontline workers make decisions more effectively. The program impact evaluation conducted in 2015–2016 found that volunteers with the mobile nutrition application were significantly more likely to provide feedback to caregivers and arrange follow-up visits than volunteers without phones.

Data supported tactical decision making in several ways in the birth registration project. As foreseen, many of these were examples of “single-loop decision making.” They helped to roll out the system itself and to meet the overall goal of providing a more accurate picture of the population and inform further expansion of birth registration. Specifically, the real-time data system helped with the following functions:

- tracking the numbers and locations of facilities and centers involved in the initiative
- pinpointing locations that entered erroneous or minimal data
- following up underperforming areas with targeted engagement and capacity development

In the agricultural learning project, the real-time data systems were seen as having potential to change farmer decisions around products, services, and practices; to influence the partners providing these products and services; and to affect decisions by FRI as the overall project lead. For example, one of the program’s theory of change was that, by encouraging farmers to participate in a six-week radio series about using improved cassava seeds, the farmers would gain enough understanding and interest to try them. Broadcasting live poll results demonstrated to farmers that others were engaging in this, helping to create confidence and stimulate a new social norm. Questions submitted by farmers were answered on the radio after a one-week delay.

Each Listening Post broadcast was intended to influence farmers’ immediate decision making and trigger changes in their approaches. By participating in the real-time exercises, farmers could be introduced to and seek out specific improved services (be it for new seeds and crops, new equipment, or new sources of advice). Recommendations had to be relevant

and farmers had to have the capacity and resources to act upon them. According to the MAVC research, this worked best when the farmers used data to make decisions about specific, relevant partner services (e.g., where/how to acquire a specific piece of equipment or resource).

8.1.2 The greater the scope of the decision and the further from frontline case management, the greater the need for real-time data to be complemented with other sources of data

All the data systems were meant to inform and influence higher levels of decision making, in addition to immediate decisions at the front line. In the birth registration case, decisions about the actual content of the real-time data gathered through the mobile system were made at the national, regional, district, ward, and village levels. These higher-level decisions generally took place over longer timeframes and were focused less on technical issues and more on planning, allocation of resources, and so on. They also required more information than was available in the real-time data system itself.

In the mobile nutrition case, WVI drew on real-time data discussed in monthly staff meetings to inform higher level operational decisions—such as whether further training was needed or whether the posyandu network could be expanded. WVI also incorporated data to track the progress of specific interventions (such as nutrition counseling) over time and to adjust existing interventions and programs. As with the birth registration program, stakeholders emphasized that the real-time data system is just one of several information sources consulted and considered when embarking on such changes. If an intervention is not working as expected, the team typically discusses this with volunteers, the head of the posyandu, community leaders, local midwives, and health workers to gain deeper understanding of the reasons. Any changes in interventions are also discussed with the sub-district health office to gain their approval and ensure compliance with national guidance for posyandu management. When individual posyandus are under the stewardship of local women organizations or religious groups, these are also consulted. In case of more substantial changes to programming, approval may be sought in turn from country, regional, and global HQs. While such deliberations may be *informed* by real-time data, the decision making structures and processes mean decisions *per se* are seldom real time.

In the agricultural learning case, the Listening Posts did increase demand for partner services. One case was so successful that a major partner has shown interesting in funding its own series of Posts. While sharing information about their services with partners, the Posts also helped to give private sector partners a better sense of farmers day-to-day concerns. Aggregating questions from across different shows helped to highlight critical issues. As one partner lead noted, if many farmers in different regions were asking the same question, it was safe to assume this indicated a genuine challenge—and one worth investigating further. Partners also reported gaining a better understanding of how to work with participating farmers—such as how to deliver a specific good or service. However, because partners viewed the Listening Posts primarily as marketing exercises, there was little potential that the real-time data collected would actually trigger changes in their own decisions. For the most part, the partners' own data systems—which included agricultural, marketing, and business information—remained more important for informing operational and strategic decisions.

The data *about* the real-time data system from Listening Posts was used by FRI to adapt their approach as they went along. This led to experimentation in how data was processed, analyzed, and interpreted, as well as with incentives for farmers to participate in the show. By their own admission, FRI really struggled with the first few Listening Posts, not least due to difficulties designing messages for broadcast on national radio shows but aimed at a relatively small scale and isolated set of projects. It took time to home in on relevant questions and models for encouraging interaction. Perhaps the most notable shift was from

using national radio stations, which have high reach but can't target very specifically, to community radio stations, which had lower reach but could respond better to the local context.

In the urban resilience case, web-using citizens can make daily decisions based on the data provided in the maps on the dashboard. The system provides instant information about where to go and how to get there, places to avoid, and how to make decisions to secure their families. Stakeholders provided several examples of how citizens succeeded in rapid reorganization and humanitarian efforts using the maps. However, since the dashboard is web-based, it is not accessible to those with no internet access, thus limiting how communities can benefit.

The data in the urban resilience case has not led to greater attention by responders to specific localities flagged as hotspots. This is because the frequency of reports from Twitter is not an accurate indication that a specific area is more affected than others. Similarly, because the app relies mostly on input from people with smart phones and access to Twitter, the correlation of participation to level of vulnerability is also unclear. So, while PetaJakarta can be a useful tool for sense-making around disasters, it must complement rather than replace other kinds of assessment and notification.

At a higher institutional level, the real-time data generated during floods has catalyzed greater coordination and information sharing between different agencies. It has enabled local disaster management agencies to work as more of an information and coordination hub. It has also highlighted other data needs and gaps must be addressed and what data could be combined with PetaJakarta data to support informed decisions. For example, urban hydrological infrastructure maps are essential in conjunction with the twitter-generated data to see if and where critical infrastructure failures might be taking place during floods.

Box 7: Key messages for tactical decisions and learning processes

Two key messages
1. Real-time data informed frontline operational decisions directly, enabling more timely responses to emerging case-based issues or to specific operational performance issues.

2. In combination with other data sources, real-time data systems in some cases also informed higher levels of decision making—e.g., in relation to resource allocation or performance of certain activities.

Implications for bridging real-time data and adaptive management
Across the board, most of the decisions and learning processes triggered by the real-time data were aimed at optimizing and enhancing *existing* processes and practices through the use of better and more timely data.

Much of the learning from the real-time data systems in these initiatives was single loop in nature, focused on tactical adjustments. For the most part, the decisions made and lessons learned pertained to the original parameters of the respective initiatives. Data helped to improve the system that had been designed and helped to further its implementation. The greatest and most direct value of the real-time data for decision making was for frontline staff. In many ways, this was predictable—a function of the transactional nature of real-time data systems and the way in which they frame the problem at hand.

Examples of these problems included the need for real-time data systems to specify clear indicators up front that can be tracked; the need to define thresholds and triggers for pre-defined actions; and the need to increase the time of response.

The real-time data systems investigated here are primarily about automating and accelerating existing decision-making processes.

8.2 Strategic decisions and learning processes

8.2.1 The value of real-time data systems for strategic adaptation is in expanding the space of possibilities for wider changes

The larger the scope of the decision or learning process, the more necessary it is for real-time data to be combined with additional forms of data and information. Strategic decisions and learning processes are not necessarily about optimizing existing approaches or systems but about questioning assumptions and undertaking more in-depth and systemic changes in interventions.

Such learning and strategic shifts have taken place when new understandings were generated by a real-time data system *as a whole* and had *potential* to underpin larger scale policy changes. Resulting changes were not *directly driven by the data* but rather *led via the data system* through a process of rethinking structures and development approaches.

In the birth registration case, for example, data from the real-time data system was used to enhance operations of the registration initiative itself. The data was also used at a higher level to inform village-level budget and planning discussions. There were also plans to use the data in ward and regional budget and planning discussions in the months to come. The data initiative and its rapid success became the subject of policy discussions about the development and expansion of the Civil Registration and Vital Statistics (CRVS) system at a national level. Government officials talked about “strategic use cases” for the system, which included a wide range of related essential services. It was anticipated that the birth registration data system would eventually help support the following decisions:

- *In demographics:* to have a more complete and accurate picture of the population
- *In CRVS*: to further build the national system and expand registration to under-ten-year-olds
- *In health systems*: to ensure an appropriate number of dispensaries, health centers, and vaccines
- *In educational systems*: to ensure appropriate number of schools, desks, and teachers
- *In civil planning*: to understand and address municipal growth and make decisions (e.g., should a specific village be divided into two)

In the agricultural learning case, the Listening Post processes led to useful strategic adaptations for FRI. These were triggered by the real-time data initiative as a whole and the programatic learning that it engendered. Specifically, FRI found that designing a good radio show and *also* brokering new digital data and knowledge to development partners meant wearing too many hats. Indirectly, the process of supporting real-time data delivery contributed to a strategic sharpening of FRI’s methods over time.

In the PetaJakarta case, the digital platform helps provide and disseminate information for rapid responses. The data is not always sufficient to address questions about urban planning, sewage and water management, infrastructure for water runoff, and so on. Therefore, the real-time data needs to be integrated with other data sources for decision making and supported by resources to act on those decisions at higher institutional levels.

A key lesson from the urban resilience case is the need for "glue" to tie together multiple digital platforms collecting different kinds of information. Funding for new tools creates a wider market place but also creates challenges via increasingly fractured information and coordination systems. A lesson from PetaJakarta is that strategic *use* of real-time data systems depends on how wider information is combined and aggregated, as much as on the specific real-time data collected.

8.2.2 Strategic adaptations require involving decision makers in the design of systems

If a real-time data system is to trigger strategic adaptations, relevant decision makers must be involved in the design of that system and not simply be passive recipients of data.

The agricultural learning system aimed to inform strategic decision making among farmers, partners, and FRI. Through the Listening Post, the hypothesis went, participants would be encouraged to take on new farming methods and practices. Farmers who had support from relevant partner organizations were willing to take on new methods, partly because of their trust in information conveyed over the radio.

FRI's own research suggested farmers' willingness to take on new methods was due in part to the show's design. For example, the presenter's authority and the trust this inspires is important because, as the FRI lead said, "Radio makes celebrities in rural Africa." In phone interviews for the case study, farmers also suggested they considered radio a trusted source of information and those on the show tended to be experts.

FRI's research suggested that farmers are four times more likely to adopt new strategies discussed in radio shows if they are involved in designing the show. However, this was not a feature of the Listening Post design approach. In addition, the length of the Listening Post (six weeks) did not allow the show to map onto the timing of crop cycle management—limiting the utility of information for farmers' decisions. For partners who were viewing the show mainly as a marketing exercise, this could mean advertising (e.g., of bags or seeds) might be broadcast when the products were not relevant. The timing, length, and content of the show was essential to get "right for real-time data" to influence farmer decision making.

8.2.3 Real-time data systems are not always designed to influence strategic adaptations—but may do so anyway

The real-time data systems looked at here were not created with a view to catalyzing systemic change or triggering profound questioning of assumptions. They are not, for the most part, systems to underpin deliberation and reflection but instead to inform immediate, transactional decisions. For example, the mobile nutrition system was primarily seen as a "job-aid" to enhance routine growth monitoring (which requires a straightforward calculation). The idea of promoting wider use of real-time data emerged and grew over time. But because of its origins as a tool to support frontline workers, a number of operational barriers might inhibit its use in this way.

For example, the data gathered is highly granular and about the specific processes of child growth monitoring. Any attempt to fundamentally change or adapt this would make previous data collection processes null and void. Incentives are strong to keep the system focused on set indicators and not to consider any questions that might arise about whether it is gathering the right information about the right phenomena.

The birth registration initiative is limited so far by the partial/incomplete nature of the data sets. The program has not yet scaled up nationally; thus the data is not representative of the general population. The data would need to be complete to support more strategic analysis and use. Government officials interviewed mentioned that they would not be able to legitimately use the data until it was complete. Others, by contrast, had not given much consideration to how the data could be used.

The urban resilience system is directly limited by the real-time nature of the effort. Part of the goal of PetaJakarta is to involve both citizens and the local disaster management agency to immediately respond to flooding situations. This was a feature common to other initiatives, where teams were focused on how to provide faster and better responses or services.

These might be emergency response teams, rapid service improvement teams, or inventory monitoring teams. However, this focus does not promote longer term planning around these issues. Long-term solutions for the problem of rising flood levels, and associated damage, requires cooperation and planning with the city's department of urban planning and public works.

Double-loop learning for urban resilience in Jakarta usually takes place among different teams (or departments) from those tasked with effective single-loop learning for disaster response. In the PetaJakarta case, this reflected the difference between real-time data used by the disaster management agency and the data systems used by the urban planning teams (which may or may not be real time in nature). The latter teams are housed in totally different departments, with different mandates, budgets, operational timelines, and political pressures.

Despite a lack of intent or design, data systems can sometimes contribute positively to strategic changes by generating information and promoting understanding of the possibilities for improved decision making.

8.2.4 Real-time data systems can often be perceived to be incomplete or of low quality, which places limits on their strategic utility

The operational focus of a real-time data initiative can lead to a perception that the system is low quality and has low utility except at the frontline. In the mobile nutrition case, at the district level, regional, and national levels—where strategic decisions are more likely to take place—the perception is that real-time data is just one low-quality data source among many. District-level and national-level health authorities said that they consulted posyandu data to inform policy making related to community-based nutrition interventions. However, they were usually just interested in posyandu attendance rates and rarely considered other aspects of the data.

Lack of trust—in both the accuracy and representativeness of nutrition data collected at community level by volunteers (rather than by trained health workers)—was a huge concern for all higher level stakeholders in the mobile nutrition program. It was also the main reason cited for lack of higher-level up-take and engagement with the data. One stakeholder said that concerns about quality made him reluctant to use data collected by the community to inform programing and policy decision making and cited nationally representative surveys as the best source for reliable data on nutrition. This lack of trust in the posyandu data was highlighted by the recent decision by the Ministry of Health to fulfill the presidential call for data-driven governance by increasing the frequency of national representative health and nutrition surveys from every two-to-three years to annual surveys. Drawing on already available, monthly community-based data from posyandus was not considered an option.

In the Listening Post, similar issues emerged concerning how partner organizations either used or did not use the data. Very few (if any) partner strategic decisions were made based on the data. Its perceived utility for critical reflection was very low. Although FRI tried to create space for key partners to reflect on the data, issues of time and willingness intervened. For partners, their own monthly data systems were more important drivers of decision making.

8.2.5 There are many practical barriers to strategic adaptations which are not addressed by the speed or quality of data

Both practical and institutional barriers—independent of the quality of the data being generated—diminish the potential for strategic adaptations. Information is seldom if ever the major constraint to making profound changes in how a problem is conceptualized or managed. More often these barriers are about rules, institutions, and resources.

In the Indonesian administrative system, specific rules and procedural guidelines shape how nutrition work is planned and implemented. Strategic decisions about nutrition programing are made on an annual basis using aggregated historical data. More frequent decision cycles, supported by real-time data, are impossible due to lack of capacity, time, and finances. National-level stakeholders also pointed out that the incidence of child under nutrition usually follows a seasonal pattern (i.e., higher incidence during the rainy season when diarrhea and fever peak) and that these trends are already considered in annual planning.[32]

The agricultural learning case also identified very practical constraints to strategic adaptations—including a lack of resources and inputs, technological deficits, and cultural barriers to changing practices. These issues played out as much for farmers as for international organizations. Among the interviews conducted with farmers, only one mentioned changing practices as a result of the initiative—and this was possible because he had sufficient land to respond to a recommendation (i.e., to plant in wider spaces at a larger scale). Others interviewed simply did not have the land to take advantage of this recommendation or worked in drought-affected regions where it would not have been feasible.

[32] Also problematic were central government regulations and policies for compliance with budget allocation, service delivery, and anti-corruption measures. Using any new data to inform decision making is a challenge because of the need to stay within the remit of centrally provided guidance. Any diversion from the guidance—especially if linked to changes in budget allocations to individual posyandus—will be made transparent by auditors from the central government and risk reprisal. Similarly, at community level, the official guidance for the posyandu management must be followed by the community volunteers; any adaption in response to the data might be penalized. The government is currently revising these procedures because of their negative impact on local innovation and data-driven decision making.

Box 8: Key messages for strategic decisions and learning processes

Three key messages

1. A real-time data system can best inform and influence strategic adaptations when it is part of a larger strategically focused decision-making system.

2. The value of real-time data to strategic adaptation is two-fold: to expand the possibilities for policy frameworks and to serve as an on-the-ground sensor for potential trends, changes, and issues.

3. Barriers to strategic adaptations include intent within initiatives, perceptions, and practicalities. The solutions to these barriers are seldom related to the speed or quality of data.

Implications for bridging real-time data and adaptive management

Real-time data systems are prevented, for many reasons, from generating useful information for strategic adaptation. These relate to both the supply and demand for information. On the supply side, real-time data systems are seldom designed to focus on potential strategic adaptations—any contribution is less by design than chance and is likely to be indirect. The primary purpose of real-time data is typically to inform operational decisions that are narrower in scope and less demanding in terms of analytical resources and institutional buy-in. These systems are not, generally, about questioning pre-existing problem definitions and decision-making processes. Moreover, the main users of real-time data systems are often frontline workers who do not have the strategic space or authority to question the overall system.

On the supply side, not all organizational or programmatic cultures are open to strategic adaptations in the first place. Where there is scope, the timeframes and the requirements for strategic change usually call for different kinds of information and data than what is generated by real-time data systems. When real-time data can be used in this way, it is never a sole source of insight, but rather one element in a larger package of data, information, and knowledge. Its greatest value is as a kind of early-warning, on-the-ground alert system that can highlight possible issues and challenges that require further investigation.

9. Summary Findings, Lessons, and Conclusions

9.1 Summary findings on bridging real-time data and adaptive management

As explained at the start of this report, bridging real-time data and adaptive management requires working at the intersection of two new and emerging fields. While one is a tool and the other a management approach, each is still evolving and developing. And while both incorporate principles and manifestos and have growing applications, both have farther to go in terms of being effectively applied to change practices, standards, behaviors, culture, and organizational leadership. Realizing the tangible benefits of either field is very much a work-in-progress.

This is doubly true for the interface between the two areas. It is worth re-stating that this interface has seen little in the way of resources or investment to date. Few individuals or organizations—aside from those involved in commissioning, managing, and implementing the present study—have undertaken substantive research or invested significant operational resources on this issue.

However, based on the case study findings presented here, potential value does exist in more integrated approaches to real-time data and adaptive management. The findings indicate many ways in which real-time data initiatives, if designed with appropriate considerations and resources, could make meaningful contributions to both operational and strategic adaptive management efforts.

Specifically, in response to the core research question of when, where, and how real-time data can contribute to adaptive management, the research points to the following findings:

Finding 1: Real-time data systems can generate data that directly informs immediate operational adaptations to specific “case-based” challenges faced by frontline workers. These adaptations can happen more-or-less at the point the system is used.

Finding 2: Real-time data systems can generate data that, in combination with other data and information sources, inform higher level tactical decisions about resource allocation, individual and organizational performance management, rollout of initiatives, and progress of specific interventions.

Finding 3: Real-time data systems can provide data that, when aggregated in meaningful and comparable ways, provide useful inputs into strategic dialogue and discussions—as part of broader strategic information management systems.

Finding 4: Real-time data initiatives can open individual and collective space to imaginatively explore wider implications of the respective systems for other related areas of development policy and practice.

This research also identified several areas worthy of further study:

1. Because this study starts with the question of how real-time data systems can contribute to adaptive management, it essentially explores real-time data as a potential ”supply.” To better understand the “demand side,” there is also a clear need to synthesize and deepen understanding of the data, knowledge, learning needs, and opportunities of adaptive programs. An alternative entry point would be to ask “What are the different ways in which ongoing adaptive management efforts currently make use of data and information (whether real-time, digital, or otherwise), and what is the potential of digital, real-time data to inform such efforts?

2. To some extent, international organizations were enablers, supporters, and implementers of formal real-time data initiatives in all of these case studies. As such, it would be very useful to real-time data efforts fit with issues of culture, language, religion, gender national identities, and so on.
3. Digital technologies are critical to real-time data initiatives. Given this, a more in-depth analysis of the role played by IT infrastructure and applications in enabling or inhibiting real-time data initiatives would be useful. Of particular relevance is the role such IT systems play in resolving or exacerbating existing digital divides—especially in terms of *who* is included or excluded.
4. Given the cooperative ideals of development work and digital development more generally, it would be useful to understand better the mechanisms and platforms that exist for *inter-organizational* real-time data systems, how different initiatives may support such efforts, and how such efforts can create the space for better adaptive management.
5. A more in-depth analysis of the cost of setting up and maintaining real-time data systems would be very useful.

9.2 Lessons bridging real-time data and adaptive management

In each of the case studies, several enabling factors needed to be in place for real-time data to contribute to adaptive management. In some settings these factors were not in place to any extent. In others, some were in place for a period of time, or for specific kinds of issues, but not in a comprehensive fashion. No initiative comprehensively and systematically integrated real-time data and adaptive management. This is not surprising, given the early stage of such efforts. However, research across the case studies does allow articulation of common lessons about enabling factors. Below are ten lessons than can be generalized across programatic and operational contexts. They are preliminary and emerging ideas drawn from the findings. Taken together, they may provide a structured means for informing future discussion, debate, and learning on the subject.

9.2.1 Lesson 1: Design holistically for adaptation

Many of the real-time data systems looked at here, like real-time data systems more generally, were built without the explicit goal of contributing to adaptive decision making. They were built to initiate different kinds of rapid response. The types of decisions the systems were designed to facilitate were those requiring timely response to a variety of challenges—not to the need for adaptations *per se*. Speed of response is not the same as adaptiveness of response. And for the most part, real-time data systems are aimed at the former and not the latter.

Where adaptations did occur, these were primarily aimed at optimizing tactical operation of the existing processes and systems (doing things right). In a minority of cases, the real-time data initiative facilitated and fed into strategic thinking about novel and innovative approaches (doing the right things). The two are not separate but feed into and play off each other in dynamic ways.

To be effective, integrated real-time data systems and adaptive management must be explicitly designed to provide triggers and inputs into different levels and types of decision making. The design of real-time data initiatives must consider both the *technical* infrastructure and the *social*, *organizational,* and *political* systems within which they are embedded.

The rationale for setting up a real-time data system must be considered critically from the outset. In general, adaptive management efforts are introduced into settings where there is a need to shift from existing norms that may not be working—to provoke openings for

transparency and decision making where they don't currently exist. Where this is the goal, adding conventionally designed real-time data systems may not be useful for accomplishing particular adaptive outcomes. There is a risk that conventional real-time data systems could reinforce existing business models and assumptions and become a problem to overcome rather than an enabler of adaptation.

9.2.2 Lesson 2: Design for decision makers needs and interests

A real-time data system can contribute significantly to adaptive management when a decision-oriented mentality is already in place. However, on the whole, real-time data systems cannot themselves bring about this mindset or approach at an institutional and organizational level. Across these case studies, more resources were put into implementing real-time data systems to gather and share data than to ensure meaningful responses to that data. Although this is perhaps inevitable for relatively new projects, a better balance could and should be struck.

Striking such a balance would require a change in how real-time data systems are generated and run, would take the attention away from the technology (which is often the initial attraction), and would require involvement of different expertise from the beginning. Using a theory-of-change-inspired approach to real-time data and adaptive management systems would put more focus on the strategic value of such integration.

The distinction between single- and double-loop learning is pertinent to identifying when and how a system might contribute to program *optimization,* versus to *innovation*. In some instances, an emphasis on data-driven single-loop learning might serve to preclude or inhibit emphasis on systemic forms of learning—rather than to trigger to enable it.

An important goal is to anticipate how to acquire and convey different kinds of data, in the right form, at the right time, to the right people and groups who can make use of it for different strategic and tactical purposes.

Integrated real-time data and adaptive management initiatives should establish different possible scenarios for adaptation—including both tactical optimization and strategic innovation—and the tangible ways in which real-time data can contribute. Data *use* might contribute to a range of challenges, including the following:

- To set and assess progress towards goals
- To identify where performance is and is not being achieved
- To highlight and map emerging individual and group needs, interests, and opportunities
- To spot unexpected behaviors, incidents, or patterns
- To reallocate resources in response to outcomes or trends
- To generate new insights and ideas about a specific process, issue, or challenge
- To support strategic reflection processes about overall program direction and effectiveness
- To inform new discussions about the purpose and ambition of organizations or alliances

9.2.3 Lesson 3: Emphasize right-time data over real-time data

Just because a system is real time in theory does not mean it will lead to real-time decisions. Despite the availability of continuous data streams, in all of the case studies, data was incorporated into decision making when there was consideration not just of the supply of data but also of the factors that shape demand. In particular, many of the development efforts within which the real-time data systems were embedded had existing structures—and data was most useful when it was in the *right form at the right place at the right time.*

Disseminating information at key moments was critically important to increase its chance of being used for decision making—rather than assuming the data systems would be consulted on a continuous basis.

The speed at which real-time data will be used for decision making mirrors the frequency at which decision makers meet. Furthermore, even when systems can collect, analyze, and disseminate data in real time, contextual factors can lead to delays in the data being *inputted* in real time.

In general, and in keeping with research from the business world, the notion of "right-time data" might be more useful and practical that that of "real-time data." The difference is more than one of semantics: right-time data places the emphasis on understanding the data requirements of a development challenge before determining the time frame for data delivery. It also avoids the over-used and often incorrect term "real time," which is seldom found in development contexts.

Right-time data also serves to put the purpose of an overall program first, and views data as an input to achieving that purpose.

This also implies that real-time data systems may be just one of a series of inputs to achieve that/those purposes, and need to be combined with other data sources and types (see section 7.4 on *strategic data integration*).

9.2.4 Lesson 4: Ensure quality and coverage to build trust among diverse stakeholders

The data in real-time data systems is subject to a range of quality issues. Trade-offs between speed and quality are common in most organizational and business processes. In addition to up-front design mechanisms to ensure appropriate data is collected, checks and balances must be put in place—both automated, human, and combinations thereof—to ensure data quality is adequate to inform decisions at different levels. Quality checks of real-time data must themselves occur in real-time in order to avoid bottlenecks. Multiple stages of verification may be necessary, combining digital and technical approaches for collecting, organizing, aggregating, analyzing, and using data.

Quality checks are necessary at different levels: on specific data sources (be they human or automated) and their effectiveness, on specific data-sharing and transmission channels, on specific analytical processes, and finally on the overall picture that is generated by the data. An important consideration for a real-time data system is whether it provides a comprehensive *picture* of a given situation for a specific decision maker's sphere of influence. For example, if a district health officer has a real-time data picture of only half of the villages under her jurisdiction, then the data will be of less utility.

Decision makers may have a number of biases against real-time data. The perception that real-time data is lower quality can undermine meaningful engagement—even when the data in question does have the potential to contribute to decision making. In some cases, data collection by communities and volunteers is de-valued by decision makers who work further from the frontline. While data-driven decision making may be advocated by a project's political or administrative champions, it is clear that not all data "count" equally. Good stakeholder analysis can help understand the diverging opinions that exist around a specific form or type of data and provide strategies for overcoming these.

9.2.5 Lesson 5: Build real-time data into overarching strategic information systems and approaches

In general, real-time data can indicate that something is happening, that some opinion or perception is held, or that some threshold is being reached or passed. But overall, real-time

data systems cannot generally say much about why those things are happening, or how. Instead, they can provide triggers for further investigation, creating a window of opportunity for adaptation.

Stand-alone real-time data systems can be helpful in responding to specific issues and alerts that arise in a diversity of operational contexts and at the front line of programs. However, as this data moves up the decision making chain, its value diminishes.

To hold maximum potential value for different levels of decision makers and for different kinds of decisions, real-time data must be part of a broader strategic orientation that seeks to aggregate and align data. And this must be accompanied by appropriate mechanisms for people to meet and interpret integrated data flows on a regular basis. This requires measures to ensure that the data processes are repeated and can be trusted (section 7.3) and that people understand and are able to make use of data and its analysis (section 7.5).

9.2.6 Lesson 6: Invest in capacity of individuals and teams to be "data ready"

The role of individuals and teams in real-time data and adaptive management processes and efforts is considerable. For the most part, the systems in these case studies relied on human actors to collect, verify, share, and utilize the data. Capacity issues around data management and use are critical in adaptive management programs and processes.

Training, mentoring, and other forms of individual and collective capacity are integral to such a system. Data skills and capacities must be linked to overall performance management—through inclusion in performance appraisals, assessments, and other forms of evaluation. Analytical skills are particularly important, to understand the different ways in which data can be processed to generate actionable information.

Effort must also be made to understand and address possible disincentives for using real-time data for adaptive management. Communities and frontline workers may be involved in numerous data systems and approaches—often without consideration for the additional time or resources required. In some cases, the introduction of real-time data systems can slow responsiveness and timeliness.

Confirmation of use and feedback on quality can be a positive incentive for supporting individual and group participation. At the same time, the processes need to be designed carefully to avoid any unintended consequences—such as becoming a tool for judging performance or reducing budget allocations.

9.2.7 Lesson 7: Focus as much on the social as the technical life of data

Across the case studies, it was clear that data can not just be picked up and used. It requires unpacking, analysis, and explanation. Individuals and organizations seldom have spare resources or incentives to try to understand data that may or may not prove valuable. Data intermediaries and brokers who can put data into useful forms for different audiences can be crucial.

Specific kinds of "data brokers" can also play roles in what might be termed "socializing." The case studies showed that data is not easily divorced from social contexts—and these social contexts become ever more important when the goal is to use data to shape and influence strategic decisions.

Work by the Overseas Development Institute (ODI) suggests that a range of different roles are necessary to move from using knowledge for optimization to using knowledge for innovation. Information intermediaries are needed at one end of the spectrum and *innovation brokers* at the other (see figure 4). Currently these roles tend to be held within real-time data systems by accident rather than by design. More attention to the human face of data

systems—the brokers, gatekeepers, and champions of data—will be essential if real-time data for adaptive management is to contribute to program innovation as well as optimization.

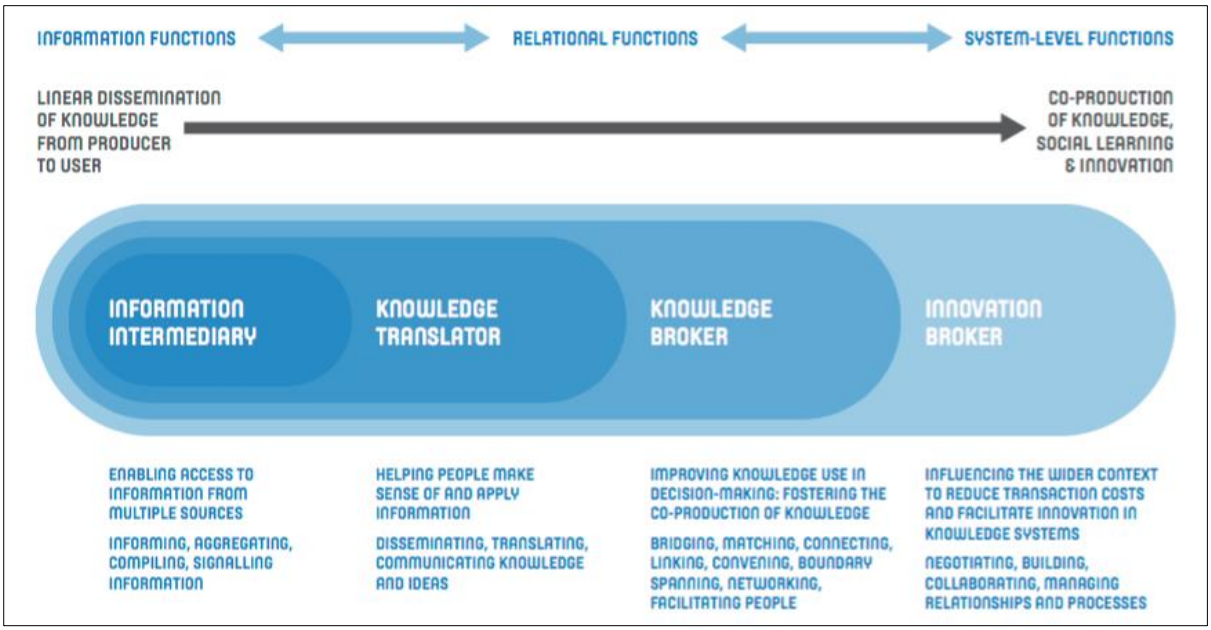


Figure 4: The varying roles of data brokers

9.2.8 Lesson 8: Ensure appropriate, agile and accessible technologies

Clearly, technology is an important enabler of real-time data systems. But the present research suggests that all too often, when a keen focus is put on specific technologies and approaches, insufficient attention may be put on both the human factors that enable and support real-time data for adaptive management and the wider infrastructure considerations on which successful technological deployments rely. Real-time data related technological developments must be appropriate and relevant. A participatory approach to system design can greatly enhance the use of the data generated.

Agile approaches are also essential. Real-time data initiatives must inevitably undergo course corrections to align with the human, social, and technological processes that come together over the course of an intervention. Course corrections might occur because of feedback loops in the data; core technology; supporting infrastructure; social, institutional, and political factors; or in relation to several or all of these domains. Agile approaches are important not just to support technical delivery, but to ensure the analogue and digital aspects of an initiative work in a coherent and integrated fashion.

It is important not to conflate the use of agile approaches in software development—and the use of adaptations within the rollout of specific real-time data initiatives to ensure that they are working as intended—with adaptive management that enables a response to an underlying development challenge. Although clearly related, technological or project related adjustments are distinct from problem-driven approaches that aim to ensure the underlying challenge is being addressed. The two processes should inform each other. A problem-driven approach should enable the right indicators to be measured. Success or failure in achieving those indicators should highlight that either the approach is not being implemented correctly or the approach needs to be changed.

It may seem inevitable that the use of technology to gather data on specific challenges is going to leave some people out—because of a lack of voice, access, or coverage. This can

affect the representativeness of data being gathered and of the data users. For example, data collectors tend to be younger; providers of data are more likely to be male; citizen users are more likely to be those with higher technology use (e.g., smart phone users). Numerous risks associated with such efforts actually serve to leave the poorest and most vulnerable out of technological sight, and therefore out of institutional mind. These risks should be kept at the forefront of design efforts, so that adaptations that do occur are in the interests of the poorest and most vulnerable communities.

9.2.9 Lesson 9: Work to strengthen data culture and data leadership

Perhaps the most important enabler of real-time data for adaptive management is the culture, space, endorsement, and prioritization of for data responsiveness—as both a leadership and behavioral imperative. Without such space and endorsement within implementing organizations, it will be difficult for such initiatives to get off the ground, for resources to be mobilized, partners to be engaged, middle management to support them, and frontline staff to be constructively engaged collecting and using real-time data.

Support must go beyond specific development organizations and extend to the constellation of national and local actors who participate in efforts to bridge real-time data and adaptive management. This may include strategic and operational partners in specific implementation efforts, or those who create an authorizing environment in which initiatives are given time, attention, and credibility.

Political support (and the nature of that support) from internal and external champions matters. Efforts to bridge real-time data and adaptive management must be distinguished from wider sectoral or organizational efforts to strengthen top-down accountability. Otherwise initiatives can easily be perceived, and used, as simply upward reporting mechanisms. And they are likely to become associated with the possibility of reprisal and punitive actions (for non-compliance or errors), rather than with the hunger for learning and the space for flexibility. This wider environment can serve to inhibit the use of real-time data, the application of adaptive management, and their effective integration.

Put another way, if the wider culture emphasizes adherence to plans and accomplishing extant goals and pre-defined processes and outcomes, then efforts to bridge real-time data and adaptive management will run counter to both the culture and logic of the institutions concerned. **An enabling culture is one that places high value on the potential uses of real-time data; on its collecting, sharing, analysis, and application; *and* promotes a climate of creativity, free flow of ideas, and questioning assumptions**.

Underlying all of this is the notion of trust: it will be almost impossible for such an initiative to work effectively without trust, even with the best technology and resources. Importantly, this trust cannot be only one way (superiors trust frontline staff) but must be mutual—addressing any concerns about hidden motivations and intentions that may underpin a real-time data system.

An important follow-up to the present study will be to examine how real-time data and adaptive management can be effectively integrated and also to take a *different* starting point to the present study—and ask whether and how the application of adaptive management in a particular context would allow real-time data to be used more effectively in projects and programs.

9.2.10 Lesson 10: Develop realistic ambitions—start from where you are

The final lesson is to have realistic ambitions for interventions involving real-time data systems and adaptive management approaches. New programs must usually deal with and navigate existing contexts. Aiming for an ideal-world alignment between real-time data and

adaptive management can easily give rise to the adage “perfection is the enemy of the good.” Expectations and ambitions should be based on the realities of where a program starts.

A program that sets out to make *faster decisions* about maternal health issues that arise during childbirth, for example, can use a real-time data system that is constructed around assumptions about potential problems, what data to gather to detect these, and how to respond. A real-time system of this nature can be seen as a means of reinforcing existing norms and approaches. The shift toward adaptive management may need to take this into account. By contrast, a system for *enabling learning* among midwives could be much more open-ended in terms of data collection, more reflective and learning-oriented, and embedded within a culture of learning and adaptation. In this case, the challenge might be to ensure that learning is genuinely data-driven. If these two systems represent two ends of a spectrum, one can also imagine intermediate points—areas where real-time data *may inhibit* adaptive management (because of data system or culture limitations) and areas where adaptive management *cannot be undertaken* (because effective, timely information is lacking.) These scenarios are set out in illustrative form in box 9. Each scenario can be seen as an archetypal way in which real-time data and adaptive management are brought together, or not, in different settings.

Box 9: Illustrative scenarios for bridging real-time data and adaptive management

Scenario 1: The existing data system reinforces the existing program, assumptions, and ideas and serves to limit the space and scope for adaptation.

Scenario 2: The data system is flexible, iterative, and responsive—but the culture is not conducive to understand or make use of the system for adaptation.

Scenario 3: The data system is in place but there is a mismatch between the developers of the system and the dominant culture, and relationships and linkages between decision makers and data experts are inadequate.

Scenario 4: The mindset, assumptions, and ideas for adaptive management are present, but the data system is not fit-for-purpose so adaptations are not data-driven or credible.

Scenario 5: A learning culture is in place and used to question, challenge, and adapt an existing program, and the data system is enabled and supports different levels of adaptation.

The key point is simply that before embarking on any effort to bridge real-time data and adaptive management, the starting point for the issue, team, organization, and context in question must be clear. Otherwise it is too easy to have unrealistic ambitions and claim failure when the goals should have been more carefully considered. Such clarity at the outset will also help ensure that lessons are learned about what was achieved, and why, and are fed back to improve the effort.

9.3 Conclusions: From filling data gaps to realizing data opportunities

Lessons from across the case studies indicate that real-time data can, in the right circumstances and with the right enabling conditions, enable adaptive management. In settings where there are no political and institutional constraints to adaptation—and where the timeliness of information is the binding constraint on strategic and operational

improvements—real-time data systems can underpin and catalyze *data-driven tactical adjustments* and *data-enabled strategic adaptations*.

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However, in the development sector as a whole, adaptive success does not hinge primarily on investments in the timeliness or the accuracy of data, but rather on investment in the culture and mindset that determines how real-time data—and indeed all forms of data and evidence—are interpreted and used.

This message is clear across the case studies. Real-time data efforts aim to provide inputs into better decisions and to help decision makers be more data-driven. For the most part, this has led initiatives to focus on ways real-time data can fill gaps and satisfy needs within existing processes and systems—providing a technical means for improving performance. Data is treated as a *fix* to the problems of development interventions.

By contrast, adaptive management often requires decision making that is *data-led*, rather than *data-driven*. Data is used to "do things right" *and* to ask "what are the right things to do." Data can be less about filling gaps and more about triggering questions—an important potential value of real-time data efforts. Adaptive management uses data to interrogate, question, test, and probe assumptions and hypotheses. Adaptive management is less technical, and more social and political in nature. Adaptive management is a way of *rethinking* the problems of development interventions.

For the most part, real-time data initiatives are not built with such social and political ambitions—and should not be. And for the most part, adaptive management does not have such technical underpinnings. While the two kinds of initiatives should not be judged using yardsticks they don't use themselves, these distinctions do point to the potential for their integration.

This study proposes that the **ambition and scope** of real-time data initiatives must evolve and focus more on how to inspire and enable innovative and novel development practices. And adaptive management programs need to **change** too and expand the sources of information and technologies they draw upon—to realize the potential that real-time and digital data systems have in providing evidence for improved programs, policies, and practices. To support such improvements, further work is needed to examine how real-time data and adaptive management can be effectively integrated. At the same time, a different starting point is needed from that of the present study—one that asks whether and how the application of adaptive management in a particular context would allow real-time data to be used more effectively in projects and programs.

Such developments, if realized in timely and efficient ways, have considerable potential to inspire and underpin a new generation of development interventions that ultimately benefit poor and vulnerable groups. Many have called for new business models for development work that are more appropriate to the complex challenges of the twenty-first century. Our research suggests that this fusion of the latest technological and managerial advances could well provide an important element of such models.

A willingness and openness is needed among both those involved in real-time development initiatives and those working on adaptive management efforts to allow a number of shifts to take place: from data-driven optimization to data-led innovation; and from implicit, invisible adaptive decision-making approaches to explicit, transparent ones. In short, practioners of both areas have untapped value and benefits to lend the other. Development actors should continue to work to better understand and realize this value in practical terms.

The closing point is simple: the use of real-time data for adaptive management is not, paradoxically, about technology. It is about the strategic and cultural environment that

enables technology to be utilized as a driver of organizational decision making and of institutional transformation. While technology can certainly raise questions and opportunities, it cannot open the door to this kind of transformation in either programs or more broadly in organizations and alliances. As with other forms of evidence utilization, the key factors are political, institutional, and individual will.